Sustainable Production and Consumption 39 (2023) 451–465

Contents lists available at ScienceDirect

Sustainable Production and Consumption

journal homepage: www.elsevier.com/locate/spc

Consumer concerns over food insecurity drive reduction in the carbon footprint of food consumption

Selene Righi [a,b], Elena Viganò [a], Luca Panzone [c,d,*]

[a] Department of Economics, Society, Politics, University of Urbino Carlo Bo, Italy
[b] Department of Agriculture, Food and Environment, University of Pisa, Italy
[c] School of Natural and Environmental Sciences, Newcastle University, UK
[d] The Alan Turing Institute, UK

ARTICLE INFO

Editor: Dr. Laura Piscicelli

JEL Classifications:
C21
C83
D12
D91
H41
Q54

Keywords:
Consumer behaviour
SEM
Sustainability
Food security
Carbon footprint
Consumer concerns

ABSTRACT

Food security is increasingly a societal concern, also in developed economies. While originally developed through a nutritional lens, food security is also increasingly incorporating the environmental quality of diets. This study develops a Structural Equation Model to examine how consumers concerns over food insecurity – in terms of its impact on health and poverty – and environmental beliefs influence the carbon footprint of diets. Using data from a survey representative of the Italian population, this study shows that health-related food insecurity concerns increase the use of health motives when shopping for food, in turn reducing the carbon footprint of the diet. Conversely, poverty-related food insecurity concerns are associated to diets higher in carbon footprint, as they reduce health motives, and increase private shopping motives (e.g., taste, low price). Overall, the study highlights how shifts to more sustainable food systems require a better understanding of what motivate consumers to make more sustainable food choices.

1. Introduction

Food security is increasingly a concern for policymakers. The rising global population, rising food prices, and recent supply chain shocks (e.g., Covid-19) have put significant stress on food systems, and exposed critical limits on their resilience (Béné, 2020; Hynes et al., 2020; Thilmany et al., 2021). Worldwide, food insecurity has increased, with an increase in the number of people suffering from hunger despite a 50 % growth in global food production between 2000 and 2020 (World Bank, 2023). Food insecurity is not a problem limited to developing countries: even in developed economies, where food is generally easy to access and standards of living are on average relatively high, food insecurity is a problem affecting very large segments of the population (Barrett, 2010; Brown et al., 2022; Loopstra, 2018). As such, the ability to source sufficient amount of food is an important concern for households, and food security concerns are likely to influence household decision-making (Brown et al., 2022; Kneafsey et al., 2013; Loopstra, 2018).

The concept of food security is complex and multifaceted, consisting of multiple criteria. The basic definition of food security refers to the ability of the food system to supply enough nutrients for the needs of a population, also ensuring that this supply is accessible (both economically and physically), consumed, and stable over time, particularly in the face of potential shocks to the food system.[1] This definition is often considered insufficient, because it fails to incorporate a sustainability constraint, which requires that the ability of the food system to supply nutrients safely and effectively at a given point in time does not compromise the health of the food system for future generations (Berry et al., 2015; Molotoks et al., 2021; Vermeulen et al., 2012). As a result, food security has an inherent environmental dimension, and the environmental sustainability of the food system is a key element of food

* Corresponding author at: Applied Economics and Social Science Group, School of Natural and Environmental Sciences, Newcastle University, UK
E-mail address: luca.panzone@newcastle.ac.uk (L. Panzone).

[1] https://www.worldbank.org/en/topic/agriculture/brief/food-security-update.

https://doi.org/10.1016/j.spc.2023.05.027
Received 8 March 2023; Received in revised form 12 May 2023; Accepted 19 May 2023
Available online 29 May 2023

security, particularly in promoting intragenerational equity (Huang and Rust, 2011; Tai, 2019). The environmental dimension of a food system is often measured in terms of the carbon footprint of food consumption (Clark et al., 2022; Leach et al., 2016; Poore and Nemecek, 2018), which measures the amount of greenhouse gases (GHG) emitted to produce and consume food (IPCC, 2018; McMichael et al., 2007).

In this article, we use primary survey data to study the relationship between consumer concerns for food security and the carbon footprint of food consumption in Italy, a country with important food security problems (Zaçe et al., 2021). The aim of the research is to understand the role of food insecurity concerns as a psychological driver of carbon emissions, particularly in its role of motivating reduction in the carbon footprint of diets. Food consumption – and its associated GHG emissions – is strongly dependent on the (deliberate or automatic) achievement of consumption goals (Hoek et al., 2021; Panzone et al., 2021a; Steptoe et al., 1995). Consumers then make choices aiming to achieve these goals, subject to their own values, and beliefs (Steg, 2016; van Herpen and Trijp, 2011; Vermeir et al., 2020). Previous research has indicated that environmental problems like climate change causes significant psychological distress, due to the degradation of the environment and the loss of livelihood it generates (Evans, 2019). As a result, environmental concerns motivate more sustainable consumer choices (Azzurra et al., 2019; Bamberg, 2003; Fujii, 2006; Panzone et al., 2016). Health concerns can also lead to more sustainable choices (Hoek et al., 2004; Prada et al., 2017), because they are associated to consumers' awareness of the sustainability problem. There is more limited research on what food insecurity concerns consumers hold, and how these concerns relate to the environmental quality of diets.

Food consumption is a key area of interest in the study of sustainable consumption. Recent estimates indicate that food is responsible for over 30 % of global GHG emissions (Poore and Nemecek, 2018), due to their dependence on land use, energy, and other resources within the supply chain. Western economies increasingly dedicate attention to policies to achieve significant reduction in carbon footprint (IPCC, 2018), also targeting net carbon neutrality (Allen et al., 2022; Fankhauser et al., 2022). Within food systems, consumers have been often considered key in driving change within the system (Camilleri et al., 2019; Panzone et al., 2021b), as changes in demand can be transmitted back along the supply chain (Garnett et al., 2020; Hynes et al., 2020; Macfadyen et al., 2015). Research already indicates that food security is central to the resilience of a food system, and the presence of consumers who are food insecure is an indicator of a food system that is unable to fully respond to stressors and shocks (Béné, 2020). While significant improvements in the food system require large scale changes in behaviour (Cerri et al., 2018; Macfadyen et al., 2015; Panzone et al., 2021a), there is limited understanding of the psychological drivers of the carbon footprint of food consumption.

The remainder of the article is as follows. Section 2 will briefly summarise the literature on the link between concerns, particularly environmental concerns, and pro-environmental behaviour, which will be used to build a model of behaviour used in the empirical analysis. Section 3 presents the data used in the empirical research, also presenting the statistical model used in the analysis, with parameters estimated using a Structural Equation Model (SEM). The data refers to a survey made to a representative sample of the Italian population, counting on a sample of over 2000 individuals. Results are presented in Section 4. Section 5 discusses the findings of the research, while Section 6 concludes.

2. Literature review

2.1. The role of concern in driving pro-environmental behaviour

The decision to engage in pro-environmental behaviour, as well as any other behaviour, depends on the awareness of consequences caused by one's own behaviour (Bimbo, 2023; Steg, 2016). The literature calls this attitudinal element of awareness "concern", referred to as "environmental concern" when referring to the environmental public good (Bamberg, 2003; Fujii, 2006; Milfont et al., 2006). The literature identifies 3 key types of concerns: egoistic concerns, which reflect the expected consequences on the decision-maker, e.g., concerns about gaining weight; social-altruistic concerns, which refers to the consequences on other parties, e.g., concerns about hurting others; and biospheric concerns, which reflect consequences on the environment, e.g., concerns over wasting resources (Schultz, 2001; Snelgar, 2006). Egoistic concerns can be further divided into two groups: health concerns, which refer to personal health, and the ability to keep the body healthy and functioning (Prada et al., 2017; Snelgar, 2006); and poverty concerns, which refer to preoccupations associated to money and lack of other resources (Haushofer and Fehr, 2014; Snelgar, 2006).

The literature observes that environmental concern is a key driver of pro-environmental behaviour (Bamberg, 2003; Fujii, 2006; Milfont et al., 2006): the decision to engage in behaviour that protects the environment – particularly when this behaviour requires giving up personal consumption – tends to stem from the belief that the environment is under serious threat, and appropriate action is needed (Bimbo, 2023; Steg et al., 2014). As an example, concern has been shown to predict pro-environmental behaviour, such as sales of organic products (Ahmed et al., 2021; Azzurra et al., 2019; Tandon et al., 2020), sustainable food shopping (Panzone et al., 2016), and more general pro-environmental behaviour (Bamberg, 2003; Saari et al., 2021). At the same time, environmental concerns are reflected in the willingness to prioritise environmental protection over economic growth (Costanza et al., 2014; Daly, 2013), a concept often referred to a human utilization of nature (Milfont and Duckitt, 2010).

However, pro-environmental behaviour can also be associated to other types of concerns that individual decision-makers consider associated to environmental degradation, or consumption reduction. For instance, consumers may save energy to save money rather than on environmental grounds (Nauges and Wheeler, 2017; Panzone, 2013), yet the resulting behaviour will benefit the environment. Similarly, consumers may reduce their meat consumption in response to animal welfare concerns (Hoek et al., 2004; Perino and Schwickert, 2023), yet their decision will reduce carbon emissions. In the case of food, a common egoistic concern for consumers relates to food (in)security (Brown et al., 2022; Kneafsey et al., 2013). The lack of food, or the occasional or regular inability to access food is a known sort of stress and concern for consumers, even in modern developed economies. These concerns tend to stem from not having enough money to purchase food, as well as the inability to source a sufficient amount of quality nutrients as part of the diet of the family. Environmental degradation is often associated to a decline in food security (Béné, 2020; Molotoks et al., 2021; Vermeulen et al., 2012). Consumers can tackle concerns over food insecurity by, for instance, opting for a more sustainable diet, as a way to prevent shocks in the food system (Macdiarmid et al., 2012).

2.2. The relationship between concerns and motivation

We expect the effect observed in the literature between concern and behaviour to be mediated by the personal shopping motives of the consumer. Specifically, consumers shop for food, and more generally make food-related decisions targeting the satisfaction of several consumption goals, for instance long-term health, convenience, or sensory appeal (Sautron et al., 2015; Steptoe et al., 1995). Health and food security are also reported in the literature as key consumer motives in more recent research (Béné, 2020; Kneafsey et al., 2013). The outcome of the choices made to satisfy these goals will result in diets with differing levels of carbon emissions (Hoek et al., 2004), as different goals will lead to choices with different environmental impacts. Indeed, these motives can be private in nature: for instance, healthy eating, saving money, or satisfying personal taste preferences gives benefits primarily or purely to the decision-maker (Nadricka et al., 2020; Raghunathan

et al., 2006; Visschers and Siegrist, 2015). Other motives are instead pro-social in nature, for example protecting the environment, or more general altruistic motives (Milfont et al., 2006; Sautron et al., 2015).

