Did the COVID-19 lockdown affect consumers' sustainable behaviour in food purchasing and consumption in China?

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ABSTRACT

The COVID-19 pandemic situation has altered consumers' behaviour in food purchasing and consumption. This study, as a first attempt, assesses how the COVID-19 lockdown affects Chinese consumers' purchasing and consumption behaviour from a sustainability point of view. To reach this objective, a semi-structured questionnaire is designed, collecting data from 1006 participants. The food purchasing behaviour towards the importance of sustainable attributes (P), sustainable and healthy diets (D), and food waste (W) as three dependent variables are measured, and three binary logistic regressions are estimated. The results suggest that gender and age are relevant factors affecting sustainable behaviour. Household size has a significant effect on the healthy diet shift and food waste reduction. Risk attitude has a negative and significant impact on the sustainable purchase decision. In addition, consumers' food security, financial, and health risk perceptions are highly important factors in understanding consumers' sustainable purchasing and consumption behaviour. Consumers' subjective and objective knowledge levels regarding COVID-19 influence consumers' sustainability shift during the lockdown. The findings provide some practical implications for policymakers and stakeholders to carry out more socially acceptable policy actions that ensure consumers' sustainable purchasing and consumption behaviour during the COVID-19 pandemic.

1. Introduction

A novel coronavirus (SARS-CoV-2) caused a newly emerged respiratory disease named by the World Health Organization as COVID-19 (COronaVIrus Disease 2019), which was first reported in Hubei Province, China in December 2019 and then spread across China and worldwide (Velavan & Meyer, 2020). Many countries began to conduct restrictions starting by washing hands with alcohol-based hand sanitisers, wearing face masks, decreasing social activities and ending with a complete lockdown. As a result, citizens were asked to stay home, and mobility was only justified for essential journeys, such as going to medical centres, buying food (e.g., going to grocery stores) or going to essential work, which affected their food buying and consumption behaviour (Ruiz-Roso et al., 2020).

The pandemic situation altered consumers' dietary habits, and the uncontrollable stress caused by the pandemic played an important role in affecting consumers' eating patterns (Yau & Potenza, 2013). For example, stress made people towards overeating, especially "comfort food" high in sugar, defined as "food craving" (Rodríguez-Martín & Meule, 2015) due to their effect in reducing stress (Ma et al., 2017). However, many consumers switched to a healthier and balanced diet during the COVID-19 lockdown in order to maintain a correct nutrition status and reduce health risks (Di Renzo et al., 2020; Sidor & Rzymski, 2020). For instance, in Spain, consumers tended to have healthier dietary habits during the COVID-19 pandemic (Rodríguez-Pérez et al., 2020). Also, some Chinese adults shifted to a healthier diet by increasing their consumption of vegetables and fruit than the situation before the restrictions (Wang, Lei, et al., 2020). This dietary change is also related to the time available for preparing meals. The COVID-19 situation brings individuals to spend more time cooking and trying new recipes (Sidor & Rzymski, 2020). However, although many restaurants were closed during the lockdown, restaurant-to-consumer delivery was still optional for consumers, and the order could be made directly through the restaurant's online platform (e.g., KFC, McDonald's, and Pizza Hut) or via a

third-party platform (e.g., Eleme platform in China) (Li et al., 2020). Previous studies have shown that food and dietary choices can affect the environment in different ways, such as climate change (GHGE greenhouse gas emissions), land, water and energy use, and biodiversity (Macdiarmid, 2013). Meat and dairy products contributed the most to these emissions (Garnett, 2008), while fruit and vegetables contributed less (low environmental impact). The 2010 Food and Agriculture Organization (FAO) defined sustainable diets as those diets with low environmental impacts which contribute to food and nutrition security and healthy life for present and future generations (Food and Agriculture Organization of the United Nations, 2010). According to their recommendation, a more sustainable diet included consumption of fresh ingredients, more seasonal foods, especially fresh fruit and vegetables, and less red and processed meat and salt. The study of Duchin (2005) showed that a healthy diet is rich in fresh fruit and vegetables, low in meat, and low in added sugar, salty snacks and saturated fatty acids. Thus, an increase in a healthier diet was regarded as more sustainable consumption in this research.

In fact, there have been many studies showing a trend for consumers' purchasing behaviour towards more sustainable attributes of food before the COVID-19 pandemic. These include consumers seeking more local, animal welfare, fair-trade, organic, seasonal, and carbon footprint food products (Codron et al., 2006). There is no doubt that the crisis caused by the COVID-19 pandemic has changed consumers' behaviour to buy even more of these food products with sustainable attributes. Previous research conducted in Catalonia (Spain) indicated that consumers' preferences for the local food products were enhanced during the economic crisis from 2008 (Escobar et al., 2018). Therefore, exploring the rationale for consumers' purchasing behaviour towards food products with sustainable attributes during the COVID-19 lockdown will allow policymakers and multi-agents stakeholders to carry out and design more socially acceptable policy actions that ensure the production and retail of food with sustainable attributes during the COVID-19 pandemic.

Consumers' food behaviour consists of the food product journeys: planning, purchasing, storage, preparation, and consumption of food, and food waste is an outcome of the way households deal with these different stages (Kim et al., 2019). At the buying stage, consumers often rely on food shopping routines and admit to regularly buying more food than needed (Evans, 2011) or buying food products they never use or seldom use, thus increasing the likelihood of food being spoiled and discarded as waste. In fact, one-third of the food produced globally for human consumption is lost or wasted (Food and Agriculture Organization of the United Nations, 2011). Food waste has negative environmental, economic, and social consequences for the sustainability of the food sector (Aschemann-Witzel et al., 2015; Garnett, 2011). More food that is wasted is a measure of less sustainability. The COVID-19 lockdown measures forced consumers to stay at home, resulting in a higher possibility of panic buying at grocery stores, which may cause food waste (Pappalardo et al., 2020). In addition, food waste increased due to the broken supply chains (e.g., absence of labour and food items getting stuck on the road due to restrictions on vehicle movements), which caused millions of products to rot in the fields (Sharma et al., 2020).

One of the major goals of the European societies is their quest for sustainable development (Abeliotis et al., 2010), and proper food production and consumption is a major component of overall achievable sustainability (Annunziata & Scarpato, 2014). A growing number of consumers are beginning to realize the importance to have more sustainable consumption as it can be an effective way to solve sustainability problems (Annunziata & Scarpato, 2014; de Bakker & Dagevos, 2012). In the last decades, many researchers have studied consumers' sustainable consumption (de Bakker & Dagevos, 2012; Gallenti et al., 2016; Lorek & Spangenberg, 2014). Because there are fewer studies on consumer sustainable consumption in Asian (emerging economy) countries compared with those in European (developed economy) markets, it seems appropriate to understand consumers' sustainable behaviour in

China in general, and specifically to analyze how the COVID-19 lockdown has affected such behaviour. We believe that the following research is the first study to explore such an impact. In order to examine Chinese consumers' consumption and purchasing behaviour from a sustainability point of view, several specific objectives were proposed as follows: a) changes in buying food products with sustainable attributes as a sustainable purchasing behaviour; b) the effect of the lockdown on the sustainability of behavioural decisions using changes in consumers' diets (whether they adopted a healthier food choice or not) as a sustainable consumption shift; and c) how food waste behaviour changed during the COVID-19 lockdown.

