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Loss framing effect on reducing excessive red and processed meat consumption: Evidence from Italy

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ABSTRACT

A reduction of meat consumption is crucial for addressing public health problems, especially in industrialized countries. Among low-cost interventions, emotionally provocative health-information strategies could be effective options in fostering meat reduction. Through an online experimental survey, administrated to a quota-based national sample ($N = 1142$), this study analysed the profile of Italians consuming red/processed meat above World Health Organization (WHO) recommended amounts. *Via* a between-subjects design, the research tested whether two health frame-nudges (societal impact and individual impact of over consumption) persuaded these individuals to reduce future meat consumption. Results showed that adhering to an omnivore diet, higher consumption of meat than peers, household size (larger) and positive moral perception of meat consumption increased the likelihood of overconsumption. In addition, both nudges proved to be effective in positively impacting future intentions to reduce meat consumption among individuals exceeding WHO recommended amounts. The two frame-nudges were more effective among females, respondents with children in the household and individuals with a low health status perception.

1. Introduction

Meat consumption significantly contributes to the intake of energy, fat, and protein, providing essential amino acids and a high number of micronutrients in an individual's diet (De Smet & Vossen, 2016; Ferguson, 2010; González, Marquès, Nadal, & Domingo, 2020). However, it has been demonstrated that overconsumption of meat can lead to serious health problems (Hielkema & Lund, 2021). In 2015, the World Health Organization (WHO) classified red meat as a probable human carcinogen and processed meat as a group one carcinogen. Numerous studies have associated high intake of red and processed meat in individuals' diets with an increased risk of cancer (*e.g.*, Domingo & Nadal, 2017; González et al., 2020). Specifically, overconsumption of processed meat has been associated with the possible development of colorectal and stomach cancer, while overconsumption of red meat has a positive association with colorectal, pancreatic, and prostate cancer (Bouvard et al., 2015). In addition to the risk of cancer, a high intake of red and processed meat is also associated with other diseases, including metabolic, cardiovascular, and kidney diseases (Luan, Wang, Campos, & Baylin, 2020; Tantamango-Bartley, Jaceldo-Siegl, Fan, & Fraser, 2013).

This information identifies overconsumption of red and processed meat as harmful to human health and provides a solid basis for the recommendation not to eat more than three servings of red meat per week. Additionally, it suggests avoiding or limiting processed red meat consumption as much as possible (World Health Organization, 2015).

Despite these recommendations, in many countries, and particularly in developed nations, red and processed meat continues to be consumed in excess (Carfora, Conner, Caso, & Catellani, 2020). Europeans, on average, consume 51 g of red meat per day (women consume an average of 33.1 g per day). In Italy, men consume an average of 57.8 g of red meat per day, whereas women consume 40.8 g (Carfora, Caso, & Conner, 2017).

A matrix of factors strongly hinders behavioural change among meat-loving consumers, although some recognise plant-based diets as credit-worthy practices (Ruby & Heine, 2011). Individuals who regularly eat red meat often associate their consumption with healthy and necessary practices (*e.g.,* Font-i-Furnols & Guerrero, 2022; Piazza et al., 2015). Specifically, they believe that it would be unhealthy to deprive the human body of nutrients available in meat, as eating meat is an inherent activity of humans who are omnivores by nature (Hopwood &

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Bleidorn, 2019). Other barriers, such as self-perception, social norms, and socio-demographic characteristics, seem to play an important role in the choice to consume meat in everyday diets (*e.g.,* Borusiak, Szymkowiak, Kucharska, Gálová, & Mravcová, 2022; Carfora et al., 2020; Migliore, Di Gesaro, Borsellino, Asciuto, & Schimmenti, 2015). In addition, meat eaters tend to avoid meat-related information that contradicts their existing values or beliefs (Loughnan, Haslam, & Bastian, 2010), known as *cognitive dissonance*, which occurs when a behaviour is inconsistent with their beliefs or attitudes (*e.g.,* love for animals). This inconsistency generates arousal, which subsequently leads to the desire to reduce the dissonant state (Buttlar & Walther, 2018; Rothgerber, 2020). However, individuals are unlikely to engage in dissonance reduction every time they eat meat since "eating meat" is a ritualised and ingrained habit often accompanied by low or no conscious reflection (Rothgerber & Rosenfeld, 2021). This condition provides suitable grounds for the application of *nudges*, where the use of salient triggers (such as *framing*) can generate ambivalent feelings about the natural desire to eat meat.

A key feature of nudging strategies is the alteration of choice architecture by leveraging cognitive biases (Thaler & Sunstein, 2009). For example, changing the default option to exploit individuals' tendency to passively accept defaults, thus inducing subjects to change their behaviour towards healthy or ethical positive choices that benefit society. Nudges do not impose material costs and are not mandatory; therefore, they are placed in contrast to traditional policy interventions (which aim to modify behaviour with mandates or bans or through subsidies and fines), generating a better impact-cost ratio (Benartzi et al., 2017; Shah, Mullainathan, & Shafir, 2012).

Recent reviews have outlined several strategies that implemented nudging to reduce meat consumption and promote more sustainable diets; *e.g.,* naming the vegetarian dish 'dish of the day', reducing the portion size of meat dish, increasing the visibility of the vegetarian option (for a complete overview see, among others, Kwasny, Dobernig, & Riefler, 2022 and Harguess, Crespo, & Hong, 2020).

Among these, the technique with a high percentage of application and variety of results is related to *framing*, declined as both textual (message) and visual (image/label) information (Vainio, Irz, & Hartikainen, 2018; Zickfeld, Kunst, & Hohle, 2018).