According to norm activation theory (NAT), the presence of a concern plays an important motivational role (Fujii, 2006; Schultz, 2001). Knowledge of the damage caused by a behaviour activate concerns by creating awareness of negative consequences of that action (Bamberg, 2003; Saari et al., 2021; Tandon et al., 2020). This changed awareness changes the cost-benefit assessment of the action, in turn activating relevant social and personal norms in the mind of the decision-maker (Steg, 2016). In the case of pro-environmental behaviours, food insecurity concerns are expected to increase the salience of the negative consequences a wrong action can have on food consumption, also motivating the protection of the environment as a mean to protect food security itself, due to the close association between them (Berry et al., 2015; Molotoks et al., 2021). NAT also emphasises that the concern induces the individual to evaluate the action against a clear norm of environmental preservation, that is, the general understanding that damaging the environment is bad. The desire to comply to the environmental norm will activate an environmental or related motive that will lead to a more sustainable choice.

2.3. Theoretical model and testable hypotheses

The literature presented in the previous subsections provides a framework to build a theoretical model of behaviour, presented in Fig. 1, which borrows from other theoretical frameworks linked to the theory of planned behaviour (Ajzen, 1991; Bagozzi and Kimmel, 1995). In this model, consumers have concerns and beliefs over the consequences of food (in)security (Brown et al., 2022; Kneafsey et al., 2013; Loopstra, 2018), in line with NAT. Based on the model of goal-directed behaviour (MGB) (Aarts and Dijksterhuis, 2000; Perugini and Bagozzi, 2001), concerns are part of self-regulatory process, and activate the motivation to pursue an existing goal – which is equivalent to goal desire in MGB parlance. Goal desire is captured by the activation of specific motives for consumers to use when shopping; the intensity of each motive depends fundamentally on the strength of the beliefs of the consumer, so that stronger concerns and attitudes towards a specific object would be expected to lead to stronger motives to protect the object. As in self-determination theory (Ryan and Deci, 2000), "perceived relatedness" – which is captured by concerns – activates motivations, and the need to act in line with social norms, as in NAT. The activation of congruent motives then translates into a behavioural outcome, captured in this model in terms of the carbon footprint of the diet. This step is also supported by self-affirmation theory, who suggests that behaviour is reflective of the underlying goals of the consumer (Schmeichel and Vohs, 2009; Sherman and Cohen, 2006). Finally, socio-demographic characteristics are expected to affect behaviour, as well as motives and concerns (Dickson-Spillmann et al., 2011; Panzone et al., 2016).

The resulting model can be seen in Fig. 1, where motives mediate the role of concern on behaviour. In the analysis that will follow, we separate two concerns: ***health-related food insecurity concerns***, and ***poverty-related food insecurity concerns***; one ***environmental beliefs***; and three motives: ***pro-social motives***, ***health motives***, and ***private motives***. This classification is data-driven and obtained from exploratory data analysis on the constructs presented in Section 3. The model allows developing 4 sets of hypotheses.

A first set of hypotheses relates to health concerns. Consumers concerned about the healthiness of the food they buy are expected to translate this concern into motives that support healthiness (Prada et al., 2017), as well as pro-social motives, which consumers expect to correlate with health (Lazzarini et al., 2016). Conversely, health concerns should reduce the relevance of private motives, as healthy food may be perceived as costly (Jones et al., 2018) or less tasty (Raghunathan et al., 2006). The resulting hypotheses are:

H1a. Health-related food insecurity concerns increase the strength of health motives.

H1b. Health-related food insecurity concerns increase the strength of pro-social motives.

H1c. Health-related food insecurity concerns reduce the strength of private motives.

A second set of hypotheses relates to poverty concerns. Poverty causes a significant amount of stress that causes short-sighted decision-making – it induces individuals to favour present over future consumption (Haushofer and Fehr, 2014), and make choices under significant cognitive pressure (Mani et al., 2013). Poverty induces consumers to focus their attention to private motives that require immediate satisfaction, such as pleasure, at the expense of altruistic goals that provide future benefits, for instance prioritise entertainment over work in Bartoš et al. (2021). As a result, poverty concerns associated to food security may induce consumers to focus their attention to private motives such as taste, at the expense of pro-social goals such as environmental preservation. At the same time, poverty concerns may detract from health motives, as consumers target personal pleasure over future health (Dominguez-Viera et al., 2023). This leads to the following hypotheses:

H2a. Poverty-related food insecurity concerns reduce the strength of health motives.

H2b. Poverty-related food insecurity concerns reduce the strength of pro-social motives.

H2c. Poverty-related food insecurity concerns increase the strength of private motives.

A third set of hypotheses relates to the role of beliefs over the importance of the environment, which influence pro-environmental

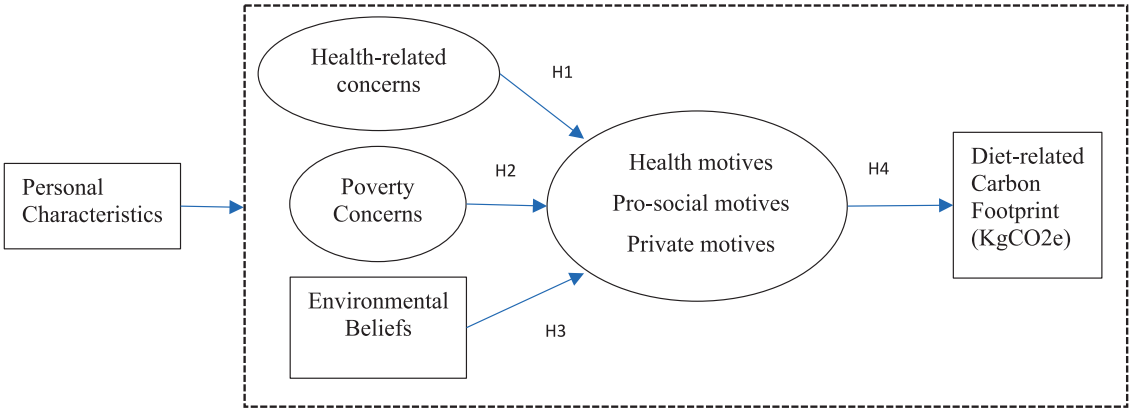

Fig. 1. Theoretical model.

Table 1
Summary of variables included in the final model.

Construct	Items	Scale
Concerns	How often do you feel concerned about certain characteristics of the foods you eat: - The safety of the food we eat - The presence of unhealthy ingredients in the food we eat (additives, residues, etc.) - Not having money to buy enough food - Lack of food due to emergencies, natural disasters or droughts - Having health problems due to the diet	From 1 = often to 4 = never
Environmental Belief	Which of the following statements about the environment and the economy would you agree with? - The protection of the environment should have priority - Economic growth should take priority, even if the environment is affected to some extent	1 = Environment should have priority. 0 = Economic growth should have priority.
Motives	When shopping for food, how much importance do you give to certain aspects? - They must be tasty products that I and my family like - There should be no ingredients on the label that I consider unhealthy - They must be fat-free products - They must be of Italian origin (Made in Italy) - They must be organic or zero km - They must be convenient or on offer - They must respect the environment - They must be quick to prepare - They must be produced by companies that respect workers - They must respect my religious beliefs - They must not be industrially sourced, too refined	From 1 = little to 10 = very much
Consumption	How often would you say you eat the following types of food? - Meat - Fish and seafood products - Vegetables and legumes - Dairy - Fruit - Ready meals	From 1 = never to 5 = several times a day
Demographics	Gender Education qualification Age Monthly income	0 = "Male"; 1 = "Female" From "primary school" to "postgraduate" From 18 to over 65 From "up to 1000 euros" to ">3000 euros"

behaviour (Bimbo, 2023; De Groot and Steg, 2007). Economic growth has been often associated to high-carbon emissions (Mardani et al., 2019) and a major challenge of our time is the design of economic policies that can balance economic growth and environmental degradation (Kopittke et al., 2019). This leads to the following hypotheses:

H3a. Environmental beliefs increase the strength of health motives.

H3b. Environmental beliefs increase the strength of pro-social motives.

H3c. Environmental beliefs reduce the strength of private motives.

A final set of hypotheses relates to the relation between motives and consumption. Pro-social motives, which include environmental motives, would be expected to lead to pro-environmental behaviour, therefore reducing the carbon footprint of the diet (Hoek et al., 2021; Kanay et al., 2021; Saari et al., 2021). Similarly, in the case of health motives lead to more sustainable diets (Macdiarmid et al., 2012; Springmann et al., 2016), therefore leading to diets with a lower carbon footprint. On the other hand, private motives tend to be associated to carbon-intensive decisions: taste preferences give advantage to unhealthy foods (Raghunathan et al., 2006), and convenient ready meals have higher carbon emissions than home-cooked meals (Schmidt Rivera et al., 2014). The final set of hypotheses is:

H4a. Health motives reduce the carbon footprint of diets.

H4b. Pro-social motives reduce the carbon footprint of diets.

H4c. Private motives increase to the carbon footprint of diets.

3. Data and methods

3.1. Survey

The data were collected through interviews with a large sample ($N = 2029$) of the Italian population, aged 18 years and over.[2] The survey was conducted on 18–26 January 2021 by the Demetra polling institute using a mixed mode method: 50 % of the sample was interviewed using a CATI (Computer Assisted Telephone Interviewing)-CAMI (Computer Assisted Mobile Interviewing) approach; and 50 % of the sample was interviewed using a CAWI (Computer Assisted Web Interviewing) approach. The full sample was selected to reproduce national quotas for four socio-demographic variables: gender, age group, regional distribution, and area of residence (city centre; residential area; periphery; or rural area). Table 1 reports all the questions asked to participants relevant to this study. The full questionnaire is reported in Appendix A, Table A1. The rest of this section will describe the questions associated to each construct in detail.

3.1.1. Concerns

To measure concerns, the survey contained 5 questions (Table 1), capturing concerns from different areas of life associated to food security, such as "safety of the food we eat", "presence of unhealthy ingredients in the food we eat", as well as "not having money to buy enough food". These are measured with a 4-point Likert scale, as coded 1 = frequently, 2 = sometimes, 3 = rarely, 4 = never. In our analysis, we reverse this scale to ensure that it is in line with the other variables

[2] The survey was carried out by the Department of Economics, Society, and Politics (DESP) of the Carlo Bo University of Urbino, as part of the "Sustainability and food [in]security" project. Notably, the questionnaire was longer, and in order to keep the interview to a manageable length, a subset of the question in the questionnaire was only asked to some of the participants. In this study, we only include variables that were asked to the entire sample.

considered.

3.1.2. Environmental beliefs: Human Utilization of Nature (HUN)

To capture the belief that environmental protection should take priority over economic growth, we used the simplified version of the Human utilization of Nature scale (Milfont and Duckitt, 2010). To this extent, we measure Human Utilization of Nature using the question: "Which statement about the environment and the economy would you agree with?". Respondents could choose either "Environmental protection should be a priority, even at the cost of constraining economic growth"; or "Economic growth should take priority, even if the environment is affected to some extent". Answers were mutually exclusive. We assign a dummy equal to 1 if the individual indicates the belief that the environment should take priority, 0 otherwise.