2. Material and methods

2.1. Data collection

Data were collected from 1006 consumers in China using a semi-structured questionnaire in an online environment (Wenjuanxing platform, similar to Qualtrics) in June 2020, two months after the lifting of the Wuhan lockdown (April 8, 2020), when the sanitary situation was gradually returning to be normal. The starting point of our sampling procedure was using a non-probabilistic sampling method (Quota sampling) where we divided the sample size into mutually exclusive subgroups based on known quotas of gender, and a selection criterion to be eligible was selected. Thus, data were collected by promoting the link to the questionnaire in several electronic media following the snowballing procedure by sending it to students' contacts (e.g., family and relatives), consumer associations or organizations, local municipality contact and public institutions (e.g., consumers/citizens issue office), and personal and institutional social network (WeChat, similar to WhatsApp and Facebook; Weibo, similar to Twitter; and other Chinese social networks) and asked them to share with their contacts (e.g., family and relatives). Snowball sampling could reduce costs and time, achieve higher response rates, and expand samples with different professions, places, genders, and ages (Baltar & Brunet, 2012; Benfield & Szlemko, 2006). Only consumers who were totally or in part responsible for food purchasing were included in the study. Respondents who volunteered to participate in the survey and received an explanation of the objectives of the study were told that the information received would be exclusively used for research and that their confidentiality would be honoured. At the same time, we offered incentives (5 RMB) to the participants through the Wenjuanxing platform to boost completion rates. That is, when they complete the questionnaire (finish answering the last question of the questionnaire), they will see and get incentives to thank them for participating in the survey. The questionnaire was approved by the Ethics Committee of the Centre for Agro-food Economy and Development and was conducted according to the ethical principles in social science studies.

2.2. Measuring sustainability of consumers' purchasing and consumption behaviour

In order to measure how the COVID-19 lockdown influences consumers' purchasing and consumption behaviour from a sustainability point of view in China, three dependent variables were defined, consisting of identifying sustainable purchasing behaviour *(P)* (purchasing food products with sustainable attributes), sustainable and healthy diets adoption *(D)*, and food waste behaviour change *(W)*.

Consumers' change in purchasing behaviour *(P)* towards sustainable attributes was identified, based on the following food selections: local, animal welfare, fair-trade, and organic food. Changes were measured to determine whether consumers' purchasing behaviour during the COVID-19 lockdown became more or less sustainable. Respondents were asked about the change in sustainable attributes of food purchasing behaviour *(P)* scoring from "-3" (decreased a lot) to "+3" (increased a lot) (*How has the importance of the following attributes changed for you*

during COVID-19? - Local; animal welfare; fair-trade; organic). Regarding sustainable consumption, it was measured using a proxy variable representing changes in a healthy diet adoption (*D*). An increase in a healthier diet was considered a tendency to more sustainable consumption. As previously noted, according to the FAO and previous study (Duchin, 2005), a more sustainable diet may include consumption of fresh ingredients, more fruit and vegetables items, and less salt. Thus, changes in the consumption of these food items were considered as a proxy for a sustainable and healthy diet in this research. A synthetic index was created reflecting the increase in the consumption of healthy food products. Individual scores from "-3" (decreased a lot) to "+3" (increased a lot) of healthy food items (fruits, vegetables, fresh food, less processed food, low in calories, low in fats, low in sugar, low in salt, high in fibre, and high in calcium) were summed up. Furthermore, individual scores of unhealthy food items (sweets, chocolate, candies, and snacks) were also summed up after reversing the scale. Finally, the food waste (*W*) variable was measured by asking respondents about the change in food waste at home scoring from "-3" (decreased a lot) to "+3" (increased a lot) (*How has COVID-19 impacted the amount of food waste in your home?*). In the case of the mentioned changes to be investigated (*P, D, and W*), the binary logistic model was used to analyze the behavioural changes before and during the lockdown. The first one comprised respondent who stated that the lockdown caused an increasing change in behaviour analyzed (*Y = 1*) compared to those they didn't (*Y = 0*).

Previous research demonstrated that risk attitude and risk perception could affect consumers' purchasing and consumption behaviour (Zhu & Deng, 2020). The preponderance of the literature concludes that consumers' knowledge influences their food purchasing behaviour. For example, some studies show that knowledge plays an important role in the purchase of organic products (Hill & Lynchehaun, 2002; Wang et al., 2019). In addition, health concerns and food security concerns influence consumers' attitude and ultimately influence purchasing behaviour towards organic food (Basha et al., 2015). Consumers' buying and consumption intentions and behaviour may change due to their experiences during the COVID-19 lockdown. Therefore, the independent variables were those noted as potentially relevant factors and were presented as follows:

(1) Socio-demographic variables presented in Table 1;
(2) Multiple Price List (MPL) stated risk attitude;
(3) Risk perception (including health, financial, and food security risks);
(4) Consumers' health concerns level about COVID-19;
(5) Experience (food shortages, food price increases, and neither);
(6) Subjective knowledge level regarding COVID-19;
(7) Objective knowledge level regarding COVID-19.

Fig. 1 summarizes the different determinant factors finally included in this study to understand consumers' shift in the sustainability behaviour of food consumption and purchasing in China.

2.2.1. Multiple Price List stated risk attitude: the lotteries approach

Risk perception and risk attitude can exert an influence on behavioural intention (Zhu & Deng, 2020). In this context, the consumers' stated risk attitude is measured by adopting a multiple price list (MPL), known as "Lotteries", introduced by Holt and Laury (H&L) (Drichoutis & Lusk, 2016). All definitions of "risk" included two characteristics. One was related to uncertainty, and the other one was its consequences. The simplest definition of risk was "uncertainty that matters", since uncertainty without consequence poses no risk (Hillson & Murray-Webster, 2006). "Risk attitude" was defined as "consumers' consistent choice tendency to face different risk levels" or "consumers' willingness to accept risks" (Schroeder et al., 2007). Different risk attitude elicitation techniques were employed in previous research (Pennings & Garcia, 2001; Smidts, 1997), and the MPL was very popular in some experimental studies in psychology and economics (Harrison et al., 2007). The

Table 1
Socio-demographic variables in the research.