Framing exploits the heuristics of availability (information processing) and affect (immediate emotional response) to influence readers' decisions simply by focusing on the way information is presented rather than on the information itself (Newell, McDonald, Brewer, & Hayes, 2014). For example, people are willing to pay more for minced meat described as 75% lean than one described as 25% fat (Levin & Gaeth, 1988) and they demonstrate a higher preference for 80% fat-free chocolate compared to 20% fat chocolate (Braun, Gaeth, & Levin, 1997). Consequently, equivalent information may be appealing depending on the characteristics highlighted.

To try to change behaviour, information messages should state what is necessary for an individual to accept the message, i.e., specifically choose which message aspects to emphasise, to promote the desired behaviour (Entman, 1993). Many researchers have proposed messaging interventions focused on the health, environmental, and ethical consequences of high consumption of red and processed meat to raise awareness of the issue among meat lovers, in line with drivers reported as significant by consumers (Charlebois, McCormick, & Juhasz, 2016; Neff et al., 2018).

Specifically, most studies in the literature that use framing to enhance consumers' awareness of reducing meat consumption in their daily diet use either 'loss *vs.* gain' framing (Dolgopolova, Li, Pirhonen, & Roosen, 2021) or factual *versus* pre-factual framing (Bertolotti, Carfora, & Catellani, 2020; Bertolotti, Chirchiglia, & Catellani, 2016) in different combinations. In the first case, interventions framed in terms of gains were the most successful to increase the consumption of plant-based alternatives. Conversely, interventions presented in terms of loss were the most effective to convey a message to individuals confident of their actions (Carvalho, Godinho, & Graça, 2022). In the second case, health/safety messages had stronger effects on participants' engagement, attitudes, and intentions to change dietary behaviour when framed in factual terms (*i.e.,* describing the actual effects of certain behaviours, such as an unbalanced diet) rather than pre-factual terms (*i.e.,* describing hypothetical future effects as a consequence of hypothetical present behaviours) and *vice versa* for wellness/growth messages (Bertolotti et al., 2016; Bertolotti et al., 2020).

To the best of our knowledge, no study has been conducted on the effect of 'societal' *versus* 'individual' framing in reducing red meat consumption. As reported in Nan (2007) study, which investigated the influence of social distance on individuals' responses to persuasive messages, a social frame can be defined as a message strategy that focuses on the implications of adherence or non-adherence to advocacy for society in general (*i.e.,* taking public transport instead of driving a car provides cleaner air for people in the community). An individual framework, on the other hand, emphasises the consequences of compliance or non-compliance for the individual (*i.e.,* taking public transport instead of driving a car, for daily commuters, provides cleaner air for you). In the literature, these types of framing are generally used to provide environmental safeguards (Graham & Abrahamse, 2017). Indeed, it represents a social issue that needs to be addressed by everyone, both as individuals and members of society. Specifically, Graham and Abrahamse (2017) explained that messages aimed at individuals leverage self-improvement values, while those centred on society involve self-transcendence values. As the meat consumption issue also relates to the sphere of sustainability and involves the individual consumer, as well as society as a whole, it would be interesting to understand whether messages framed in terms of individuality *vs.* society can be effective in influencing beliefs and behaviours in favour of reducing red and processed meat consumption specifically.

Based on these premises, the current research has a twofold objective:1) identifying and describing the profile of consumers of red and processed meat above WHO recommendations among a stratified Italian sample, focusing on the drivers that specifically motivate and identify those who consume excessive amounts of meat and, thus, are more at-risk to the associated health consequences; 2) testing the effectiveness of nudges in influencing change intentions of this at-risk segment, investigating whether messages presenting the negative outcomes of red and processed meat consumption on individual and social health have an effect on future intentions to reduce red and processed meat consumption.

2. Materials and methods

2.1. Data collection

An online experimental survey[1] was administered in September 2021 by a professional market research agency that abides by the ICC/ESOMAR International Code on Market and Social Research (ICC/ESOMAR, 2008) to a stratified Italian national sample. Screening criteria were that the participants be aged ≥18 years, at least partially responsible for household food shopping, and red/processed meat consumers (at least once every 15 days). Respondents who reported being vegetarian or vegan were excluded ($n = 8$). The average time to complete the survey was 15 min; all respondents who completed the questionnaire in less than half of the median duration or failed the attention check, demonstrating inattentiveness, were excluded from the dataset ($n = 25$). The final sample included 1142 individuals aged between 18 and 67 years (mean age 44.12) distributed almost equally by gender (52.5% women). Most participants reported consuming an omnivorous diet

[1] The questionnaire was pre-tested online in two, separate waves to fine-tune the nudge frames and food habits questions on two convenience samples ($n = 20$ and $n = 45$); these results are not included in the current study.

(90.4%), while a smaller percentage consumed only certain types of meat (9.6%). All data were collected, recorded, and managed in accordance with the Declaration of Helsinki and the "Italian Personal Data Protection Code" (Law Decree no. 196 of 30 June 2003).

2.2. Experimental procedure

The experimental survey used a between-subjects design (Fig. 1). The questionnaire was the same for the entire sample, except for the nudge section, where each subgroup read a differentiated message (see the subsequent section for more details). Eligible participants first answered a series of questions on food habits, meat consumption, and purchasing habits. Respondents then provided psychographic and sociodemographic information to complete the survey. Multiple randomisation techniques were employed during the administration of the survey to reduce common method bias and enhance the validity of the responses. Based on a prior power analysis, it was determined that a minimum sample of 150 participants per condition was needed to detect differences among groups, given the medium and expected effect size, and an alpha level of 0.05 and 80% power (Cohen, 1992). The expected effect size was based on the findings of a recent meta-analysis of healthy eating nudges (Cadario & Chandon, 2020). All participants provided informed consent prior to participating in the online survey.