3.1.3. Consumption motives

To measure consumption motives, the survey contained 11 questions (Table 1). The question asked, "When shopping for food, how much importance do you give to each of the following aspects?". These represent the level of importance given to certain food characteristics when shopping for food and are expressed by Likert scales from 1 to 10 where 1 = little to 10 = a lot.

3.1.4. Food consumption and GHG

To determine food consumption, we used a food frequency questionnaire (Mulligan et al., 2014; Scarborough et al., 2014; Subar et al., 2000). The question asked participants to indicate "How often would you say you eat the following types of food?" for 6 food categories, on a scale going from 1 to 5 where 1 = never and 5 = several times a day. GHG emissions have then be calculated as follows:

- Answers to the frequency questions were converted into weekly portions.
- Portions were then converted into weekly grams of food consumed using the standard daily portion size for the Italian population as indicated by the Italian Society of Human Nutrition (SINU, 2014).
- From weights, we calculated the carbon footprint, in Kg of CO_2 equivalents ($KgCO_2e$) of each food category by multiplying kilograms of food by the carbon footprint per kilogram.
- The total carbon footprint of a diet is the sum of the individual categories.

Food diaries are commonly used in nutrition research to study actual behaviour, and their good performance in doing so is well established (Mulligan et al., 2014; Scarborough et al., 2014; Subar et al., 2000); as a result, the behavioural variable obtained from this approach should capture actual consumption as opposed to stated consumption.

Table 2 shows the standard portions of each average food category and its carbon footprint (in CO_2e). Carbon emissions in a category has been determined by averaging the carbon footprint of the various food items within it, using published data (Clark et al., 2022; Poore and Nemecek, 2018) (see also Table A2 in Appendix A). In the case of meat, we used the data in Table 2 as follows: the average portion, 0.075 kg, was multiplied by the average carbon footprint per Kg of meat (24 kg CO_2e), to obtain the carbon footprint per portion as 1.8 kg CO_2e; this value was then multiplied by the weekly portions, so that a consumer eating meat "once or twice a week" had 1.5 portions/week, resulting in the emission of 2.7 $kgCO_2e$ from meat consumption, while the value would go to 6.3 $kgCO_2e$ for a consumer eating meat three or four times a week (3.5 portions/week), 11.7 $kgCO_2e$ for every day or almost (6.5 portions/week) and 19.8 $kgCO_2e$ for more than once a day (11 portions/week). Then we repeat it for all categories. Only for ready meals we perform a different procedure as there is no standard portion indicated by the LARN but we find in the literature directly the kg of CO_2 produced per portion (Clark et al., 2022; Schmidt Rivera and Azapagic, 2019; Schmidt Rivera et al., 2014).

Table 2
Conversion factors used to covert frequency of consumption to CO2e.

Food category	Average standard portion (Kg)	Average Kg CO_2e (1 kg of products)	Kg CO_2 per portion
Meat	0.075	24	1.8
Fish and seafood products	0.10	6.6	0.66
Vegetables and legumes	0.14	0.8	0.11
Dairy and eggs	0.081	6.4	0.52
Fruit	0.15	0.7	0.11
Ready meals[a]	/	/	3.5

[a] For ready meals, we don't have standard daily portion and we have no available carbon footprint information so we used the average of different ready meals emissions (meat-based ready meals, fish-based ready meals, and pizza), whose emissions were estimated from the carbon footprint of the main ingredients and cooking process (Clark et al., 2022; Schmidt Rivera et al., 2014; Schmidt Rivera and Azapagic, 2019).
Source: Società Italiana di nutrizione umana, 2014; Clark et al., 2022; Poore and Nemecek, 2018.

3.1.5. Demographics

Finally, the survey collected information on the socio-demographic characteristics of the sample (Table 1): respondent age, in 5 bands ranging from 18 years to over 65; gender; education, in 5 different classes, ranging from primary schools to postgraduate degree; and monthly income, in bands ranging from 1000 euros or less, to >8000 euros. Respondents above € 3000 were aggregated to obtain a more homogeneous class in terms of size, as very few respondents had very high salaries.

3.2. Statistical analysis

To estimate the parameters of the model described in Section 3, we use a Structural Equation Model (SEM) approach, which merges two methods: regression analysis and factor analysis. In particular, the structural part of the model, which reflects the model of Section 3, is expressed as:

$$\begin{aligned} CO_{2i} &= \beta_0 + \beta_1 X_i + \beta_2 M_i + e_i \\ M_i &= \alpha_0 + \alpha_1 X_i + \alpha_2 C_i + u_i \\ C_i &= \gamma_0 + \gamma_1 X_i + \varepsilon_i \end{aligned} \quad (1)$$

where CO_{2i} is the carbon footprint of the diet of consumer i, M_i refers to motives, C_i are concerns and environmental beliefs, and X_i are demographics. We estimate the model suing a full-information Maximum Likelihood (FIML) estimator: this approach is simpler and more flexible than alternative methods (e.g., multiple imputations) to handle missing values in independent variables. Specifically, the approach uses the variables in the model to predict the missing variables, under the assumptions of joint normality of all variables (observed and latent), and that missing values are random (Acock, 2013).

4. Results

4.1. Summary demographics

Table 3 describes the demographic characteristics of the 2029 respondents, comparing them with the Italian population using data from the national Institute of Statistics (http://dati.istat.it/). The sample consists of 47.81 % men and 52.19 % women. The majority of the sample is over 65 (26 %) followed by 24 % of the 30–44 age group with an average age of 51, slightly above the average of the Italian population (which however includes individuals below the age of 18). Most of the sample had a high school diploma, and the modal income is between 1500 and 2000 euros. The sample compares well with the Italian

Table 3
Results of descriptive analyses of demographic variables.

Demographics		Frequency	Sample	National (2020)
Gender	Male	970	47.81 %	48.82 %
	Female	1059	52.19 %	51.18 %
Age	18–29	285	14.05 %	11.96 %
	30–44	487	24.00 %	17.77 %
	45–54	404	19.91 %	15.95 %
	55–64	322	15.87 %	14.89 %
	65 or over	531	26.17 %	23.80 %
Education qualification	Primary school	77	3.79 %	15.90 %
	Middle school	293	14.44 %	32.19 %
	High school diploma	965	47.56 %	36.63 %
	University – Undergraduate (UG)	575	28.34 %	15.28 %
	University – Postgraduate (PG)	119	5.86 %	(UG + PG)
Level of income	up to 1000 euros	293	14.44 %	€ 2,046[a]
	1000–1500 euros	373	18.38 %	
	1500–2000 euros	418	20.60 %	
	2000–2500 euros	240	11.83 %	
	2500–3000 euros	227	11.19 %	
	Over 3000 euros	303	14.93 %	

[a] Salary refers to monthly estimate from a median yearly salary of € 26,597 (for 13 mensilities).

population in terms of gender age, and income, but includes individuals with an overall higher education – in particular, the survey contains fewer respondents with primary school or middle school education, and more respondents with high school of university degree.

4.2. The carbon footprint from food consumption in the sample

Fig. 2 portrays the distribution of carbon footprint from food consumption in the sample of 2029 respondents. On average, individuals are estimated to emit on average of 13.43 kg CO_2e per week from food consumption (s.d. = 7.79), with a minimum value of 2 and a maximum of 73.65 kg CO_2e. Moreover, the data shows that the distribution is noticeably positively skewed, with a small number of consumers with very high carbon emissions, and a larger number of consumers with lower values.

Table 4
Rotated factor loadings and unique variances for "Concerns".

Variable	Health & safety concerns	Poverty concerns	Uniqueness
The safety of the food we eat	**0.8343**	0.1139	0.2910
The presence of unhealthy ingredients in the food we eat (additives, residues, etc.)	**0.8467**	0.0642	0.2790
Not having money to buy enough food	0.0764	**0.8766**	0.2258
Lack of food due to emergencies, natural disasters or droughts	0.1967	**0.8140**	0.2986
Having health problems due to the diet	**0.5925**	0.3551	0.5228
Proportion of explained variance	0.3617	0.3149	

Note: The proportion of explained variance is based on the factors after rotation. Terms with correlation above 0.55 are highlighted in bold.

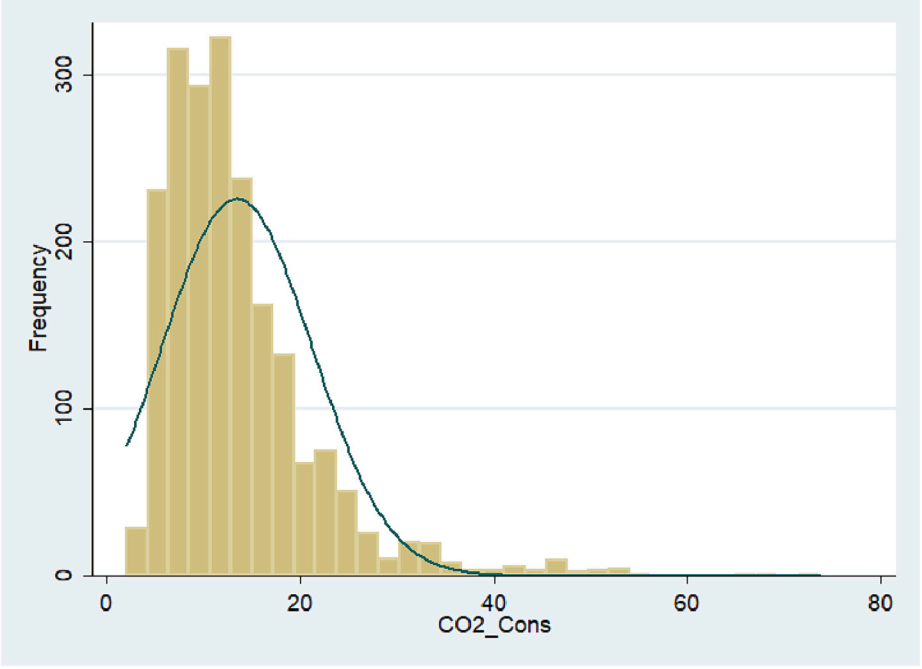

Fig. 2. Histogram of diet-related GHG emissions in the sample (kgCO2e).

Table 5
Rotated factor loadings and unique variances for "Motives".