Socio-demographic variables		Numbers (%)
Gender	Male	507 (50.4)
	Female	499 (49.6)
Age	18–39 years	631 (62.7)
	40–59 years	367 (36.5)
	More than 60 years	8 (0.8)
	Average age (years)	36.5
Monthly household income (before the lockdown)	<5,000 RMB	149 (14.8)
	5,001–15,000 RMB	371 (36.9)
	>15,001 RMB	279 (27.7)
		Missing 207 (20.6)
Monthly household income (during the lockdown)	<5,000 RMB	286 (28.4)
	5,001–15,000 RMB	335 (33.3)
	>15,001 RMB	176 (17.5)
		Missing 209 (20.8)
Stated health status	Unhealthy	272 (27.0)
	Healthy	734 (73.0)
Household size	1 person	22 (2.2)
	2 persons	67 (6.7)
	3 persons	241 (24.0)
	4 persons	326 (32.4)
	5 persons	186 (18.5)
	6 persons or more	164 (16.3)
Sample size		1006

Note: 1 RMB = 0.13 euro = 0.14 US dollar (at the time of writing this paper).
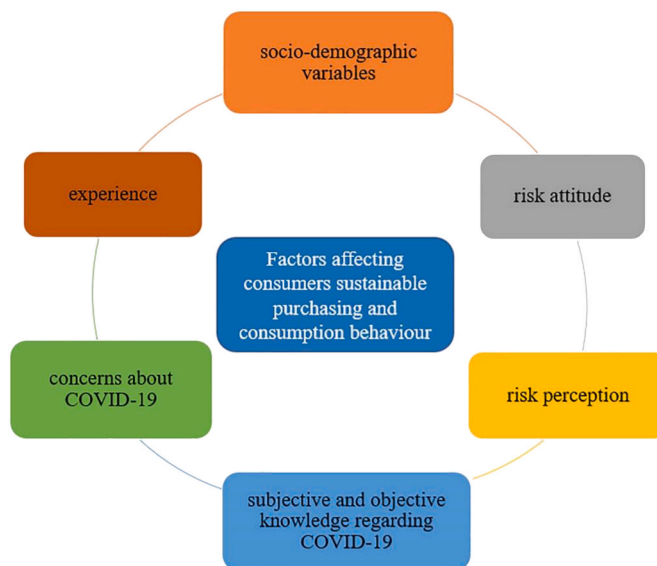

Fig. 1. Factors affecting consumers' sustainable behaviour.

MPL is a relatively simple procedure for eliciting values from a subject (Anderson et al., 2007), and it is based on the economic theory of the expected utility (Orduño et al., 2019). Tversky (1995) indicates that one of the fundamental assumptions of the economic analysis of risk that is built into portfolio theory is the assumption of risk aversion. Analysts assume that, holding expected value constant, people would rather have a certain return than an uncertain return, and people need to be compensated for bearing risk and people exhibit inconsistent attitudes towards risk. Moreover, risk aversion is not always valid, especially in the domain of losses, where risk-loving is frequently observed.

The point at which an individual switches from choosing one

outcome over the other is often used as a measure of risk aversion (Drichoutis & Lusk, 2016). In the Lottery Game of this research, question 1: Option A is that individuals can be sure to get 200 RMB, while option B is flipping a coin. If the coin comes out HEADS, they will get 200 RMB, but if TAILS comes out, they will get nothing. Question 2: Option A is that individuals can be sure to get 190 RMB, while option B is flipping a coin. If the coin comes out HEADS, they will get 200 RMB, but if TAILS comes out, they will get nothing. By that analogy, 20 questions (until option A is 10 RMB, option B remains unchanged) are asked to measure consumers' risk attitudes. This part of the questionnaire about risk attitudes will be over when respondents choose option B at any time. In the 20 questions, the payoff associated with option A declines systematically, while the payoff for option B remains unchanged (Brick et al., 2012).

Table 2 displayed the payoff matrix from the risk attitude experiment in this research. Previous literature indicated that participants who were risk-loving would choose option B in the first lottery task, while risk-averse participants would choose option A in the second last row. A risk-neutral subject should switch from choosing A to B when the expected values (EV) of each are approximately the same, so a risk-neutral subject would choose A for the first four rows and B thereafter (Andersen et al., 2006; Brick et al., 2012; Harrison et al., 2005). In this research, a risk-loving person would choose option B in the first task, and a risk-neutral participant would choose option B from A in the eleventh task, meaning that a risk-neutral person would choose A ten times before switching to B. Risk-averse subjects would choose option A in the twentieth task. The number of "safe choices" (choosing option A) or the switching point from choosing A to B is often used to describe risk attitude (Lusk & Coble, 2005). According to expected utility theory, people should choose A from task 1 to 10 and choose B from task 11 to 20. The safe choices number of risk-loving people should be below or equal to 9, and the safe choices number of risk-neutral ones should be equal to 10. The safe choices number of risk-averse people should be more than or equal to 11. This research used this method to analyze the risk attitude variable.

2.2.2. Risk perception

Risk perception refers to people's judgments and evaluations of hazards they (or environments) are or might be exposed to. Such perceptions steer decisions about the acceptability of risks and have a crucial impact on behaviour before, during, and after a disaster

(Rohrmann, 2008). As a consequence, three types of perceived risks, including health risk, financial risk, and food security risk, are measured in this research. Participants' health risk perception is elicited using a 10-point Likert scale ranging from 1 (not serious at all) to 10 (very serious) (*In case you contract COVID-19 in the next six months, how serious do you think your health condition will be?*) and a 5-point Likert scale that ranges from 1 (very unlikely) to 5 (very likely) (*How likely do you think it is that you will develop or contract COVID-19 in the next six months?*). Respondents are asked to indicate the feelings about their current financial situation, including uncertainty, at risk, threatened, worried about it, and think about it, to measure their financial risk perception via a 5-point Likert scale ranging from 1 (not at all) to 5 (a great deal) (*Please indicate how you feel about your current financial situation?*). A higher point indicates a higher financial risk perception. In addition, consumers' perceived food security risk is elicited using a 7-point Likert scale ranging from 1 (very unlikely) to 7 (very likely), and the questions are the possibility of perceived food shortages and food price increases in the next six months (*Do you think the following scenarios are likely or unlikely in the next six months? -Food shortages; Food price increases*).

2.2.3. Subjective and objective knowledge level regarding COVID-19

Knowledge is divided into what individuals perceive they know (subjective knowledge) and what they actually know (objective knowledge) (Brucks, 1985). Peschel et al. (2016) demonstrated irrespective of product or country under investigation, consumers who have higher subjective and objective knowledge levels tend to have a more environmentally sustainable food choice. Taufique et al. (2017) found that environmental and eco-label knowledge is positively associated with attitudes towards the environment and affects their pro-environmental consumer behaviour. As a result, consumers' subjective and objective knowledge levels are measured to test their influence on consumers' purchasing and consumption behaviour in this research. Specifically, respondents are asked to respond to their perceived subjective knowledge level via a 7-point Likert scale ranging from 1 (not knowledgeable at all) to 7 (very knowledgeable), and its result is presented in percentage terms ranging from 0 (not knowledgeable at all) to 100 (very knowledgeable) (*Please indicate how knowledgeable you feel with regard to COVID-19*). Respondents' objective knowledge is measured by asking them to judge whether the symptoms of COVID-19 are right or false by including several existing symptoms and non-existent symptoms (*True or False? These are common symptoms of*

Table 2
Payoff matrix from the risk attitude lottery experiment.