2.3. Nudge-frame

Participants were randomly assigned to one of three different conditions: a control condition in which no information message on the consequences of excessive meat consumption was reported, and two treatment conditions in which individuals read a different version of a short text (64 words) on the negative impact of excessive consumption of red/processed meat (Table 1 contains the full text). The text reports the results of WHO studies on the effects of red meat intake. Depending on the nudge treatment, the content of the article either focused on the irreversible consequences of a high intake of red and processed meat in terms of death, capturing the influence of the phenomenon at a global level (social nudge), or with a focus on the individual, the exposure to the increased risk of developing cancer and other chronic diseases linked to the regular and constant consumption of red or processed meat in the daily diet (individual nudge).

In both the section before the nudge and after reading the manipulated message, participants answered an identical self-reported meat-eating intention question as follows: "Considering your current consumption, do you believe that in the future your consumption of red and processed meat will be..." with 'more', 'the same', or 'less' as possible response options. Thus, comparing the responses before and after the nudge treatment allowed us to measure the effectiveness of the two treatments.

The choice of a health appeal (rather than ethical issues) and framing in terms of loss (rather than gain from more plant-based diets) of the communicated message is strongly linked to the target segment selected. Previous research found that health appeals appeared to have a stronger effect on intentions to reduce meat consumption than environmental appeals (Cordts, Nitzko, & Spiller, 2014) and seemed to be particularly effective when framed in factual terms (Bertolotti et al., 2016). A possible explanation for the stronger effect of health appeals could be that selfish motivations, such as health consciousness or simply greater familiarity with health, generally tend to influence food consumption more strongly than altruistic motivations (Birch, Memery, & Kanakaratne, 2018). This is especially true for conscious meat consumers who, very often, do not associate meat consumption with environmental impacts nor consider it a climate change mitigation option (Campbell-Arvai, 2015; de Boer, de Witt, & Aiking, 2016. Indeed, appeals with an environmental or animal welfare background have been effective in changing behavioural intentions within the group of meat sceptics or, in general, in those who were already sensitive towards ethical issues, but not in meat believers (Palomo-Vélez, Tybur, & Van Vugt, 2018; Vainio et al., 2018; Ye & Mattila, 2021). Therefore, applying a health framework appears to be the most functional approach. Similarly, if the aim is to increase the likelihood of influencing the processing and thus the evaluation of a message by highly convincing interlocutors, it is more effective to inculcate feelings of fear related to negative consequences and thus a loss frame (Carfora, Pastore, & Catellani, 2021; De Hoog, Stroebe, & De Wit, 2007; Tannenbaum et al., 2015). Previous studies have shown that avoiding negative consequences can be more effective than presenting an otherwise equivalent gain (*i.e.,* the experience of losing an amount of money is greater than that of winning the same amount of money). These findings are consistent with the tenets of Prospect Theory on loss aversion (Kahneman & Tversky, 2013), while acknowledging the limitation of a reduced perception of choice freedom (Psychological Reactance Theory - Brehm & Brehm, 2013). Although recent studies have pointed out that the gain frame is more effective in guiding consumers to reduce meat consumption, it is important to highlight that these are exhortative appeals to increase the consumption of plant alternatives (Carfora et al., 2021; Carvalho et al., 2022) rather than focusing on discouraging red meat consumption (as in our case). According to Rothman and Salovey (1997), gain-framed messages should be more effective than loss-framed messages in promoting health behaviours perceived as minimally risky to perform (openness to

Table 1
Different framing of the consequences of overconsumption of red/processed meat (translated from Italian).

NUDGE 1: Social consequences	*NUDGE 2: Individual consequences*
The World Health Organization (WHO) classified red meat as a possible carcinogen, meaning it could cause cancer. Based on estimates from the Global Disease Burden Project, the WHO states that >34.000 cancer deaths per year worldwide are attributable to high intake of processed meat, while the total number of deaths attributable to a diet rich in red meat was 644.000.	The World Health Organization (WHO) classified red meat as a possible carcinogen, meaning it could cause cancer. Just 50 g of red or processed meat consumed in a regular daily diet can increase cancer incidence by 18%. It is known that high consumption of red or processed meat can increase the risk of other chronic diseases (such as stroke and type II diabetes).

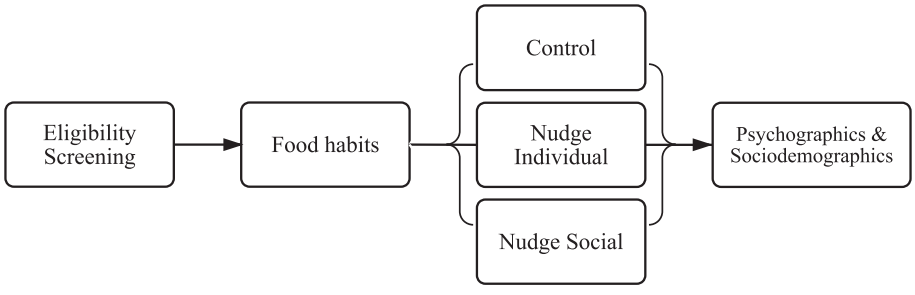

Fig. 1. Experimental design scheme.

alternatives to meat). Loss-framed messages should be more effective for health behaviours perceived as having a higher degree of risk associated with their execution.