Variable	Motives			Uniqueness
	Health & Pro-social	Private 1: Constraints	Private 2: Taste	
They must be tasty products that I and my family like	0.2411	0.1044	**0.8141**	0.2682
There should be no ingredients on the label that I consider unhealthy	**0.7452**[h]	0.0341	0.0399	0.4419
They must be fat-free products	**0.5489**[h]	0.4208	−0.0293	0.5208
They must be of Italian origin (Made in Italy)	**0.7498**[p]	−0.0605	0.1536	0.4106
They must be organic or zero km	**0.7713**[p]	0.0394	−0.1360	0.3851
They must be cheap or on offer	0.0141	**0.6596**	0.4310	0.3789
They must respect the environment	**0.8146**[p]	0.0100	0.1061	0.3250
They must be quick to prepare	0.0675	**0.7685**	0.0351	0.4036
They must be produced by companies that respect workers	**0.7583**[p]	0.0065	0.1603	0.3992
They must respect my religious beliefs	0.3104	**0.5481**	−0.4129	0.4328
They must not be industrially sourced, too refined	**0.6775**[h]	0.0793	−0.0852	0.5274
Proportion of explained variance	0.3519	0.1388	0.1008	

Note: p = pro-social motive; h = health motive. The proportion of explained variance is based on the factors after rotation.

4.3. Measurement model

SEM measures the relationships between a series of latent variables, but it does not automatically determine the underlying structure of these variables, which has to be established a priori by the investigator (Acock, 2013; MacCallum and Austin, 2000). To this extent, we run an exploratory factor analysis of the variables in the dataset before running the SEM. This exploratory analysis reduces the vulnerability of the model to measurement error and gives a more precise interpretation to the final model (Acock, 2013; Ricci et al., 2018). Throughout, we used a principal component analysis with oblimin rotation, which allows for correlated factors.

Table 4 shows that the five concerns variables can be grouped into two concerns: **Health & safety concerns** about the diet, related to the health element of food security; and **poverty concerns** related to the inability to have enough food to eat, either due to lack of money to buy it, or due to external environmental factors such as natural disasters. Table 6 indicate that health and safety concerns have a reasonable sampling adequacy, with KMO > 0.60, while poverty concerns have a low sampling adequacy, with KMO = 0.5; the Bartlett test of sphericity indicates that in all cases the variables are intercorrelated, supporting the use of a factor analysis.

Similarly, Table 5 shows that the eleven shopping motives converge into three factors: a first factor contains **health motives**, related to the interest in products with no unhealthy ingredients, that are fat-free, and that are not industrially sourced, as well as **pro-social motives**, related to an interest in Italian food, organic or zero km food, food that respects the environment, and food produced by companies that respect workers; the other two factors refer to **private motives**, that is the search for products that are not expensive, quick to prepare, and respectful of religious beliefs (factor 2), and tasty (factor 3).

In the SEM analysis, we use three motives: we separate health motives and pro-social motives, which loaded together in the first factor, to understand the contribution of each element to the carbon footprint of diets, as these motives have important conceptual differences related to the beneficiary of the action (self vs other); and we merge the two private motives into a single variable, as they cover the same set of underlying interests. Table 6 indicates that sampling adequacy is very good for pro-social motives, and acceptable for Health & Safety Concerns and health motives; while it is low for poverty concerns and private motives. As before, the Bartlett test of sphericity indicates that in all cases the variables are intercorrelated, supporting the use of a factor analysis.

Table 6 reports the estimated Cronbach's alpha[3] for each of the constructs used in the SEM analysis. Results indicate that pro-social concerns have strong reliability (α = 0.82); and health and safety concerns, poverty concerns, and health motives all have an acceptable reliability (0.7 > α > 0.65). Private motives have the lowest reliability (α = 0.44), which is explained by the very different items represented by the variables in this factor.

4.4. Structural equation model

Table 7 presents the estimated standardized parameters of the SEM, using the structure derived from the previous section. The model is estimated using a maximum likelihood. As indicated in Section 3.2, the methodological approach we used retained all observations with missing values by estimating the missing observations using all variables (observed and latent) in the model. Consequently, Table 7 contains all 2029 observations; the same model estimated with the 1836 complete observations (90.5 % completion rate) is presented in Table A3 in Appendix A, providing very similar results, and it is not discussed here.

A likelihood ratio test indicates that the present model performs better than both a saturated model (Chi2 (286) = 1440.30, $p < 0.001$) and a baseline model that includes mean, variances, and covariances of all exogenous variables (chi2 (423) = 10,328.161, p < 0.001). The model also performs well in all measures of fit: the Comparative fit index CFI is 0.88 (benchmark would be 1) and the Root mean squared error of approximation RMSEA equals 0.045 (benchmark would be 0).

Results (Table 7) indicate that behaviour, measured in terms of the carbon footprint of diets in $KgCO_2e$, is significantly related to consumer motives. In particular, an increase in one standard deviation in health motives lead to a reduction in carbon footprint of 0.29 standard deviations, as predicted in *hypothesis H4a*. Pro-social motives, on the other hand, are unrelated to the carbon footprint of diets, contradicting *hypothesis H4b*. Conversely, private motives are positively related to carbon emissions, in line with *hypothesis H4c*, with one standard deviation increase in private motives increasing the carbon footprint by 0.33 standard deviations. As a result, consumers holding strong health motives have diets that are lower in carbon emissions compared to those with weak health motives; while consumers with strong private motives

Table 6
Cronbach's alpha for the constructs used in the analysis.

Synthesis variables	Cronbach's α	KMO	Bartlett χ^2
Health & safety concerns	0.6866	0.642	1061.74***
Poverty concerns	0.6634	0.500	570.69***
Pro-social motives	0.8239	0.775	2897.47***
Health motives	0.6728	0.645	947.17***
Private motives	0.4431	0.579	376.02***

Significance is as follows: * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$. Note: KMO = Kaiser-Meyer-Olkin Measure of Sampling Adequacy; Bartlett χ^2 = Bartlett test of sphericity.

[3] Cronbach's alpha indicates strong reliability if α ≥ 0.8, good reliability if 0.7 ≤ α < 0.8, and acceptable reliability if 0.6 ≤ α < 0.7.

Table 7
Results from the Structural Equation Model, standardized (maximum likelihood with missing values).

	CO2e		Motives						Concerns				Env. beliefs (HUN)	
			Pro-social motives		Health		Private		Health & Safety		Poverty			
Structural	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Intercept	2.048***	0.137	/	/	/	/	/	/	/	/	/	/	/	/
Pro-social motives	0.074	0.090	/	/	/	/	/	/	/	/	/	/	/	/
Health motives	−0.294***	0.093	/	/	/	/	/	/	/	/	/	/	/	/
Private motives	0.329***	0.043	/	/	/	/	/	/	/	/	/	/	/	/
Env. beliefs	/	/	0.071***	0.022	0.076**	0.025	−0.092***	0.031	/	/	/	/	/	/
Health & safety conc.	/	/	0.369***	0.033	0.440***	0.038	−0.081*	0.050	/	/	/	/	/	/
Poverty concerns	/	/	−0.079*	0.042	−0.091*	0.048	0.332***	0.059	/	/	/	/	/	/
Female	0.055**	0.023	−0.044**	0.022	−0.020	0.026	−0.051*	0.033	−0.128***	0.026	−0.091***	0.025	0.031	0.022
Age: 18–29	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Age: 30–44	−0.044	0.032	0.040	0.031	0.040	0.036	−0.042	0.045	0.057*	0.037	0.006	0.036	0.002	0.032
Age: 45–54	−0.135***	0.318	0.106***	0.030	0.127***	0.035	0.034	0.045	0.049	0.037	−0.066*	0.035	0.046*	0.031
Age: 55–64	−0.170***	0.034	0.271***	0.030	0.179***	0.035	−0.070*	0.045	0.068*	0.036	−0.117***	0.034	0.020	0.030
Age: >65	−0.020***	0.038	0.418***	0.034	0.294***	0.040	0.040	0.052	0.012	0.040	−0.269***	0.038	0.080**	0.034
Primary school	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Secondary school	−0.020	0.047	−0.006	0.045	−0.015	0.053	0.046	0.067	0.027	0.054	−0.008	0.052	0.109**	0.046
Diploma	0.069	0.064	−0.147**	0.062	−0.120*	0.073	−0.087	0.092	0.104	0.073	−0.115*	0.071	0.263***	0.062
UG degree	0.061	0.060	−0.168***	0.058	−0.135**	0.068	−0.066	0.087	0.116*	0.068	−0.202***	0.066	0.269***	0.058
PG degree	0.073**	0.037	−0.080**	0.036	−0.077*	0.042	−0.051	0.054	0.068*	0.043	−0.096**	0.041	0.144***	0.036
Income: < 1000	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Income: 1000–1500	0.042	0.031	−0.068**	0.030	−0.016	0.035	−0.031	0.044	0.030	0.035	−0.120***	0.034	−0.052*	0.030
Income: 1500–2000	0.090***	0.033	−0.084***	0.033	−0.007	0.038	−0.022	0.048	0.029	0.037	−0.269***	0.035	0.005	0.031
Income: 2000–2500	0.072**	0.030	−0.058**	0.030	−0.023	0.035	−0.029	0.044	−0.013	0.034	0.268***	0.032	−0.010	0.028
Income: 2500-€000	0.075***	0.030	−0.048*	0.030	−0.024	0.035	−0.054	0.044	−0.051*	0.337	−0.303***	0.032	−0.003	0.029
Income: > 3000	0.118***	0.034	−0.086***	0.034	−0.007	0.040	−0.081*	0.050	0.010	0.036	−0.404***	0.033	0.021	0.031
Income: NA	0.054*	0.029	−0.018	0.028	0.013	0.033	−0.071*	0.041	0.012	0.032	−0.184***	0.031	−0.017	0.027

Significance is as follows: * = p < 0.1; ** = p < 0.05; *** = p < 0.01. Number of observations: 2029. Estimation method = maximum likelihood with missing values. Log Likelihood = −75,897.38. Note: UG = undergraduate; PG = postgraduate. The model allows for correlated residuals of the following pairs of equations: Pro-Social Motives-Health Motives; Private Motives-Health Motives; Pro-Social Motives-Private Motives; Health & Safety Concerns-Poverty Concerns.

are characterised by diets higher carbon emission than those with weak private motives. Table A4 in Appendix A shows the same regression of Eq. (1) repeated separately by category. Results indicate that the reduction in carbon footprint due to health motives is driven by a reduction in the consumption of meat and ready meals; while pro-social motives are positively associated to the carbon footprint from the consumption of fruit and vegetables. The reduction in carbon footprint from the reduction of private motives is linked to a reduction in the consumption of meat, fish, dairy and ready meals, also reducing the consumption of low-carbon substitutes like vegetables and fruit.

Concerns play an important role in the activation of these motives. Specifically, health motives and pro-social motives are higher in those respondents who report higher health & safety concerns, in line with *hypotheses H1a* and *H1b*. Health & safety concerns are also negatively correlated (at 10 % level of significance) with private motives, confirming *hypothesis H1c*. Poverty concerns, on the other hand, reduce both pro-social motives and health motives, supporting *hypotheses H2a* and *H2b*; and increase private motives, supporting *hypotheses H2c*. Finally, respondents with stronger environmental beliefs (HUN = 1) have significantly higher pro-social and health motives, in support of *hypotheses H3a* and *H3b*, respectively, as well as lower private motives, in line with *hypothesis H3c*. As a result, an increase in health and safety concerns, and stronger environmental beliefs lead to a lower diet-related carbon footprint, by increasing health motives and reducing private motives; on the other hand, an increase in poverty concerns is conducive to an increase in diet-related carbon emissions through an increase in private motives, and a reduction in health motives.