Task No.	Option A	Option B		Expected values and difference		
	P (¥)	P (200¥)	P (0¥)	EV^A (¥)	EV^B (¥)	Difference (¥)
1	1 (200¥)	0.5 (200¥)	0.5 (0¥)	200	100	100
2	1 (190¥)	0.5 (200¥)	0.5 (0¥)	190	100	90
3	1 (180¥)	0.5 (200¥)	0.5 (0¥)	180	100	80
4	1 (170¥)	0.5 (200¥)	0.5 (0¥)	170	100	70
5	1 (160¥)	0.5 (200¥)	0.5 (0¥)	160	100	60
6	1 (150¥)	0.5 (200¥)	0.5 (0¥)	150	100	50
7	1 (140¥)	0.5 (200¥)	0.5 (0¥)	140	100	40
8	1 (130¥)	0.5 (200¥)	0.5 (0¥)	130	100	30
9	1 (120¥)	0.5 (200¥)	0.5 (0¥)	120	100	20
10	1 (110¥)	0.5 (200¥)	0.5 (0¥)	110	100	10
11	1 (100¥)	0.5 (200¥)	0.5 (0¥)	100	100	0
12	1 (90¥)	0.5 (200¥)	0.5 (0¥)	90	100	−10
13	1 (80¥)	0.5 (200¥)	0.5 (0¥)	80	100	−20
14	1 (70¥)	0.5 (200¥)	0.5 (0¥)	70	100	−30
15	1 (60¥)	0.5 (200¥)	0.5 (0¥)	60	100	−40
16	1 (50¥)	0.5 (200¥)	0.5 (0¥)	50	100	−50
17	1 (40¥)	0.5 (200¥)	0.5 (0¥)	40	100	−60
18	1 (30¥)	0.5 (200¥)	0.5 (0¥)	30	100	−70
19	1 (20¥)	0.5 (200¥)	0.5 (0¥)	20	100	−80
20	1 (10¥)	0.5 (200¥)	0.5 (0¥)	10	100	−90

Note: The last three columns in this table, which showed the expected values (EV) of the lotteries and their difference, were not shown to the participants.

COVID-19). Objective knowledge is expressed as the percentage of correct answers to questions of knowledge on seventeen statements. In addition, respondents' discrepancy intensity between subjective and objective knowledge is also explored in this research. Knowledge discrepancy has two aspects: subjective knowledge level is higher than objective knowledge (overestimation), or subjective knowledge level is lower than objective knowledge (underestimation) (Khan et al., 2017).

2.2.4. Health concerns about COVID-19 and experience during the COVID-19 outbreak

The COVID-19 pandemic is a challenge for global food supply chains. It may result in food shortages and food price increases in developing countries (Reardon et al., 2020). Consumers' behaviour is sometimes designed to mitigate against the risk of not being able to purchase food, or indeed other items, at a later date for those who have experienced food shortages or food price increases during the COVID-19 outbreak (Power et al., 2020). Therefore, experience as an explanatory variable is elicited in this research (*Did you experience the following scenarios? - You faced food shortages in your area during the COVID-19 outbreak; You experienced an increase in food prices; You experienced neither*). During the COVID-19 pandemic, there are concerns about food security and health (Pu & Zhong, 2020), and they may influence consumers' food purchasing and consumption behaviour. As a consequence, respondents' level of health concerns about COVID-19 is also measured using a 7-point Likert scale ranging from 1 (not concerned at all) to 7 (extremely concerned) (*Please indicate your level of health concern about COVID-19*).

2.3. Empirical application

Methodologically, this analysis is based on a binary logistic regression model using the IBM SPSS v.24 software. This model is often used when the dependent variable is a dichotomous variable to check out the factors that influence the odds ratio of the dependent variable (Serrano-Cruz et al., 2018). The logit model has the formula (Osborne & King, 2011):

$$\text{Logit (P)} = \text{Log} [P_i / (1 - P_i)] \tag{1}$$

Where P_i is the probability of the event occurring (the probability of increasing food purchase and consumption in this research). $1 - P_i$ refers to the probability that respondents do not increase their food purchase and consumption. The odds ratio (OR) is the ratio of both previous probabilities. In this research, the logistic model of the relationship between the variable of food increasing or not and its explanatory variables is specified as follows:

$$\ln [P_i / (1 - P_i)] = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_{14} X_{14i} \tag{2}$$

Where the subscript i denotes the i-th observation in the sample. P is the probability of the outcome. $X_1, X_2, X_3, \ldots, X_{14}$ are independent variables. β_0 is the intercept term, and $\beta_1, \beta_2, \beta_3, \ldots, \beta_{14}$ are the coefficients associated with each independent variable. The coefficients do not directly indicate the effect of changes in the corresponding explanatory variables on the probability (P) of the outcome occurring. Rather, the coefficients reflect the effect of individual explanatory variables on the OR of the dependent variable (Zakari et al., 2014). Thus, the model can be written in terms of OR as follows:

$$P_i /(1-P_i) = \exp (\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_{14} X_{14i}) \tag{3}$$

3. Results and discussion

3.1. Characteristics of the study participants

A total of 1006 adults completed the questionnaire. As shown earlier, Table 1 displayed the characteristics of the respondents. Table 3 also presented some characteristics of the sample. The majority of the respondents were male (50.4%), 18–39 years old (62.7%), healthy (73.0%), with an average monthly household income of 5,001–15,000 RMB (36.9% and 33.3%), risk-averse (57.1%), with 4 persons in a household (32.4%), and who experienced an increase in food prices (51.3%). According to the gender distribution, the sample reflected the population of China.

3.2. Factors affecting the sustainability of consumers' purchasing and consumption behaviour

Table 3 and Fig. 2 presented the results of the factors affecting the sustainability of consumers' behaviour. The results demonstrate a high level of subjective and objective knowledge in China, with the values being above average (71.97% > 50.00% and 55.78% > 50.00%). In addition, the discrepancy intensity between knowledge is 16.19%, indicating that consumers believed that they know more than they really know (overestimation). This may be related to the first outbreak of the COVID-19 in Wuhan, China, and China has released sufficient

Table 3
Results of the factors affecting the sustainability of consumers' behaviour.