2.4. Measures

The questionnaire was structured as follows: The initial screening question was "How often did you consume red meat on average in the last 6 months (*i.e.,* beef, cows, calves, horses, pigs, sheep, and goats)?" with useful answer options for not being excluded ranging from 'every day' to 'more than once every 15 days'. The same question was then asked specifically for processed meat consumption (including as examples: canned meat; dried meat; cured meats: bacon, raw/cooked ham, and bresaola; sausages: salami, frankfurters, and mortadella), with response options from 'every day' to 'never'. In addition to questions about the consumption frequency of specific food groups, individuals were asked which diet was closest to their own habits (Piazza et al., 2015) among omnivorous *i.e.,* 'I consume all animal products except those excluded due to preference/allergy/religious reasons', semi-vegetarian *i.e.,* 'I consume some, but not all of the following food products: red meat, poultry, fish.' Consumption of eggs and dairy products or vegetarian/vegan (excluded from analysis). The starting hypothesis was that respondents with a diet more inclined towards vegetarian consumption would be more susceptible to the reported message.

Self-reported measures were collected to frame the respondent's awareness and future intention to reduce personal consumption of red/processed meat, in comparison to their peers;–'Comparing yourself to other people of the same sex and age, would you say that your consumption of red/processed meat is…' - and society – 'Considering society's current consumption, do you believe that in the future consumption of red/processed meat will be…' (adapted from Cordts et al., 2014). The aim was to determine how many meat lovers were aware of their own consumption contextualised to others' behaviour. Similarly, to detect awareness of their own health status, respondents were asked to answer on a 7-anchored scale how they perceive their overall health status (1 = 'very bad' and 7 = 'very good') (Cordts et al., 2014). Using a scale of 1 to 7, where 1 is 'not at all willing' and 7 is 'completely willing', respondents were asked about their tendency to take risks in everyday life, to assess how much this trait could actually affect the WHO warning message.

Linked to behavioural beliefs, the perceived social pressure from significant others to perform a behaviour was also included in the questionnaire. We referred to Berndsen and Van der Pligt (2004)'s study, which uses a two-item scale: the first concerns the perceived social pressure *i.e.,* 'People important to me think I should eat meat'; the second item measured the motivation to comply *i.e.,* 'How much do you want to do what these important people think you should do?' The respondents answered on a 7-anchored scale from 1= 'not at all', to 7 = 'very much'.

The 8-item scale developed by Roininen, Lähteenmäki, and Tuorila (1999) was used (referred as GHI) to obtain an indication of the participants' general interest in health. The respondents expressed their degree of agreement on a 7-point scale, where 1 = 'totally disagree' and 7 = 'totally agree'. Previous research suggests that a high score on this scale is associated with healthier food choices, and conversely with a less balanced diet.

Finally, the socio-demographic characteristics of the sample were collected, *i.e.*, sex at birth, age, weight, height, household size, presence of children under 12 years old in the household, educational level, and income.

2.5. Data analysis

The collected data were processed using the statistical software STATA 16. Cronbach's alpha was calculated to assess internal consistency among the scale items applied. For both the GHI and the subjective norm, a score of 0.78 revealed a high coherence of respondents' answers with consequent use of the average value for each scale in the subsequent elaborations (Nunnally & Bernstein, 1967). Analyses were conducted for the total sample and separately according to the subgroups. Pairwise comparisons, ANOVA followed by post-hoc Bonferroni test, and non-parametric tests were used to monitor the statistical differences between the subgroups and the effectiveness of the nudge treatments. Subsequently, correlation analyses explored the relationships among the potential independent variables to be applied in econometric modelling. Finally, a binary logistic regression model (see Appendix for equation details) was implemented to delineate the profile of red/processed meat consumers above the WHO recommendations, and further statistical tests identified the drivers that positively influenced the effectiveness of the applied nudges.

3. Results

3.1. Sample description

The final sample included 1142 Italian red/processed meat consumers. Based on self-reported consumption frequencies of red and processed meats, we identified two groups of individuals: *i)* respondents who consumed red/processed meat in excess of the quantities recommended by the WHO; *i.e.,* red meat more than thrice a week or processed meat at least once (= above WHO recommendations), and *ii)* respondents who consumed meat within portions recommended by the WHO in terms of red/processed meat; *i.e.,* red meat equal to or less than thrice per week and no consumption of processed meat (within WHO recommendations). Table 2 shows the characteristics of the total sample and the two subgroups in detail.

3.2. Profile of red/processed meat consumers above WHO recommendations

The first goal was to identify the profile of individuals consuming red/processed meat above the amounts recommended by the WHO. For this purpose, logistic regression was applied: the dependent variable is a dummy 'above WHO recommendations' set as 1 if the respondent consumed red/processed meat more than WHO recommendations and 0 if the respondent consumed red/processed meat according to WHO recommendations. Table 3 details all the variables used in the logit model.

Table 4 presents the logit model results for the entire sample. In relation to socio-demographic characteristics, neither gender nor age was statistically significant in discriminating between meat eaters within and above the WHO recommendations. Instead, as BMI increases, the likelihood of consuming red/processed meat above the recommended amounts decreases; as the number of members in the household increases, the likelihood of being over the WHO recommendation surges. Considering the diet, consuming all animal products without exclusion (except for allergies/preferences) increases the probability of belonging to the above WHO category compared to consuming only specific types of animal products (semi-vegetarian). Related to the self-perception questions, feeling more or less healthful (or a different propensity to risk) did not discriminate the amount of red/processed meat consumed. However, the WHO group is aware of the high consumption of red/processed meat. First, the perception that their personal consumption is greater than or equal to that of their peers increases the likelihood of being above WHO recommendation. Similarly, the perception that society's future consumption will be lower than the current consumption increases the likelihood of belonging to the above WHO group. Finally, according to the psychographic scales collected, an increased general interest in health reduces the likelihood of eating more red/processed meat than the recommended portions, and as the moral perception that eating meat is an expected attitude of people

Table 2
Sample characteristics.