Table 8 estimates the indirect effect of concerns and beliefs on the carbon footprint of the diet, calculated as the product $\alpha_2 \bullet \beta_2$, where α_2 and β_2 are the coefficient in Eq. (1) (MacKinnon et al., 2007). Results indicate that one standard deviation reduction in health and safety beliefs reduce the carbon footprint of the diet by 0.13 standard deviations through an increase in health motives, and by 0.03 standard deviations through a reduction in private motives. One standard deviation increase in poverty concerns, on the other hand, leads to an increase of the carbon footprint of the diet by 0.11 standard deviations through an increase in private motives, and by 0.03 standard deviations through a reduction in the importance of health motives. Finally, one standard deviation increase in environmental beliefs leads to reductions in diet-related carbon emissions of 0.02 standard deviations by increasing the importance of health motives, and of 0.03 standard deviations by reducing the relevance of private motives.

In terms of demographics, Table 7 indicates that women have diets with lower carbon footprint than men, but they do not differ in any of their motives, only showing marginally lower private motives. Carbon emissions also decrease with age, and increase (non-linearly) with income and post-graduate education. In terms of the psychological constructs, pro-social and health motives, and environmental beliefs increase with age, while age is unrelated (at 5 % significance) to private motives and health & safety concerns. Conversely, poverty concerns reduce with age. Education is associated to stronger environmental beliefs, but reduces pro-social and health motives, as well as poverty concerns; while there is no significant relation between education and private motives and health & safety concerns. Finally, income is inversely related to pro-social motives and poverty concern.

Table 8
Estimated indirect effects of concerns and believes on diet-related carbon footprint.

	via	Effect	S.E.
Health & safety concerns	Health motives	−0.129***	0.036
	Private motives	−0.027*	0.017
	Pro-social motives	0.027	0.033
Poverty concerns	Health motives	0.027*	0.016
	Private motives	0.109***	0.024
	Pro-social motives	−0.006	0.008
Env. beliefs	Health motives	−0.022**	0.010
	Private motives	−0.030***	0.011
	Pro-social motives	0.005	0.007

Significance is as follows: * = p < 0.1; ** = p < 0.05; *** = p < 0.01. standard errors are based on Eq. (4) in MacKinnon et al. (2007).

5. Discussion

This study explored the link between food insecurity concerns and the carbon footprint of diets. A key ambition of climate change policy is to motivate (intrinsically) consumers to make sustainable food choices over time (Hoek et al., 2021; Panzone et al., 2021a; Vermeir et al., 2020). To do so, this study explores the psychological drivers of behaviour, with a specific focus on the motivating role of food insecurity concerns and environmental beliefs on the environmental impact of what consumers eat. Our analysis is a step forward from previous work as it connects purchase motivations and dietary behaviour, measured using a food frequency questionnaire. This section analyses and contextualises the results, with a view of highlighting the relevance to theory and practice.

5.1. The role of motives, beliefs and concerns in GHG reductions

Food consumption goes beyond its primary function of satisfying hunger, and increasingly consumers pay attention to the environmental impact of their diets (Saari et al., 2021; Tandon et al., 2020). A general premise in the study of sustainable consumption is that pro-environmental behaviour can be made more likely by increasing the relevance of environmental motives (Cerri et al., 2018; Panzone et al., 2021a; Perino and Schwickert, 2023). For example, pro-environmental motivations, concerns regarding natural resources, or the beliefs of the importance of nature conservation should increase the likelihood of purchasing of low-carbon products (Camilleri et al., 2019; Panzone et al., 2021a). While this relationship between motives and behaviour may be appropriate in many instances, this study shows that consumers reduce the carbon footprint of their diet in response to health motives, not pro-social ones. These results are in line with previous work on Italian consumers, who find that health preferences rather than altruistic motives explain memberships to a solidarity purchase group (Baldi et al., 2019). However, while health motives are those motivating consumers to pursue a low-carbon diet, they are activated by the environmental beliefs of the individual, as well as their health & safety concerns; as a result, environmental preference play a role in the carbon footprint of a diet (as shown in Kanay et al., 2021; Muller et al., 2019; Panzone et al., 2021a; Panzone et al., 2021b), although an indirect one.

At the same time, environmental beliefs play a critical role in the carbon footprint of a food basket. Specifically, environmental beliefs operate through two separate pathways: firstly, they increase health motives; and they reduce private motives. Both pathways lead to a net reduction in carbon emissions. This result is consistent with the literature (De Groot and Steg, 2007; Milfont and Duckitt, 2010), which views beliefs as a key driver of pro-environmental behaviour, by increasing the attention of the decision-maker on the impact of a behaviour on society as opposed as to the self only.

On the other hand, the diets of consumers who are more concerned about food poverty caused by food security have higher carbon footprint. This result may seem counterintuitive, because consumers concerned with poverty would be expected to spend less and save more (Bowman et al., 1999; Jones et al., 2018), an action that should lead to less – rather than more – GHG. However, poverty concerns increase the importance of private motives, such as convenience, low price, religion, and personal taste, which are associated to a diet higher in carbon footprint. At the same time, the result may be caused by consumers over-discounting future consumption (Prelec and Loewenstein, 1991; Zauberman et al., 2009): consumers concerned about not eating tomorrow are driven to indulge or overconsume today, giving priority to carbon-intensive products, consistent with short-sighted preferences

commonly characterising poorer individuals (Haushofer and Fehr, 2014). At the same time, the positive effect between poverty concerns and carbon emission may seem to conflict with the positive relationship between income and carbon emissions in Table 7: as incomes grow, consumption also grow, and so does the carbon footprint of the household. However, as income grows, households become less concerned with not having money to buy food, and this security reduces poverty concerns, in turn reducing their carbon footprint of the household; the overall effect will depend on the characteristics of each household. On the other hand, poverty concerns refer to individuals who fear they may become poor in the future, an effect that gives an incentive to overconsume now, as indicated above.

This result is important in our understanding of the psychology of sustainable consumption. Recent research has increasingly supported the notion that while climate change goals can only be achieved by reducing the consumption of certain unsustainable categories of food, primarily meat, consumers do not find this change easy (Attwood and Hajat, 2020; Bimbo, 2023; Çoker et al., 2022). This study shows that while concerns over the health impact of food security can reduce carbon emissions, this effect is counterbalanced by the increase in carbon footprint due to increasing concerns over food poverty caused by food security. Scenarios where consumers who are concerned over food security also have a large carbon footprint may be due to a sizeable effect of poverty concerns, which may be increasing their carbon emissions more than the reduction caused by a lower income or stronger health concerns. From a policy perspective, the ability to mitigate food poverty concerns would be expected to facilitate efforts to reduce the carbon footprint of diets, all else equal.

5.2. Consumer behaviour and Net Zero targets

A key point of this research is that consumers are pivotal in driving large scale changes in behaviour. Research highlights that consumers do not feel sufficiently empowered to significantly change the sustainability of the food system (Kneafsey et al., 2013; Macdiarmid et al., 2013), and they lack the knowledge to make correct assessments of the environmental impact of food choices (Panzone et al., 2020; Shi et al., 2018; Whitmarsh et al., 2011). Yet, a better understanding of the difficulties consumers encounter, as well as clear perspective of the drivers of the carbon footprint of consumers can support policymakers and marketeers in designing better policies that can achieve NetZero targets (Allen et al., 2022; Fankhauser et al., 2022). The results from this article can be also used for the design of interventions targeting different groups of people. Increasingly, there is a need to intervene directly where consumers make choices, e.g., in a supermarket (Panzone et al., 2021a; Panzone et al., 2021b), and nudging could be used to exploit the findings of this research. For instance, framing effects have often been used to nudge consumers towards environmentally-friendly behaviours (Bolderdijk et al., 2013; Carlsson et al., 2021; Ropret Homar and Knežević Cvelbar, 2021). Based on the results of this article, in the Italian population dietary carbon footprints could be reduced in a natural or field experimental setting through the use of health frames, as opposed to environmental frames. This frame would activate health concerns, nudging consumers to healthier and more sustainable food choices. At the same time, interventions should try to suppress or control poverty concerns, which are associated to higher carbon footprints.

6. Conclusions

This study shows that consumers play an important role in driving change towards more sustainable, low-carbon food consumption patterns. We specifically study concerns over food (in)security, and their role on the decision-making of a sample of Italian consumers. Our result clearly suggest that it is important to sensitise consumers to the importance of food security, both in terms of the benefits to the environment, but especially on personal health. Over time, investments that educate consumers to the environmental problem, even if only justified as a way to protect personal health and wealth, can lead to stable reductions in carbon emissions, which may be able to strengthen society through lower healthcare costs and more environmental public good provision. Moreover, consumers have, through their purchasing choices, a strong role in driving environmentally responsible production methods, which can ensure the food system is secure for the present and future generations. We hope that concerns over the environmental impact of consumer choices, which may arise from this study will motivate the design of low-carbon interventions!

Declaration of competing interest

None.

Acknowledgements

The research was founded and conducted as part of the 'Sustainability and Food [in]security' project of the Department of Economics, Society, Politics at the University of Urbino Carlo Bo and is part of the innovative PhD 'Models for the diffusion and impact assessment of innovations for organic food chains' at the University of Urbino Carlo Bo promoted by the Marche region. We are grateful to participants to the Workshop on "Climate change and ecological behavior: driving the transition" at the University of Florence, and to the LVIII SIDEA Conference for useful comments.

Appendix A

Table A1
Questionnaire – translated version in English.

Question	Answer
What gender do you identify with?	Male Female
Please indicate your birth year	*[open ended]*
What is the highest education qualification you have?	Elementary school Secondary school Diploma Degree Post-graduate degree (master, PhD..)
How often would you say you eat the following types of food? (1 = Never; 2 = Once or twice a week; 3 = Three or four times a week; 4 = Every day or almost; 5 = Several times a day)	Meat Fish and seafood products Vegetables and legumes

(*continued on next page*)

Table A1 (*continued*)

Question	Answer
	Bread, pasta, rice
	Sugar, jams, honey, chocolate and confectionery
	Milk, cheese and eggs
	Fruit
	Ready meals
	Wine and alcoholic beverages
	Mineral waters, soft drinks, fruit and vegetable juices
When shopping for groceries, how much importance do you give, on a scale of 1 to 10, to each of the following?	They must be tasty products that I and my family like
	There should be no ingredients on the label that I consider unhealthy
	They must be fat-free products
	They must be of Italian origin (Made in Italy)
	They must be organic or zero km
	They must be convenient or on offer
	They must respect the environment
	They must be quick to prepare
	They must be produced by companies that respect workers
	They must respect my religious beliefs
	They must not be industrially sourced, too refined
How often do you feel concerned, for yourself or your family members, about (frequently, sometimes, rarely, never)	The safety of the food we eat
	The presence of unhealthy ingredients in the food we eat (additives, residues, etc.)
	Not having money to buy enough food
	Lack of food due to emergencies, natural disasters or droughts
	Having health problems due to the diet
Which of the following statements about the environment and the economy would you agree with?	Environmental protection should be a priority, even at the cost of slowing economic growth
	Economic growth should take priority, even if the environment suffers to some extent
Can you tell me what your family's monthly net income is closest to?	Less than €600
	Between €600 and €1000
	Between €1000 and €1500
	Between €1500 and €2000
	Between €2000 and €2500
	Between €2500 and €3000
	Between €3000 and €4000
	Between €4000 and €5000
	Between €5000 and €8000
	Over €8000

Table A2
Greenhouse gas emissions across the supply chain.