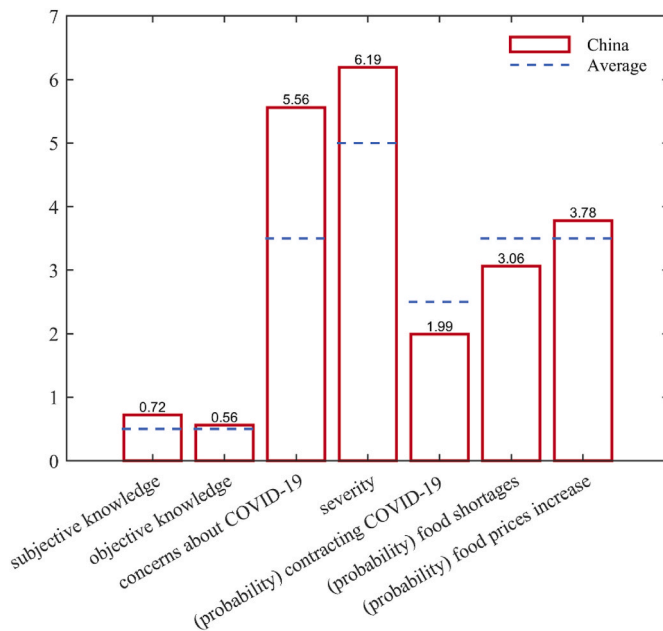| Variables	Percentage	Scale
Knowledge regarding COVID-19		
Subjective knowledge level	71.97%	0–100%
Objective knowledge level	55.78%	0–100%
Discrepancy intensity between knowledge	16.19%	
Experience		
Food shortages	8.40%	
Food price increases	51.30%	
Experienced neither	40.30%	
Risk attitude		
Risk-loving	32.90%	
Risk-neutral	10.00%	
Risk-averse	57.10%	
	Mean (SD)	
Concerns about COVID-19	5.56 (1.42)	7-point Likert scale
Health risk perception		
The severity of health condition will be if contract COVID-19 in the next 6 months	6.19 (2.66)	10-point Likert scale
The probability of contracting COVID-19	1.99 (0.92)	5-point Likert scale
Food security risk perception		
The probability of facing food shortages in the next 6 months	3.06 (1.62)	7-point Likert scale
The probability of facing food price increases	3.78 (1.75)	7-point Likert scale

Fig. 2. Factors affecting the sustainability of consumers' behaviour.

Table 4
Logit model of purchasing food with sustainable attributes (**P**) (model 1).

Variables	B	Sig.	Exp (B)
Gender			
Female	0.417	0.035	1.517
Age			
40–59 years old	0.520	0.011	1.682
Risk attitude			
Risk-neutral	−0.843	0.020	0.430
Risk-averse	−0.404	0.056	0.667
Financial risk perception			
Think moderately about the current finance	−1.453	0.054	0.234
Food security risk perception			
Neutral likely to face food shortages	0.707	0.097	2.028
A lot likely to face food shortages	1.009	0.093	2.743
Percentage of correct classification		68.8%	
Hosmer-Lemeshow's goodness of fit		0.367	

with sustainable attributes than those aged 18–39 years. It is in line with a study which showed that Chinese consumers aged more than 36 were more likely to buy certified organic food (McCarthy et al., 2014).

In addition, risk-neutral and risk-averse people were less likely to increase their purchase of food with sustainable attributes during the lockdown. One possible reason is that the purchase of food with sustainable attributes (e.g., organic food) is considered a risky choice, as consumers lack information and some are unfamiliar compared to conventional ones, such that they prefer the certainty of conventional products to the uncertainty of sustainable ones (Anderson et al., 2006; Smith & Paladino, 2010). Therefore, information campaigns in China could play an important role in promoting consumers' current sustainable attributes information level, where the domestic market for food products with sustainable attributes is still at an early stage (von Meyer-Höfer et al., 2015). The result also demonstrates that respondents who perceived a higher financial risk (got a higher point on a 5-point Likert scale for the financial risk variable) were less likely to purchase more food products with sustainable attributes. Not surprisingly, food products with sustainable attributes were more expensive than conventional food (Bhaskaran et al., 2006), so consumers purchased less of these food products when they perceived a higher financial risk, and they would be more cautious about spending money during the COVID-19 lockdown. In addition, individuals who perceived a higher food security risk were more likely to purchase more food products with sustainable attributes.

information about COVID-19 to the society, increasing individuals' confidence that led them to believe that they know more than they really know. This is supported by Pejman et al. (2019), who proved that when respondents receive sufficient information, their perceived knowledge will increase.

As shown in Fig. 2, respondents' concern level about COVID-19 is above average (5.56 > 3.5 points on a 7-point scale). With regard to the severity of the perceived health risk, it shows that the severity is above average (6.19 > 5 points on a 10-point scale). As for the probability of contracting COVID-19 in the next 6 months, the result indicates that Chinese consumers perceive a low likelihood (1.99 < 2.5 points on a 5-point Likert scale). This is because the Chinese are very confident in the measures adopted by the Chinese government and perceive a very low likelihood of contracting COVID-19, a very high likelihood of survival, and a high level of satisfaction with health information (Wang, Pan, et al., 2020). The value of the probability of facing food shortages in the next 6 months is below average (3.06 < 3.5 points on a 7-point scale), while the value of the probability of facing a price increase is above average (3.78 > 3.5 points on a 7-point scale). These are in line with the results of experience in this research that 51.30% of respondents experienced a price increase, while only 8.40% of them experienced food shortages, and thus they perceived a higher risk of a price increase.

3.3. Results of consumers' sustainable purchasing and consumption behaviour

3.3.1. Changes in purchasing food products with sustainable attributes during the COVID-19 lockdown

The results were presented as the coefficient (β), significance (Sig.), and Exp (β). Table 4 (model 1) listed the results of purchasing behaviour towards food with sustainable attributes. The fit was acceptable as indicated by Hosmer-Lemeshow's goodness of fit measures and the percentage of correct classification. The result implies that, during the lockdown, females were 1.517 times more likely to increase the purchase of food with sustainable attributes than males when compared to the situation before the lockdown. It is consistent with the previous research which indicated that females are more proactive in the purchase and consumption of organic food than males due to their lifestyle (Olivas & Bernabéu, 2012; Ureña et al., 2008). It also demonstrates that respondents aged 40–59 years were more likely to purchase more food

Table 5
Logit model of sustainable and healthy diets (**D**) (model 2).