		Total Sample (N = 1142)	Above WHO recommendations (n = 712)	Within WHO recommendations (n = 430)
Sex at birth	*Female*	596 (52.2%)	360 (50.6%)	236 (54.9%)
	Male	546 (47.8%)	352 (49.4%)	194 (45.1%)
Age	*Mean ± S.D.*	44.37 ± 12.02	43.99 ± 11.85	44.99 ± 12.28
BMI	*Mean ± S.D.*	25.95 ± 11.19	25.57 ± 7.87	26.58 ± 15.15
Household size	*1 component*	101 (8.8%)	55 (7.7%)	46 (10.7%)
	2 components	316 (27.7%)	182 (25.5%)	134 (31.2%)
	3 components	335 (29.3%)	221 (31%)	114 (26.5%)
	4 components	306 (26.8%)	202 (28.4%)	104 (24.2%)
	5 components	73 (6.4%)	46 (6.5%)	27 (6.3%)
	6 components	7 (0.6%)	4 (0.6%)	3 (0.7%)
	>6 components	4 (0.4%)	2 (0.3%)	2 (0.4%)
Children in the household (<12 years)	*Yes*	1041 (91.2%)	657 (92.3%)	384 (89.3%)
	No	101 (8.8%)	55 (7.7%)	46 (10.7%)
Education	*Not graduated*	733 (64.2%)	454 (63.8%)	279 (64.9%)
	Graduate or higher	409 (35.8%)	258 (36.2%)	151 (35.1%)
Monthly income	*Very low*	113 (9.9%)	71 (10%)	42 (9.8%)
	Low	414 (36.3%)	250 (35.1%)	164 (38.1%)
	Medium	511 (44.7%)	316 (44.4%)	195 (45.4%)
	High	104 (9.1%)	75 (10.5%)	29 (6.7%)
Health perception	*Mean ± S.D.*	3.11 ± 1.33	3.09 ± 1.33	3.14 ± 1.13
Risk perception	*Mean ± S.D.*	3.13 ± 1.49	3.18 ± 1.49	3.05 ± 1.50
Diet	*Omnivore*	1032 (90.4%)	672 (94.4%)	360 (83.7%)
	Semi-vegetarian	110 (9.6%)	40 (5.6%)	70 (16.3%)
Personal *Vs.* peers' meat consumption	*Lower*	104 (9.1%)	87 (12.2%)	17 (4%)
	Equal	699 (61.2%)	464 (65.2%)	235 (54.6%)
	Higher	339 (29.7%)	161 (22.6%)	178 (41.4%)
Society's future meat consumption *Vs.* current	*Lower*	64 (5.6%)	46 (6.5%)	18 (4.2%)
	Equal	597 (52.3%)	363 (51%)	234 (54.4%)
	Higher	481 (42.1%)	303 (42.5%)	178 (41.4%)
Future *Vs.* current meat consumption	*Lower*	27 (2.4%)	19 (2.7%)	8 (1.9%)
	Equal	873 (76.4%)	557 (78.2%)	316 (73.5%)
	Higher	242 (21.2%)	136 (19.1%)	106 (24.6%)
Subjective norm	*Mean ± S.D.*	3.80 ± 1.58	3.96 ± 1.59	3.54 ± 1.52
GHI	*Mean ± S.D.*	4.70 ± 0.98	4.60 ± 0.97	4.85 ± 0.98

important for the respondent increases, the probability of eating more meat increases.

3.3. Impact of the nudge-framings

The second objective of this research was to test whether nudges were able to decrease future consumption intention of red/processed meat among those who exceeded the recommended amount. Therefore, our analysis focused on 712 individuals who consumed above the WHO suggestion and were randomly assigned to one of the three study conditions. The Hotteling test confirmed successful randomisation, proving homogeneity between the subgroups in sociodemographic terms. As previously outlined, the respondents answered the same question regarding their future intention to consume red/processed meat at two distinct times during the questionnaire. Table 5 shows the percentage of respondent selections for each subgroup. For the control subgroup, the 'before' and 'after' percentages were not associated with any persuasive messages but represented a neutral follow-up condition. The difference between the same question posed at two distinct times in the questionnaire was not statistically different, underlining the consistency of the responses provided by the respondents. For the nudge treatment subgroups, the 'before' and 'after' percentages concern the answers to the same question presented before and after the framed message. In both subgroups, nudge individual and nudge social, the percentages were statistically different, with a higher rate of individuals above the WHO recommendations planning to reduce future consumption of red/processed meat after reading the text. In particular, 50 respondents out of 243 in the nudge social subgroup and 52 respondents out of 246 in the nudge individual subgroup were affected by the nudge and stated that they intended to reduce future consumption of red/processed meat after being informed. Thus, both nudges proved to convince individuals towards the future reduction of red and processed meat intake (compared to the neutral condition). Framing messages in individual or social terms did not differ in overall effectiveness.

Mean-comparison and Pearson's chi-squared tests were performed to identify potential key traits discriminating the consumers of meat influenced by nudge (102 in total) from the 387 respondents who did not change their intention about future meat consumption after reading the loss frame. Significantly more females than males were affected by the nudge (*p-value:*0.004). Likewise, information messages acted significantly on respondents with children under 12 (*p-value:*0.089) and respondents with a larger household size (*p-value:*0.065). The perception of individuals' own state of health was also statistically significant (*p-value:*0.000); the treatments impressed respondents who self-reported being in poor health more than those with a positive perception of their own state. In contrast, neither a different intensity of risk perception (*p-value:*0.799) nor a semi-vegetarian (as opposed to omnivorous, *p-value:*0.249) diet was statistically significant in discriminating respondents' different susceptibilities to nudge (for further details, see Tables A1-3 in the Appendix).