		GHG (kg CO_2eq)								
Product		LUC	Feed	Farm	Processing	Transport	Packaging	Retail	Sum	Average
Meat	Bovine Meat (beef herd)	16.3	1.9	39.4	1.3	0.3	0.2	0.2	59.6	24.0
	Bovine Meat (dairy herd)	0.9	2.5	15.7	1.1	0.4	0.3	0.2	21.1	
	Lamb & Mutton	0.5	2.4	19.5	1.1	0.5	0.3	0.2	24.4	
	Pig Meat	1.5	2.9	1.7	0.3	0.3	0.3	0.2	7.3	
	Poultry Meat	2.5	1.8	0.7	0.4	0.3	0.2	0.2	6.1	
	Animal Fats	2.0	2.4	1.2	0.4	0.3	0.3	0.2	6.7	
	Buffalo	9.6	2.2	29.0	1.2	0.4	0.3	0.2	42.8	
Fish and seafood	Fish & Crustaceans (capture)	0.0	0.0	2.4	0.0	0.1	0.1	0.1	2.8	6.6
	Fish (farmed)	0.5	0.8	3.6	0.0	0.1	0.1	0.0	5.2	
	Crustaceans (farmed)	0.2	2.5	8.4	0.0	0.2	0.3	0.2	11.9	
Vegetables and legumes	Other Pulses	0.0	0.0	1.1	0.0	0.1	0.4	0.0	1.6	0.8
	Peas	0.0	0.0	0.7	0.0	0.1	0.0	0.0	0.9	
	Tomatoes	0.4	0.0	0.7	0.0	0.2	0.1	0.0	1.4	
	Onions & Leeks	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.4	
	Root Vegetables	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.4	
	Brassicas	0.0	0.0	0.3	0.0	0.1	0.0	0.0	0.4	
	Other Vegetables	0.0	0.0	0.2	0.1	0.2	0.0	0.0	0.5	
Dairy and eggs	Soymilk	0.2	0.0	0.1	0.2	0.1	0.1	0.3	0.9	6.4
	Milk	0.5	0.2	1.5	0.1	0.1	0.1	0.3	2.8	
	Cheese	4.5	2.3	13.1	0.7	0.1	0.2	0.3	21.2	
	Eggs	0.7	2.2	1.3	0.0	0.1	0.2	0.0	4.5	
	Butter, Cream & Ghee	0.5	0.2	1.5	0.1	0.1	0.1	0.3	2.8	
Fruit	Citrus Fruit	−0.1	0.0	0.3	0.0	0.1	0.0	0.0	0.3	0.7
	Bananas	0.0	0.0	0.3	0.1	0.3	0.1	0.0	0.7	
	Apples	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.4	
	Berries & Grapes	0.0	0.0	0.7	0.0	0.2	0.2	0.0	1.2	
	Other Fruit	0.1	0.0	0.4	0.0	0.2	0.0	0.0	0.8	

Source: Poore and Nemecek, 2018.

Table A3
Results from the structural equation model standardized (maximum likelihood).

	CO2e		Motives						Concerns				Env. beliefs	
			Pro-social motives		Health		Private		Health & Safety		Poverty			
Structural	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Intercept	1.981***	0.1607	/	/	/	/	/	/	/	/	/	/	/	/
Pro-social motives	0.074	0.0859	/	/	/	/	/	/	/	/	/	/	/	/
Health motives	−0.286***	0.089	/	/	/	/	/	/	/	/	/	/	/	/
Private motives	0.303***	0.044	/	/	/	/	/	/	/	/	/	/	/	/
Env. beliefs	/	/	0.075***	0.023	0.081**	0.026	−0.081***	0.032	/	/	/	/	/	/
Health & safety conc.	/	/	0.370***	0.034	0.423***	0.038	−0.106**	0.050	/	/	/	/	/	/
Poverty concerns	/	/	−0.086**	0.041	−0.088*	0.047	0.330***	0.059	/	/	/	/	/	/
Female	0.053**	0.024	−0.038*	0.023	−0.016	0.027	−0.062*	0.033	−0.118***	0.028	−0.093***	0.026	0.026	0.024
Age: 18–29	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Age: 30–44	−0.049	0.033	0.043	0.032	0.043	0.037	−0.039	0.047	0.060*	0.039	0.009	0.037	0.004	0.033
Age: 45–54	−0.136***	0.033	0.113***	0.032	0.136***	0.036	0.040	0.046	0.054	0.038	−0.069*	0.036	0.047	0.032
Age: 55–64	−0.150***	0.035	0.281***	0.030	0.195***	0.035	−0.065	0.046	0.080**	0.037	−0.115***	0.035	0.015	0.031
Age: >65	−0.207***	0.037	0.392***	0.033	0.282***	0.039	0.058	0.050	0.035	0.040	−0.228***	0.037	0.071**	0.034
Elementary school	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Secondary school	−0.019	0.054	−0.037	0.052	−0.026	0.060	0.095	0.076	0.055	0.063	−0.012	0.060	0.116**	0.053
Diploma	0.076	0.077	−0.202*	0.073	−0.126*	0.085	−0.056	0.108	0.127	0.089	−0.115	0.084	0.263***	0.075
UG Degree	0.059	0.072	−0.219**	0.069	−0.146*	0.080	−0.026	0.103	0.133*	0.083	−0.214***	0.078	0.271***	0.070
PG degree	0.071*	0.043	−0.107*	0.042	−0.078*	0.048	−0.029	0.062	0.072	0.051	−0.102**	0.048	0.144***	0.043
Income: < 1000	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Income: 1000–1500	0.038	0.032	−0.044	0.031	−0.016	0.036	−0.039	0.046	−0.004	0.038	−0.114***	0.036	−0.052*	0.032
Income: 1500–2000	0.098***	0.035	−0.062*	0.034	−0.001	0.040	−0.032	0.050	0.018	0.040	−0.257***	0.037	0.005	0.034
Income: 2000–2500	0.077***	0.031	−0.051*	0.031	−0.033	0.036	−0.031	0.045	−0.026	0.036	0.264***	0.033	−0.010	0.030
Income: 2500–3000	0.074**	0.031	−0.033	0.031	−0.024	0.036	−0.058	0.046	−0.062*	0.036	−0.294***	0.033	−0.003	0.031
Income: > 3000	0.113***	0.035	−0.080**	0.036	−0.011	0.040	−0.096*	0.052	0.006	0.038	−0.406***	0.035	0.021	0.032
Income: NA	0.036	0.029	−0.005	0.028	0.000	0.033	−0.077*	0.041	0.012	0.033	−0.189***	0.031	−0.017	0.028

Significance is as follows: * = p < 0.1; ** = p < 0.05; *** = p < 0.01. Number of observations: 1836. Estimation method: maximum likelihood. Log Likelihood = −68,728.394. The model allows for correlated residuals of the following pairs of equations: Pro-Social Motives-Health Motives; Private Motives-Health Motives; Pro-Social Motives-Private Motives; Health & Safety Concerns-Poverty Concerns.

Table A4
Results from the structural equation model by category, standardized (maximum likelihood with missing values).

	Meat		Fish		Vegetables		Dairy		Fruit		Ready meals	
	Coefficient	S. E.	Coefficient	S. E.	Coefficient	S. E.	Coefficient	S. E.	Coefficient	S. E.	Coefficient	S. E.
Intercept	1.9428***	0.1389	1.4864***	0.1434	1.7282***	0.1413	2.0364***	0.1423	1.6928***	0.1420	0.7709***	0.1354
Pro-social motives	−0.0428	0.0891	0.0182	0.0925	0.2417***	0.0892	0.1112	0.0906	0.2508***	0.0881	0.0746	0.0888
Health motives	−0.2175**	0.0922	0.0264	0.0964	−0.0353	0.0922	−0.0906	0.0943	−0.0135	0.0915	−0.2646***	0.0917
Private motives	0.2173***	0.0439	0.0871*	0.0459	−0.1879***	0.0435	0.0853*	0.0447	−0.0729*	0.0427	0.3056***	0.0425
Female	0.0751***	0.0227	0.0294	0.0228	−0.1758***	0.0220	−0.0354	0.0228	−0.0674***	0.0219	0.0477**	0.0227
Age: 18–29	Baseline		Baseline		Baseline		Baseline		Baseline		Baseline	
Age: 30–44	−0.0592*	0.0321	0.0052	0.0322	−0.0441	0.0316	−0.0544*	0.0322	0.0039	0.0310	−0.0110	0.0320
Age: 45–54	−0.1238***	0.0316	−0.0658**	0.0318	−0.0093	0.0313	−0.0215	0.0319	0.0918***	0.0306	−0.0963***	0.0316
Age: 55–64	−0.0874***	0.0336	0.0102	0.0339	−0.0102	0.0333	−0.0153	0.0338	0.0710**	0.0325	−0.1732***	0.0332
Age: >65	−0.1482***	0.0384	−0.0215	0.0389	0.0075	0.0382	−0.0078	0.0388	0.1661***	0.0371	−0.2127***	0.0380
Primary school	Baseline		Baseline		Baseline		Baseline		Baseline		Baseline	
Secondary school	−0.0543	0.0462	−0.0065	0.0462	0.0106	0.0455	−0.1139**	0.0462	0.0127	0.0445	0.0364	0.0462
Diploma	−0.0499	0.0631	0.0660	0.0631	0.0011	0.0622	−0.0838	0.0632	0.0766	0.0607	0.1363**	0.0630
UG degree	−0.0876	0.0591	0.0725	0.0592	0.0165	0.0583	−0.1070*	0.0592	0.0953*	0.0569	0.1477**	0.0590
PG degree	−0.0370	0.0370	0.0443	0.0370	0.0379	0.0364	0.0044	0.0371	0.0779**	0.0356	0.1109***	0.0368
Income: < 1000	Baseline		Baseline		Baseline		Baseline		Baseline		Baseline	
Income: 1000–1500	0.0150	0.0308	−0.0336	0.0310	0.0161	0.0304	0.0436	0.0310	0.0228	0.0298	0.0436	0.0307
Income: 1500–2000	0.0580*	0.0330	0.0008	0.0333	0.0681**	0.0326	0.0183	0.0332	0.0027	0.0319	0.0814**	0.0329
Income: 2000–2500	0.0596**	0.0293	0.0125	0.0295	0.0548*	0.0289	0.0065	0.0294	0.0116	0.0283	0.0586**	0.0292
Income: 2500-€000	0.0432	0.0296	0.0138	0.0297	0.0782***	0.0291	0.0120	0.0297	0.0199	0.0285	0.0687**	0.0294
Income: > 3000	0.0852**	0.0336	0.0361	0.0340	0.1099***	0.0331	0.0321	0.0338	0.0325	0.0325	0.0890***	0.0335
Income: NA	0.0171	0.0285	0.0010	0.0286	0.0409	0.0281	0.0349	0.0286	0.0340	0.0275	0.0502*	0.0285
Log likelihood	−74,165.99		−71,394.56		−69,440.73		−72,347.80		−69,548.10		−75,322.96	
LR test: chi2 (286)	1423.09***		1429.26***		1414.92***		1425.17***		1421.67		1459.37	

Significance is as follows: * = p < 0.1; ** = p < 0.05; *** = p < 0.01. Number of observations: 2029. Estimation method = maximum likelihood with missing values. Note: UG = undergraduate; PG = postgraduate. The model allows for correlated residuals of the following pairs of equations: Pro-Social Motives-Health Motives; Private Motives-Health Motives; Pro-Social Motives-Private Motives; Health & Safety Concerns-Poverty Concerns.