Variables	B	Sig.	Exp (B)
Gender			
Female	0.481	0.010	1.617
Stated health status			
Healthy	−0.566	0.011	0.568
Household size			
Households with 4 members	1.358	0.061	3.887
Health risk perception			
Very likely to contract COVID-19 in the next six months	0.370	0.093	1.447
Food security risk perception			
A little likely to face food shortages	0.939	0.043	2.557
Neutral likely to face food price increases	0.715	0.081	2.044
Financial risk perception			
Feel uncertain slightly about the current finance	0.615	0.077	1.851
Feel uncertain moderately about the current finance	0.628	0.071	1.873
Think considerably about the current finance	1.034	0.089	2.812
Knowledge regarding COVID-19			
Subjective knowledge level	2.061	0.001	7.853
Objective knowledge level	0.979	0.013	2.663
Percentage of correct classification		72.4%	
Hosmer-Lemeshow's goodness of fit		0.407	

3.3.2. Changes in the sustainable and healthy diets during the COVID-19 lockdown

In Table 5 (model 2), the model had a percentage of correct predictions of 72.4%, and the Hosmer-Lemeshow's goodness of fit was equal to 0.407. The null hypothesis was accepted, indicating that there were no differences between observed and model-predicted values (Maharjan & Joshi, 2011). Both tests pointed out that the model fitted well. The result reveals that females were 1.617 times more likely to increase sustainable and healthy diets than males when compared to the situation before the lockdown. This may be related to women's attention to their weight that females seem to be more influenced by the current ideal of slimness, and thus they always attempt to reduce weight more often than males (Kiefer et al., 2000). Consequently, females tend to have a healthier diet than males. It also indicates that consumers who stated that they are in healthy conditions were less likely to increase sustainable and healthy diets than those who stated that they are unhealthy during the lockdown. The severe COVID-19 threatened consumers' health ranges from asymptomatic infection to life-threatening and fatal disease (Del Rio et al., 2020), especially for unhealthy people. As a result, unhealthy consumers were more likely to have a healthier diet to boost their immune system and reduce the health risk. The result also implies that households with 4 members were 3.887 times more likely to increase sustainable and healthy diets than those living alone during the lockdown. Individuals living in larger households exhibited a higher possibility of adopting a healthier and more sustainable diet, especially those living with children and elderly people, and they had an increased likelihood of contracting COVID-19 (He et al., 2020).

In addition, people who perceived a higher health risk were more likely to have a more sustainable and healthy diet than those with the lowest health risk in order to boost immunity and reduce their health risk. Regarding food security risk perception, the estimates indicate that individuals who perceived a higher food security risk were more likely to increase the consumption of a sustainable and healthy diet than those who perceived a lower one. The reason may be that fruit and vegetables (healthy and sustainable food items) are much cheaper than meat and dairy products in China (Yu & Abler, 2009). Therefore, people who perceived a higher food security risk (perceived a higher likelihood of food price increases or food shortages in the next six months) may tend to spend less money on food (mainly buy fruit and vegetables) during the lockdown to prevent food price increases in the next six months and thus

meet the needs of food spending in the future. Hence, they were more likely to adopt a healthier and sustainable diet. As for financial risk perception, consumers who perceived a higher financial risk (got a higher point on a 5-point Likert scale for the financial risk variable) were more likely to increase the consumption of healthy food than people who perceived a lower financial risk. Similarly, fruit and vegetables have a lower price than meat, resulting in an increase in consumption of fruit and vegetables and a decrease in consumption of red and processed meat, exhibiting an increase in a healthier diet, for those who perceived a higher financial risk. The result also reveals that consumers with higher levels of objective knowledge and subjective knowledge were more likely to increase the consumption of a healthy diet than those with lower levels of objective knowledge and subjective knowledge. It was expected that the more knowledge consumers had, the more severity about COVID-19 they perceive, such that they tend to increase the consumption of a healthy diet to reduce the risk of contracting COVID-19.

3.3.3. Changes in the total food waste during the COVID-19 lockdown

Table 6 (model 3) presented the results of total food waste. The percentage of correct classification was 71.6%, and the value of Hosmer-Lemeshow's goodness of fit was 0.058. It guided us to accept the null hypothesis, which meant that there was no difference between observed and model-predicted values. The result shows that consumers who stated that they are in healthy conditions were less likely to increase food waste than those who stated that they are unhealthy during the COVID-19 lockdown, which could be explained by the fact that unhealthy people may tend to over-shop to reduce the risk of contracting COVID-19, resulting in more food that spoils and is discarded as waste. The result demonstrates that households with 2, 3, and 4 members were less likely to increase food waste than those with one member, which is in accordance with the research of Fonseca (2013) conducted in Portugal showing that single consumers wasted more food. It also indicates that respondents who perceived a higher health risk and food security risk were more likely to increase food waste. Similarly, it seems that these individuals tended to purchase and stockpile more food during the lockdown, on the one hand, to prevent food shortages or rising food prices (food insecurity) in the future, making them unable to buy or afford the food they need. On the other hand, they could minimize trips to the grocery store to reduce the risk of contracting COVID-19 (health risk). However, stockpiling more food could lead to a lot of food that spoils and is discarded as waste. The findings also suggest that people with a higher financial risk perception were less likely to increase food waste. This ties in with Graham-Rowe et al. (2014) finding that many household food purchasers avoid wasting food for financial reasons because they think throwing away food is a waste of money.

Additionally, individuals who were more concerned about COVID-19 were less likely to increase their total food waste. In addition, people who think they know more about COVID-19 (with a higher level of subjective knowledge) were more likely to increase food waste. One possible reason is that the more consumers think they know about the virus, the more aware they are of the severity of the COVID-19, so they will reduce the health risk by buying more food, which probably leads to more food that spoils and is discarded as waste.

3.4. Summary of all models and practical implications

Fig. 3 was drawn to make the results of all models easier to observe.

The complex issue of food consumption and purchasing behaviour requires a combination of several actions to be taken. Results demonstrate that a shift towards more sustainable behaviour is realistic and likely to occur. Thus, targeting measures according to different consumers' characteristics and profiles can be designed, promoted, and applied not only during the pandemic situation, but also after the sanitary crisis to maintain the identified sustainable behaviour. The results indicate that females and consumers aged 40–59 years purchase more
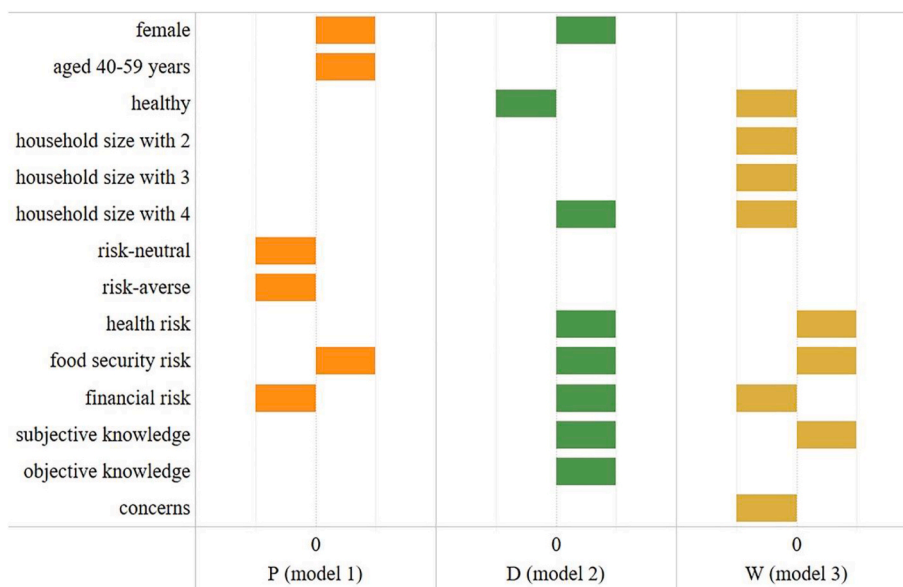
Table 6
Logit model of total food waste **(W)** (model 3).