4. Discussions

The current study analysed the profile of Italians who consume red and processed meat above WHO recommended amounts and tested whether two health nudges, framed differently, persuaded at-risk consumers to reduce their future meat consumption.

A detailed characterisation of individuals who fell outside the recommended quantities was performed to analyse how nudges may contribute to the reduction of meat consumption and achieve the goal set through systematic steps (Michie et al., 2011). Almost three-quarters of the sample (62.35%) consumed red/processed meat above the

Table 3
Variables applied in the logit model.

Variable	Description	Variable type and coding
Sex	Sex at birth	Dummy: 1 = women, 0 = men
Age	Age in years	Continuous
BMI	Body mass index = weight (in kg)/ height^2 (in m)	Continuous
Household size	Number of household members	Ordinal: 1 = "one component" to 7 = "more than six components"
Income	Average monthly household income	Dummy: 1 = high, 0 = medium/low
Omnivore	Consumption of all animal products, except those excluded for preference/allergy/ religious reasons	Dummy: 1 = omnivore, 0 = semi-vegetarian
Health perception	Perception of own health status in general	Continuous (1–7)
Risk perception	Tendency to take risks in everyday life	Continuous (1–7)
Peer consumption	Own consumption of red/ processed meat compared to peers	Dummy: 1 = "own cons > or = peer cons", 0 = "peer cons > to own cons"
Society consumption	Future consumption (compared to current consumption) of red/ processed meat by society	Dummy: 1 = lower, 0 = equal or higher
GHI	General interest in health	Continuous (1–7)
Subjective norm	Moral perception that eating meat is expected by important people in one's life	Continuous (1–7)
Above WHO recommendations	Frequency of red/processed meat consumption compared to WHO recommendations	Dummy: 1 = "exceeding WHO recom.", 0 = "within WHO recom."

Table 4
Drivers of red/processed meat over consumption - Odds ratio estimates of logit regression (with standard errors in parentheses) on the whole sample (N = 1142) on being among the above WHO recommendations subgroup.

Parameter	Odds ratio
Sex	0.950 (0.126)
Age	1.005 (0.006)
BMI	**0.989 * (0.006)**
Household size	**1.124 ** (0.065)**
Income	1.072 (0.142)
Omnivore	**2.336 *** (0.522)**
Health perception	0.941 (0.947)
Risk perception	1.036 (0.046)
Peer consumption	**2.067 *** (0.313)**
Society consumption	**1.537 *** (0.214)**
GHI	**0.826 *** (0.058)**
Subjective norm	**1.124*** (0.048)**
Constant	0.505 (0.306)
Pseudo R^2	0.06
Chi^2	94.32 ***

Note: ***, **, * represent statistical significance at $p < 0.01$, $p < 0.05$ and $p < 0.1$ respectively.

quantities recommended by WHO. A relevant number of individuals overconsume red and processed meat, which is in line with the findings of other European countries (Guyomard et al., 2021).

With reference to the first research question, neither age nor gender was found to be statistically significant in discriminating consumers who consume red/processed meat beyond WHO recommendations. These outcomes contrast with recent studies that identified male and older age groups as 'unrestricted omnivores' (Kemper, Benson-Rea, Young, & Seifert, 2023; Malek & Umberger, 2021). Another relevant finding was the strong awareness of the high consumption of red and processed meat by respondents lying above WHO recommendations. Declaring that they consume more meat than their peers and that society will inevitably be linked to a lower consumption of red and processed meat underlines how widespread the issue is (in general) and at least known by Italian consumers. However, the subsequent and fundamental transition from awareness to the implementation of healthy behaviour involves a series of equally well-established individual and social gaps. As the current analysis reveals, identifying oneself as a carnivore and having a high level of awareness can be a barrier to change (Wolstenholme, Carfora, Catellani, Poortinga, & Whitmarsh, 2021), regarding the identity-behaviour link. Self-image predicts intentions (Rise, Sheeran, & Hukkelberg, 2010; Whitmarsh & O'Neill, 2010), influences behaviour (Hagger, Anderson, Kyriakaki, & Darkings, 2007), and prompts action in line with self-perception. It iterates that an implemented behaviour becomes a habit, and the choice to consume meat requires no further reflection because it is consistent with one's identity and, therefore, right (de Boer, Schösler, & Aiking, 2017; Ueland, Rødbotten, & Varela, 2022). A low personal interest in health decreases attention towards a balanced and healthy diet by ignoring the associated consequences, such as, in the case of red meat, an increased risk of developing chronic diseases. Consistent results were found in the studies of Malek, Umberger, and Goddard (2019) and Bogueva, Marinova, and Raphaely (2017), wherein respondents avoided consuming red meat because it was associated with health problems and thus prevented disease as for greater body weight control (Cheah, Shimul, Liang, & Phau, 2020).

The current findings also suggest that social pressure, whether related to the family context or trusted people, plays a relevant role in food choices. Having friends who promote and support a meat-rich diet discourages the eventual adoption of alternative protein options, and the likelihood of being a consumer of health recommendations increases with family size. As already found by Videira, Antunes, Scholl, Gaetaniello, and Reisch (2011), a large number of family members assume greater complications in the implementation of the choice to reduce meat consumption. Indeed, the preparation of healthier dishes requires additional culinary skills and preparation time, even more so if one must satisfy the diverse tastes of loved ones (Videira et al., 2011). Moreover, if it is already difficult to manage changes in routine, lack of family support may discourage consumers from reducing meat consumption (Markowski & Roxburgh, 2019). Similar to Carfora et al. (2020) and Higgs (2015), this study revealed that as the perception that eating meat is an expected attitude of loved ones increases, the likelihood of consuming meat increases.