References

Aarts, H., Dijksterhuis, A., 2000. Habits as knowledge structures: automaticity in goal-directed behavior. J. Pers. Soc. Psychol. 78 (1), 53–63.

Acock, A.C., 2013. Discovering Structural Equation Modeling Using Stata. Stata Press Books.

Ahmed, N., Li, C., Khan, A., Qalati, S.A., Naz, S., Rana, F., 2021. Purchase intention toward organic food among young consumers using theory of planned behavior: role of environmental concerns and environmental awareness. J. Environ. Plan. Manag. 64 (5), 796–822.

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50 (2), 179–211.

Allen, M.R., Friedlingstein, P., Girardin, C.A.J., Jenkins, S., Malhi, Y., Mitchell-Larson, E., Peters, G.P., Rajamani, L., 2022. Net zero: science, origins, and implications. Annu. Rev. Environ. Resour. 47 (1), 849–887.

Attwood, S., Hajat, C., 2020. How will the Covid-19 pandemic shape the future of meat consumption? Public Health Nutr. 23 (17), 3116–3120.

Azzurra, A., Massimiliano, A., Angela, M., 2019. Measuring sustainable food consumption: a case study on organic food. Sustain. Prod. Consum. 17, 95–107.

Bagozzi, R.P., Kimmel, S.K., 1995. A comparison of leading theories for the prediction of goal-directed behaviours. Br. J. Soc. Psychol. 34 (4), 437–461.

Baldi, L., Bertoni, D., Migliore, G., Peri, M., 2019. How alternative food networks work in a metropolitan area? An analysis of solidarity purchase groups in northern Italy. Agric. Food Econ. 7 (1), 20.

Bamberg, S., 2003. How does environmental concern influence specific environmentally related behaviors? A new answer to an old question. J. Environ. Psychol. 23 (1), 21–32.

Barrett, C.B., 2010. Measuring food insecurity. Science 327 (5967), 825–828.

Bartoš, V., Bauer, M., Chytilová, J., Levely, I., 2021. Psychological effects of poverty on time preferences. Econ. J. 131 (638), 2357–2382.

Béné, C., 2020. Resilience of local food systems and links to food security – a review of some important concepts in the context of Covid-19 and other shocks. Food Secur. 12 (4), 805–822.

Berry, E.M., Dernini, S., Burlingame, B., Meybeck, A., Conforti, P., 2015. Food security and sustainability: can one exist without the other? Public Health Nutr. 18 (13), 2293–2302.

Bimbo, F., 2023. Climate change-aware individuals and their meat consumption: evidence from Italy. Sustain. Prod. Consum. 36, 246–256.

Bolderdijk, J.W., Steg, L., Geller, E.S., Lehman, P.K., Postmes, T., 2013. Comparing the effectiveness of monetary versus moral motives in environmental campaigning. Nat. Clim. Chang. 3 (4), 413–416.

Bowman, D., Minehart, D., Rabin, M., 1999. Loss aversion in a consumption–savings model. J. Econ. Behav. Organ. 38, 155–178. https://doi.org/10.1016/S0167-2681(99)00004-9.

Brown, H., Mills, S., Albani, V., 2022. Socioeconomic risks of food insecurity during the Covid-19 pandemic in the Uk: findings from the understanding society Covid survey. BMC Public Health 22 (1), 1–9.

Camilleri, A.R., Larrick, R.P., Hossain, S., Patino-Echeverri, D., 2019. Consumers underestimate the emissions associated with food but are aided by labels. Nat. Clim. Chang. 9 (1), 53–58.

Carlsson, F., Gravert, C., Johansson-Stenman, O., Kurz, V., 2021. The use of green nudges as an environmental policy instrument. Rev. Environ. Econ. Policy 15 (2), 216–237.

Cerri, J., Testa, F., Rizzi, F., 2018. The more I care, the less I will listen to you: how information, environmental concern and ethical production influence consumers' attitudes and the purchasing of sustainable products. J. Clean. Prod. 175, 343–353.

Clark, M., Springmann, M., Rayner, M., Scarborough, P., Hill, J., Tilman, D., Macdiarmid, J.I., Fanzo, J., Bandy, L., Harrington, R.A., 2022. Estimating the environmental impacts of 57,000 food products. Proc. Natl. Acad. Sci. 119 (33), e2120584119.

Çoker, E.N., Pechey, R., Frie, K., Jebb, S.A., Stewart, C., Higgs, S., Cook, B., 2022. A dynamic social norm messaging intervention to reduce meat consumption: a randomized cross-over trial in retail store restaurants. Appetite 169, 105824.

Costanza, R., Kubiszewski, I., Giovannini, E., Lovins, H., McGlade, J., Pickett, K.E., Ragnarsdóttir, K.V., Roberts, D., De Vogli, R., Wilkinson, R., 2014. Development: time to leave Gdp behind. Nature 505 (7483), 283–285.

Daly, H., 2013. A further critique of growth economics. Ecol. Econ. 88, 20–24.

De Groot, J., Steg, L., 2007. General beliefs and the theory of planned behavior: the role of environmental concerns in the Tpb. J. Appl. Soc. Psychol. 37 (8), 1817–1836.

Dickson-Spillmann, M., Siegrist, M., Keller, C., 2011. Attitudes toward chemicals are associated with preference for natural food. Food Qual. Prefer. 22 (1), 149–156.

Dominguez-Viera, M.E., van den Berg, M., Handgraaf, M., Donovan, J., 2023. Influence of poverty concerns on demand for healthier processed foods: a field experiment in Mexico City. Econ. Human Biol. 49, 101215.

Evans, G.W., 2019. Projected behavioral impacts of global climate change. Annu. Rev. Psychol. 70 (1), 449–474.