Variables	B	Sig.	Exp (B)
Stated health status			
Healthy	−0.411	0.041	0.663
Household size			
Households with 2 members	−1.731	0.023	0.177
Households with 3 members	−1.324	0.058	0.266
Households with 4 members	−1.364	0.048	0.256
Health risk perception			
Neutral likely to contract COVID-19 in the next 6 months	0.538	0.059	1.713
A lot likely to contract COVID-19 in the next 6 months	0.732	0.079	2.079
Food security risk perception			
A lot unlikely to face food shortages	0.719	0.047	2.053
Neutral likely to face food shortages	0.657	0.090	1.929
Financial risk perception			
Feel uncertain considerably about the current finance	−0.679	0.095	0.507
Concerns about COVID-19			
A little concerned	−2.429	0.039	0.088
Extremally concerned	−2.017	0.070	0.133
Knowledge regarding COVID-19			
Subjective knowledge level	1.540	0.008	4.667
Percentage of correct classification		71.6%	
Hosmer-Lemeshow's goodness of fit		0.058	

Fig. 3. Results of all models
Note: The y-axis represents the significant factors influencing consumers' behaviour, and the x-axis shows each dependent variable. On the right side of the scale line of 0, it means a positive relationship between the independent and the dependent variables, while on the left side it means a negative relationship.

food products with sustainable attributes during the COVID-19 lockdown, reminding producer marketing tools to be focused on increasing purchase by improving sustainable food product availability and consumers' access, especially for females and those aged 40–59 years. According to the findings, younger consumers aged 18–39 years are less likely to increase their purchase of food with sustainable attributes. As a result, it is necessary to increase these consumers' knowledge about sustainable food products and consider how to differentiate them in the market during the lockdown.

As for sustainable and healthy diets, males, healthy consumers, and people living alone are less likely to increase the consumption of a healthy diet, so the government can recommend through public communication campaigns with a specific focus on males, healthy consumers, and people living alone. Regarding food waste behaviour, Chinese consumers, the Chinese government, and stakeholders within the food chain should work together to reduce food waste. The results show that the household with 1 member wastes more food during the COVID-19 outbreak. Retailers can play an important role by offering food in small packages (suitable for a single person) to reduce waste. The results also suggest that people with a higher health risk and food security risk perception waste more food when compared to the situation before the lockdown. Therefore, more information about COVID-19 and food security should be delivered to consumers to reduce the perception of the risk of consumers' health and food security (e.g., information on food availability and price stability), which could reduce their panic buying and food waste. In addition, consumers should also take the initiative to improve their awareness of environmental protection and avoid food waste.

4. Conclusion

This research explored the factors in consumers' sustainable purchasing and consumption behaviour during the lockdown in China and provided a reference for academic research. Monthly household income and experience (food shortages, food price increases, and neither) were not statistically significant factors affecting the food sustainable behaviour defined in this study. Females were found to increase their purchase of food with sustainable attributes and consumption of a healthy diet than males when compared to the situation before the

lockdown. Age was only found to have a significant association with sustainable purchasing. People aged 40–59 years were more likely to purchase more food with sustainable attributes than those aged 18–39 years during the lockdown. Consumers who stated that they are in healthy conditions consumed less healthy diets and had low food waste during the lockdown. In addition, household size was found to have a significant effect on a healthy diet and food waste, which indicated that households with 4 members consumed a healthier diet and had less food waste than those living alone when compared with the situation before the lockdown. Risk attitude had a negative and significant impact on sustainable purchasing behaviour. Compared with the situation before the lockdown, the lockdown made risk-averse and risk-neutral consumers exhibit less sustainable attributes of food purchasing behaviour. Regarding health risk perception, consumers with a higher health risk perception increased their healthy diets and food waste than the situation before the lockdown. Consumers who perceived a higher food security risk tended to purchase more food with sustainable attributes, have a healthier diet, but with increased food waste behaviour due to the lockdown. Consumers who perceived a higher financial risk were less likely to increase the purchase of food with sustainable attributes and food waste, but more likely to increase sustainable and healthy diets when compared to the situation before the lockdown. Respondents who had low food waste during the lockdown exhibited higher health concerns about COVID-19. As for consumers' knowledge regarding COVID-19, when compared to the situation before the lockdown, healthy diets and food waste increased with a higher subjective knowledge level, and healthy diets increased with the rising objective knowledge level.

The main limitation of the research is that the sample size of people aged over 60 is relatively low (only 0.8%) due to the lack of access to smartphones or computers, which indicates that its result should be explained cautiously. With the COVID-19 pandemic going on, the results need to be further confirmed and investigated with a larger number of samples in future research. Future research could focus on consumers who are not familiar with online surveys. However, it enabled us to get data in a rapid and efficient way from different areas in China, avoiding face-to-face surveys due to the COVID-19 limitations.

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Declaration of competing interest

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References

Abeliotis, K., Koniari, C., & Sardianou, E. (2010). The profile of the green consumer in Greece. *International Journal of Consumer Studies, 34*(2), 153–160. https://doi.org/10.1111/j.1470-6431.2009.00833.x

Andersen, S., Harrison, G. W., Lau, M. I., & Rutström, E. E. (2006). Elicitation using multiple price list formats. *Experimental Economics, 9*(4), 383–405. https://doi.org/10.1007/s10683-006-7055-6

Anderson, S., Harrison, G. W., Lau, M. I., & Rutstrom, E. E. (2007). Valuation using multiple price list formats. *Applied Economics, 39*(6), 675–682. https://doi.org/10.1080/00036840500462046

Anderson, J. C., Wachenheim, C. J., & Lesch, W. C. (2006). Perceptions of genetically modified and organic foods and processes. *AgBioforum, 9*(3), 180–194.