Once the profile of red and processed meat consumers was identified according to WHO's recommended guidelines, the effectiveness of a

Table 5
Comparison of pre- and post-treatment responses to the question "future Vs. current red/processed meat consumption" for each subgroup and results of the Kruskal-Wallis test.

In the future, your consumption of red/processed meat will…	Total Above WHO (n = 712)		Control (n = 223)		Nudge social (n = 243)		Nudge individual (n = 246)	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
Increase	2.7%	2%	2.7%	3.1%	2.5%	1.2%	2.8%	1.6%
Be the same	78.2%	64.3%	79.4%	74%	82.3%	65%	73.2%	54.9%
Decrease	19.1%	33.7%	17.9%	22.9%	15.2%	**33.8%**	24%	**43.5%**
Kruskal-Wallis equality-of-populations rank test			1.213		22.68 ***		20.83 ***	

Note: ***, **, * represent statistical significance at $p < 0.01$, $p < 0.05$ and $p < 0.1$ respectively.

nudge technique, *i.e.,* framing, was tested in reducing meat consumption by leveraging the associated personal and public health consequences. On average, the treatments (both individual and society-related consequences) yielded significantly higher intentions (21%) to reduce future consumption of red and processed meat than the control group that received no information (7%, *p-value* < 0.01).

Similar results were also found in previous studies (Bertolotti et al., 2016; Cordts et al., 2014; Vainio et al., 2018), where reading about the negative effects of meat consumption on a variety of topics (health, animals, environment, misinformation) reduced meat-eating intentions compared to the control group or, highlighting that product sustainability attributes (rather than nutrition or indulgence information) significantly influenced the consumption of reduced-meat burgers (Sogari et al., 2022). However, the effectiveness of appeals for reducing meat consumption is mixed; while Palomo-Vélez et al. (2018) suggest that framing meat consumption as a health problem can reduce future meat-eating intentions. Vainio et al. (2018) revealed that reading an essay highlighting the health consequences of meat fails to change people's eating habits. Similarly, Whitley, Gunderson, and Charters (2018) failed to show any effect of environmental, health, and animal welfare appeals in supporting alternative dietary policies to meat. Therefore, the current results challenge previous findings that habitual food choices can be notoriously difficult to change, and that communication through messages alone is generally not effective in altering food choices (Downs, Loewenstein, & Wisdom, 2009), including influencing regular, convinced consumers of red meat (Vainio et al., 2018; Vermeir & Verbeke, 2006).

Changing attitudes is more effective when messaging interventions are custom-designed considering individuals' values and stages of change (Arnaudova, Brunner, & Götze, 2022). For example, based on the present outcomes, the individual responsibility reminder might have acted on people who already felt they had an underlying problem (*i.e.,* less than a positive perception of their health status) and therefore wished to avoid further negative implications. Similarly, the society-focused message might have been viewed as one about individual responsibility to deal with society's problems. This realisation of how seriously underestimating the high consumption of red and processed meat can be, as well as personally affecting unhealthy and overweight meat consumers, mainly affects women, respondents with children in the family, and respondents with a high family size. In line with other studies, females display a higher sensitivity to health messages (Reisch, Sunstein, & Gwozdz, 2017), a higher degree of health awareness than males (Grzymisławska, Puch, Zawada, & Grzymisławski, 2020) and appear to be more pro-socially motivated to follow a vegetarian diet (Rosenfeld, 2020) resulting in a higher likelihood of reducing meat consumption (Sanchez-Sabate & Sabaté, 2019). Similarly, families with children welcome the message as they are more open to a diet characterised by varied protein sources (Merlino, Borra, Verduna, & Massaglia, 2019). Thus, while the subgroup beyond the recommendations was aware of personal meat consumption, a portion of those receiving the nudge treatment (21%) were not informed about the real associated consequences, enough to lean towards a future reduction after the information message.

The present results add to the literature on the effectiveness of nudge techniques in the transition to more sustainable diets (Arno & Thomas, 2016; Friis et al., 2017; Kurz, 2018; Marcano-Olivier, Horne, Viktor, & Erjavec, 2020; Mohr, Dolgopolova, & Roosen, 2019; Sihvonen & Luomala, 2017) and enrich the literature on the use of framing as a low-cost strategy for reducing meat consumption (Whitley et al., 2018).

This study has several limitations that should be considered when interpreting the results and drawing more general conclusions. The first limitation is related to the wide evidence of the intention-behaviour gap in stated preferences research, as this study only measured the effect on intentions rather than actual behaviour. In the survey, individuals were requested to provide self-reported measurements that were also prone to important bias (*e.g.,* social desirability). Furthermore, online surveys are particularly prone to self-selection bias, which impacts the overall external validity of the findings. Future studies should aim to collect behavioural data in real-life settings, such as inside supermarkets, restaurants, and canteens. Moreover, respondents' level of trust in the message content and information source was not measured. Future studies should monitor this relevant aspect to highlight that the probability of framing ineffectiveness is exclusively related to the low relevance of the information content, rather than a lack of credibility in the source or message itself. Moreover, concerning framing, the current study analyzes the same topic by tackling it with different messages in two distinct frames (individual/social). Future studies should carefully consider that even with different messages, the information content should be exactly the same in all experimental conditions, avoiding the addition of potentially relevant information and thus minimising bias. Finally, the current study analysed the immediate and short-term effects of nudges, while it would be very useful to measure the impact of such techniques over a longer period by performing longitudinal research.