Fankhauser, S., Smith, S.M., Allen, M., Axelsson, K., Hale, T., Hepburn, C., Kendall, J.M., Khosla, R., Lezaun, J., Mitchell-Larson, E., Obersteiner, M., Rajamani, L., Rickaby, R., Seddon, N., Wetzer, T., 2022. The meaning of net zero and how to get it right. Nat. Clim. Chang. 12 (1), 15–21.
Fujii, S., 2006. Environmental concern, attitude toward frugality, and ease of behavior as determinants of pro-environmental behavior intentions. J. Environ. Psychol. 26 (4), 262–268.
Garnett, P., Doherty, B., Heron, T., 2020. Vulnerability of the United Kingdom's food supply chains exposed by Covid-19. Nat. Food 1 (6), 315–318.
Haushofer, J., Fehr, E., 2014. On the psychology of poverty. Science 344 (6186), 862–867.
Hoek, A.C., Luning, P.A., Stafleu, A., de Graaf, C., 2004. Food-related lifestyle and health attitudes of Dutch vegetarians, non-vegetarian consumers of meat substitutes, and meat consumers. Appetite 42 (3), 265–272.
Hoek, A.C., Malekpour, S., Raven, R., Court, E., Byrne, E., 2021. Towards environmentally sustainable food systems: decision-making factors in sustainable food production and consumption. Sustain. Prod. Consum. 26, 610–626.
Huang, M.-H., Rust, R.T., 2011. Sustainability and consumption. J. Acad. Mark. Sci. 39 (1), 40–54.
Hynes, W., Trump, B., Love, P., Linkov, I., 2020. Bouncing forward: a resilience approach to dealing with Covid-19 and future systemic shocks. Environ. Syst. Decis. 40 (2), 174–184.
IPCC, 2018. Global Warming of 1.5°C. an Ipcc Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty.
Jones, N.R.V., Tong, T.Y.N., Monsivais, P., 2018. Meeting Uk dietary recommendations is associated with higher estimated consumer food costs: an analysis using the national diet and nutrition survey and consumer expenditure data, 2008–2012. Public Health Nutr. 21 (5), 948–956.
Kanay, A., Hilton, D., Charalambides, L., Corrégé, J.-B., Inaudi, E., Waroquier, L., Cézéra, S., 2021. Making the carbon basket count: goal setting promotes sustainable consumption in a simulated online supermarket. J. Econ. Psychol. 83, 102348.
Kneafsey, M., Dowler, E., Lambie-Mumford, H., Inman, A., Collier, R., 2013. Consumers and food security: uncertain or empowered? J. Rural. Stud. 29, 101–112.
Kopittke, P.M., Menzies, N.W., Wang, P., McKenna, B.A., Lombi, E., 2019. Soil and the intensification of agriculture for global food security. Environ. Int. 132, 105078.
Lazzarini, G.A., Zimmermann, J., Visschers, V.H.M., Siegrist, M., 2016. Does environmental friendliness equal healthiness? Swiss consumers' perception of protein products. Appetite 105, 663–673.
Leach, A.M., Emery, K.A., Gephart, J., Davis, K.F., Erisman, J.W., Leip, A., Pace, M.L., D'Odorico, P., Carr, J., Noll, L.C., Castner, E., Galloway, J.N., 2016. Environmental impact food labels combining carbon, nitrogen, and water footprints. Food Policy 61, 213–223.
Loopstra, R., 2018. Interventions to address household food insecurity in high-income countries. Proc. Nutr. Soc. 77 (3), 270–281.
MacCallum, R.C., Austin, J.T., 2000. Applications of structural equation modeling in psychological research. Annu. Rev. Psychol. 51 (1), 201–226.
Macdiarmid, J.I., Kyle, J., Horgan, G.W., Loe, J., Fyfe, C., Johnstone, A., McNeill, G., 2012. Sustainable diets for the future: can we contribute to reducing greenhouse gas emissions by eating a healthy diet? Am. J. Clin. Nutr. 96 (3), 632–639.
Macdiarmid, J.I., Loe, J., Kyle, J., McNeill, G., 2013. "It was an education in portion size". Experience of eating a healthy diet and barriers to long term dietary change. Appetite 71, 411–419.
Macfadyen, S., Tylianakis, J.M., Letourneau, D.K., Benton, T.G., Tittonell, P., Perring, M. P., Gómez-Creutzberg, C., Báldi, A., Holland, J.M., Broadhurst, L., Okabe, K., Renwick, A.R., Gemmill-Herren, B., Smith, H.G., 2015. The role of food retailers in improving resilience in global food supply. Glob. Food Secur. 7, 1–8.
MacKinnon, D.P., Fairchild, A.J., Fritz, M.S., 2007. Mediation analysis. Annu. Rev. Psychol. 58 (1), 593–614.
Mani, A., Mullainathan, S., Shafir, E., Zhao, J., 2013. Poverty impedes cognitive function. Science 341 (6149), 976–980.
Mardani, A., Streimikiene, D., Cavallaro, F., Loganathan, N., Khoshnoudi, M., 2019. Carbon dioxide (Co2) emissions and economic growth: a systematic review of two decades of research from 1995 to 2017. Sci. Total Environ. 649, 31–49.
McMichael, A.J., Powles, J.W., Butler, C.D., Uauy, R., 2007. Food, livestock production, energy, climate change, and health. Lancet 370 (9594), 1253–1263.
Milfont, T.L., Duckitt, J., 2010. The environmental attitudes inventory: a valid and reliable measure to assess the structure of environmental attitudes. J. Environ. Psychol. 30 (1), 80–94.
Milfont, T.L., Duckitt, J., Cameron, L.D., 2006. A cross-cultural study of environmental motive concerns and their implications for proenvironmental behavior. Environ. Behav. 38 (6), 745–767.
Molotoks, A., Smith, P., Dawson, T.P., 2021. Impacts of land use, population, and climate change on global food security. Food Energy Secur. 10 (1), e261.
Muller, L., Lacroix, A., Ruffieux, B., 2019. Environmental labelling and consumption changes: a food choice experiment. Environ. Resour. Econ. 73 (3), 871–897.
Mulligan, A.A., Luben, R.N., Bhaniani, A., Parry-Smith, D.J., O'Connor, L., Khawaja, A. P., Forouhi, N.G., Khaw, K.-T., 2014. A new tool for converting food frequency questionnaire data into nutrient and food group values: feta research methods and availability. BMJ Open 4 (3), e004503.
Nadricka, K., Millet, K., Verlegh, P.W.J., 2020. When organic products are tasty: taste inferences from an organic = healthy association. Food Qual. Prefer. 83, 103896.
Nauges, C., Wheeler, S.A., 2017. The complex relationship between Households' climate change concerns and their water and energy mitigation behaviour. Ecol. Econ. 141, 87–94.
Panzone, L.A., 2013. Saving money vs investing money: do energy ratings influence consumer demand for energy efficient goods? Energy Econ. 38, 51–63.
Panzone, L., Hilton, D., Sale, L., Cohen, D., 2016. Socio-demographics, implicit attitudes, explicit attitudes, and sustainable consumption in supermarket shopping. J. Econ. Psychol. 55, 77–95.
Panzone, L.A., Sniehotta, F.F., Comber, R., Lemke, F., 2020. The effect of traffic-light labels and time pressure on estimating kilocalories and carbon footprint of food. Appetite 155, 104794.
Panzone, L.A., Ulph, A., Hilton, D., Gortemaker, I., Tajudeen, I.A., 2021a. Sustainable by design: choice architecture and the carbon footprint of grocery shopping. J. Public Policy Mark. 40 (4), 463–486.
Panzone, L.A., Ulph, A., Zizzo, D.J., Hilton, D., Clear, A., 2021b. The impact of environmental recall and carbon taxation on the carbon footprint of supermarket shopping. J. Environ. Econ. Manag. 109, 102137.
Perino, G., Schwickert, H., 2023. Animal welfare is a stronger determinant of public support for meat taxation than climate change mitigation in Germany. Nat. Food 4 (2), 160–169.
Perugini, M., Bagozzi, R.P., 2001. The role of desires and anticipated emotions in goal-directed behaviours: broadening and deepening the theory of planned behaviour. Br. J. Soc. Psychol. 40 (1), 79–98.
Poore, J., Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. Science 360 (6392), 987–992.
Prada, M., Garrido, M.V., Rodrigues, D., 2017. Lost in processing? Perceived healthfulness, taste and caloric content of whole and processed organic food. Appetite 114, 175–186.
Prelec, D., Loewenstein, G., 1991. Decision making over time and under uncertainty: a common approach. Manag. Sci. 37 (7), 770–786.
Raghunathan, R., Walker-Naylor, R., Hoyer, W.D., 2006. The unhealthy = tasty intuition and its effects on taste inferences, enjoyment, and choice of food products. J. Mark. 70 (4), 170–184.
Ricci, E.C., Banterle, A., Stranieri, S., 2018. Trust to go green: an exploration of consumer intentions for eco-friendly convenience food. Ecol. Econ. 148, 54–65.
Ropret Homar, A., Knežević Cvelbar, L., 2021. The effects of framing on environmental decisions: a systematic literature review. Ecol. Econ. 183, 106950.
Ryan, R.M., Deci, E.L., 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am. Psychol. 55 (1), 68–78.
Saari, U.A., Damberg, S., Frömbling, L., Ringle, C.M., 2021. Sustainable consumption behavior of Europeans: the influence of environmental knowledge and risk perception on environmental concern and behavioral intention. Ecol. Econ. 189, 107155.
Sautron, V., Péneau, S., Camilleri, G.M., Muller, L., Ruffieux, B., Hercberg, S., Méjean, C., 2015. Validity of a questionnaire measuring motives for choosing foods including sustainable concerns. Appetite 87, 90–97.
Scarborough, P., Appleby, P.N., Mizdrak, A., Briggs, A.D.M., Travis, R.C., Bradbury, K.E., 2014. Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the Uk. Clim. Chang. 125.
Schmeichel, B.J., Vohs, K., 2009. Self-affirmation and self-control: affirming core values counteracts ego depletion. J. Pers. Soc. Psychol. 96 (4), 770–782.
Schmidt Rivera, X.C., Azapagic, A., 2019. Life cycle environmental impacts of ready-made meals considering different cuisines and recipes. Sci. Total Environ. 660, 1168–1181.
Schmidt Rivera, X.C., Espinoza Orias, N., Azapagic, A., 2014. Life cycle environmental impacts of convenience food: comparison of ready and home-made meals. J. Clean. Prod. 73, 294–309.
Schultz, P.W., 2001. The structure of environmental concern: concern for self, other people, and the biosphere. J. Environ. Psychol. 21 (4), 327–339.
Sherman, D.K., Cohen, G.L., 2006. The psychology of self-defense: self-affirmation theory. In: Advances in Experimental Social Psychology, vol 38. Elsevier Academic Press, San Diego, CA, US, pp. 183–242.
Shi, J., Visschers, V.H.M., Bumann, N., Siegrist, M., 2018. Consumers' climate-impact estimations of different food products. J. Clean. Prod. 172, 1646–1653.
SINU, 2014. "Standard Quantitativi Delle Porzioni," in Livelli Di Assunzione Di Riferimento Di Nutrienti Ed Energia Per La Popolazione Italiana - Iv Revisione, ed. In: Società Italiana di Nutrizione Umana (SINU), Milan SICS Editore Srl.
Snelgar, R.S., 2006. Egoistic, altruistic, and biospheric environmental concerns: measurement and structure. J. Environ. Psychol. 26 (2), 87–99.
Springmann, M., Godfray, H.C.J., Rayner, M., Scarborough, P., 2016. Analysis and valuation of the health and climate change cobenefits of dietary change. Proc. Natl. Acad. Sci. 113 (15), 4146–4151.
Steg, L., 2016. Values, norms, and intrinsic motivation to act proenvironmentally. Annu. Rev. Environ. Resour. 41 (1), 277–292.
Steg, L., Perlaviciute, G., van der Werff, E., Lurvink, J., 2014. The significance of hedonic values for environmentally relevant attitudes, preferences, and actions. Environ. Behav. 46 (2), 163–192.
Steptoe, A., Pollard, T.M., Wardle, J., 1995. Development of a measure of the motives underlying the selection of food: the food choice questionnaire. Appetite 25 (3), 267–284.
Subar, A.F., Midthune, D., Kulldorff, M., Brown, C.C., Thompson, F.E., Kipnis, V., Schatzkin, A., 2000. Evaluation of alternative approaches to assign nutrient values to food groups in food frequency questionnaires. Am. J. Epidemiol. 152 (3), 279–286.
Tai, S., 2019. In fairness to future generations of eaters. In: Georgetown Environmental Law Review, 32, p. 515.

Tandon, A., Dhir, A., Kaur, P., Kushwah, S., Salo, J., 2020. Why do people buy organic food? The moderating role of environmental concerns and trust. J. Retail. Consum. Serv. 57, 102247.
Thilmany, D., Canales, E., Low, S.A., Boys, K., 2021. Local food supply chain dynamics and resilience during Covid-19. Appl. Econ. Perspect. Policy 43 (1), 86–104.
van Herpen, E., Trijp, H.C.M.v., 2011. Front-of-pack nutrition labels. Their effect on attention and choices when consumers have varying goals and time constraints. Appetite 57 (1), 148–160.
Vermeir, I., Weijters, B., De Houwer, J., Geuens, M., Slabbinck, H., Spruyt, A., Van Kerckhove, A., Van Lippevelde, W., De Steur, H., Verbeke, W., 2020. Environmentally sustainable food consumption: a review and research agenda from a goal-directed perspective. Front. Psychol. 11.
Vermeulen, S.J., Campbell, B.M., Ingram, J.S.I., 2012. Climate change and food systems. Annu. Rev. Environ. Resour. 37 (1), 195–222.
Visschers, V.H.M., Siegrist, M., 2015. Does better for the environment mean less tasty? Offering more climate-friendly meals is good for the environment and customer satisfaction. Appetite 95, 475–483.
Whitmarsh, L., Seyfang, G., O'Neill, S., 2011. Public engagement with carbon and climate change: to what extent is the public 'carbon capable'? Glob. Environ. Chang. 21 (1), 56–65.
World Bank, 2023. Food security update - April 2023. https://www.worldbank.org/en/topic/agriculture/brief/food-security-update.
Zauberman, G., Kim, B.K., Malkoc, S.A., Bettman, J.R., 2009. Discounting time and time discounting: subjective time perception and intertemporal preferences. J. Mark. Res. 46 (4), 543–556.
Zaçe, D., Di Pietro, M.L., Reali, L., de Waure, C., Ricciardi, W., 2021. Prevalence, socio-economic predictors and health correlates of food insecurity among Italian children-findings from a cross-sectional study. Food Secur. 13 (1), 13–24.