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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. Appendix

A.1. Detailed explanation of logit model

The logistic regression model is a non-linear transformation of the linear regression. The distribution is an S-shaped distribution function and constrains the estimated probabilities to lie between 0 and 1 (Gujarati & Porter, 1999). The logit model for the present analysis is specified as:

$$p_i = F(z_i) = F(\alpha + \delta\, x_i) = \frac{1}{1 + exp^{-z_i}}$$

Where:

p_i is the probability that respondent consumes more red and processed meat than the amount recommended by the WHO given the independent variables as x_i;

$F(z_i)$ is the value of the logistic cumulative density function associated with possible value of underlying index z_i;
α is the intercept;
And $\delta\ x_i$ is the linear combination of independent variables.

$$z_i = log\left(\frac{p_i}{1-p_i}\right) = \delta_0 + \delta_1 x_1 + \delta_2 x_2 + \ldots + \delta_n x_n + \varepsilon$$

Where: $i = 1,2, \ldots n$ observations.
z_i is the log odds of choice for the i-th observation;
x_n is the n-th explanatory variable for the i-th observation;
δ is the parameter to be estimated.
And ε is the error term.
The dependent variable z_i in the above equation is the logarithm of the probability that a particular choice will be made.
The formal, complete equation is therefore:

$$\begin{aligned} above\ WHO\ raccomendations = &\delta_0 + \delta_1 Sex_i + \delta_2 Age_i + \delta_3 BMI_i + \delta_4 Household\ size_i + \delta_5 Income_i + \delta_6 Omnivore_i + \delta_7 Health\ perception_i + \delta_8 Risk\ perception_i \\ &+ \delta_9 Peer\ consumption_i + \delta_{10} Society\ consumption_i + \delta_{11} GHI_i + \delta_{12} Subjective\ norm_i + \varepsilon \end{aligned}$$

Table A1
Key variables of individuals consuming "above WHO recommendations" who received the frame-nudges. The table presents the results of the specific tests between the subgroup treatments.

Nudged (n = 489)		Individual and Social Nudges		Test results
		Effective (n = 102)	Not effective (n = 387)	
Sex at birth [a]	Female	63.7%	47.8%	8.190 ***
	Male	36.3%	52.2%	
Children in the household (<12 years) [a]	Yes	96.1%	90.0%	2.88 *
	No	3.9%	10.0%	
Household size [a]	1 component	3.9%	9.0%	11.09 *
	2 components	19.6%	26.1%	
	3 components	36.3%	28.2%	
	4 components	31.4%	29.5%	
	5 components	7.8%	6.2%	
	6 components	0%	1.0%	
	>6 components	0.98%	0%	
Omnivore[a]	Yes	92.2%	95.1%	1.332
	No	7.8%	4.9%	
BMI [b]		26.46	25.60	0.861
Health perception [b]		3.53	2.96	0.573 ***
Risk perception [b]		3.11	3.20	0.091

Note: ***, **, * represent statistical significance at $p < 0.01$, $p < 0.05$ and $p < 0.1$respectively.
[a] Pearson's chi^2 test was performed for dichotomous and categorical variables.
[b] Two-sample test was performed for continuous variables.

Table A2
Key variables of individuals consuming "above WHO recommendations" who received the Individual consequences frame-nudge.

Individual consequences (n = 246)		Individual Nudge		Test results
		Effective (n = 52)	Not effective (n = 194)	
Sex at birth [a]	Female	53.9%	48.9%	0.390
	Male	46.1%	51.1%	
Children in the household (<12 years) [a]	Yes	94.2%	91.2%	0.492
	No	5.8%	8.8%	
Household size [a]	1 component	5.8%	8.7%	7.405
	2 components	25.0%	28.4%	
	3 components	38.5%	27.8%	
	4 components	25.0%	26.8%	
	5 components	3.8%	6.2%	
	6 components	0%	2.0%	
	>6 components	1.9%	0%	
Omnivore[a]	Yes	94.2%	95.4%	0.113
	No	5.8%	4.6%	
BMI [b]		25.30	25.83	0.534
Health perception [b]		3.56	2.99	0.563 ***
Risk perception [b]		3.35	3.21	0.130

Note: ***, **, * represent statistical significance at $p < 0.01$, $p < 0.05$ and $p < 0.1$respectively.
[a] Pearson's chi^2 test was performed for dichotomous and categorical variables.
[b] Two-sample test was performed for continuous variables.

Table A3
Key variables of individuals consuming "above WHO recommendations" who received the Social consequences frame-nudge.

Individual consequences (n = 243)		Social Nudge		Test results
		Effective (n = 50)	Not effective (n = 193)	
Sex at birth [a]	Female	74.0%	46.6%	11.92 ***
	Male	26.0%	53.4%	
Children in the household (<12 years) [a]	Yes	98.0%	90.7%	2.957 *
	No	2.0%	9.3%	
Household size [a]	1 component	2.0%	9.3%	7.097
	2 components	14.0%	23.8%	
	3 components	34.0%	28.5%	
	4 components	38.0%	32.1%	
	5 components	12.0%	6.2%	
	6 components	0%	0%	
	>6 components	0%	0%	
Omnivore[a]	Yes	90.0%	94.8%	1.592
	No	10.0%	5.2%	
BMI [b]		27.66	25.36	2.304 **
Health perception [b]		3.50	2.92	0.583 ***
Risk perception [b]		2.86	3.18	0.321

Note: ***, **, * represent statistical significance at $p < 0.01$, $p < 0.05$ and $p < 0.1$respectively.
[a] Pearson's chi^2 test was performed for dichotomous and categorical variables.
[b] Two-sample test was performed for continuous variables.

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