Annunziata, A., & Scarpato, D. (2014). Factors affecting consumer attitudes towards food products with sustainable attributes. *Agricultural Economics, 60*(8), 353–363. https://doi.org/10.17221/156/2013-agricecon

Aschemann-Witzel, J., de Hooge, I., Amani, P., Bech-Larsen, T., & Oostindjer, M. (2015). Consumer-related food waste: Causes and potential for action. *Sustainability, 7*(6), 6457–6477. https://doi.org/10.3390/su7066457

de Bakker, E., & Dagevos, H. (2012). Reducing meat consumption in Today's consumer society: Questioning the citizen-consumer gap. *Journal of Agricultural and Environmental Ethics, 25*(6), 877–894. https://doi.org/10.1007/s10806-011-9345-z

Baltar, F., & Brunet, I. (2012). *Social research 2.0: Virtual snowball sampling method using Facebook.* https://doi.org/10.1108/10662241211199960. Internet Research.

Basha, M. B., Mason, C., Shamsudin, M. F., Hussain, H. I., & Salem, M. A. (2015). Consumers attitude towards organic food. *Procedia Economics and Finance, 31*, 444–452.

Benfield, J. A., & Szlemko, W. J. (2006). Internet-based data collection: Promises and realities. *Journal of Research Practice, 2*(2).

Bhaskaran, S., Polonsky, M., Cary, J., & Fernandez, S. (2006). Environmentally sustainable food production and marketing: Opportunity or hype? *British Food Journal, 108*(8), 677–690. https://doi.org/10.1108/00070700610682355

Brick, K., Visser, M., & Burns, J. (2012). Risk aversion: Experimental evidence from South African fishing communities. *American Journal of Agricultural Economics, 94*(1), 133–152. https://doi.org/10.1093/ajae/aar120

Brucks, M. (1985). The effects of product class knowledge on information search behavior. *Journal of Consumer Research, 12*(1), 1–16. https://doi.org/10.1086/209031

Codron, J. M., Siriex, L., & Reardon, T. (2006). Social and environmental attributes of food products in an emerging mass market: Challenges of signaling and consumer perception, with European illustrations. *Agriculture and Human Values, 23*(3), 283–297. https://doi.org/10.1007/s10460-006-9000-x

Del Rio, C., Collins, L. F., & Malani, P. (2020). Long-term health consequences of COVID-19. *Jama, 324*(17), 1723–1724.

Di Renzo, L., Gualtieri, P., Pivari, F., Soldati, L., Attinà, A., Cinelli, G., Cinelli, G., Leggeri, C., Caparello, G., Barrea, L., Scerbo, F., Esposito, E., & De Lorenzo, A. (2020). Eating habits and lifestyle changes during COVID-19 lockdown: An Italian survey. *Journal of Translational Medicine, 18*(1), 1–15. https://doi.org/10.1186/s12967-020-02399-5

Drichoutis, A. C., & Lusk, J. L. (2016). What can multiple price lists really tell us about risk preferences? *Journal of Risk and Uncertainty, 53*(2–3), 89–106. https://doi.org/10.1007/s11166-016-9248-5

Duchin, F. (2005). Sustainable consumption of food: A framework for analyzing scenarios about changes in diets. *Journal of Industrial Ecology, 9*(1-2), 99–114.

Escobar, C., Kallas, Z., & Gil, J. M. (2018). Consumers' wine preferences in a changing scenario. *British Food Journal, 120*(1), 18–32. https://doi.org/10.1108/BFJ-02-2017-0070

Evans, D. (2011). Blaming the consumer - once again: The social and material contexts of everyday food waste practices in some English households. *Critical Public Health, 21*(4), 429–440. https://doi.org/10.1080/09581596.2011.608797

Fonseca, J. R. S. (2013). A latent class model to discover household food waste patterns in Lisbon city in support of food security, public health and environmental protection. *International Journal on Food System Dynamics, 4*(3), 184–197.

Food and Agriculture Organization of the United Nations. (2010). *International Scientific Symposium. Biodiversity and sustainable diets – united against Hunger.* Rome: FAO Headquarters.

Food and Agriculture Organization of the United Nations. (2011). *Global food losses and food waste.* http://www.fao.org/3/mb060e/mb060e00.htm.

Gallenti, G., Troiano, S., Cosmina, M., & Marangon, F. (2016). Ethical and sustainable consumption in the Italian coffee market: A choice experiment to analyse consumers' willingness to pay. *Rivista di Economia Agraria, 71*(2), 153–176. https://doi.org/10.13128/REA-20077

Garnett, T. (2008). Cooking up a storm: Food, greenhouse gas emissions and our changing climate. *Food climate research network*. Centre for Environmental Strategy, University of Surrey.

Garnett, T. (2011). Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? *Food Policy, 36*, S23–S32. https://doi.org/10.1016/j.foodpol.2010.10.010

Graham-Rowe, E., Jessop, D. C., & Sparks, P. (2014). Identifying motivations and barriers to minimising household food waste. *Resources, Conservation and Recycling, 84*, 15–23. https://doi.org/10.1016/j.resconrec.2013.12.005

Harrison, G. W., Lau, M. I., & Rutström, E. E. (2007). Estimating risk attitudes in Denmark: A field experiment. *The Scandinavian Journal of Economics, 109*(2), 341–368. https://doi.org/10.1111/j.1467-9442.2007.00496.x

Harrison, G. W., Lau, M. I., Rutström, E. E., & Sullivan, M. B. (2005). Eliciting risk and time preferences using field experiments: Some methodological issues. *Field Experiments in Economics, 125*, 218. https://doi.org/10.1016/S0193-2306(04)10005-7

He, S., Chen, S., Kong, L., & Liu, W. (2020). Analysis of risk perceptions and related factors concerning COVID-19 epidemic in chongqing, China. *Journal of Community Health, 46*(2), 278–285.

Hill, H., & Lynchehaun, F. (2002). Organic milk: Attitudes and consumption patterns. *British Food Journal, 104*(7), 526–542. https://doi.org/10.1108/00070700210434570

Hillson, D., & Murray-Webster, R. (2006). Managing risk attitude using emotional literacy. *Proceedings of the PMI Congress 2006 EMEA, presented in Madrid, Spain, 9 May*.

Khan, M. N., Rothwell, D. W., Cherney, K., & Sussman, T. (2017). Understanding the financial knowledge gap: A new dimension of inequality in later life. *Journal of Gerontological Social Work, 60*(6–7), 487–503.

Kiefer, I., Leitner, B., Bauer, R., & Rieder, A. (2000). Body weight: The male and female perception. *Sozial- und Präventivmedizin, 45*(6), 274–278. https://doi.org/10.1007/BF01591690

Kim, J., Lambrechts, W., & Annet van Osch, J. S. (2019). How consumer behavior in daily food provisioning affects food waste at household level in The Netherlands. *Foods, 8*(10), 428.

Li, C., Mirosa, M., & Bremer, P. (2020). Review of online food delivery platforms and their impacts on sustainability. *Sustainability, 12*(14), 5528.

Lorek, S., & Spangenberg, J. H. (2014). Sustainable consumption within a sustainable economy - beyond green growth and green economies. *Journal of Cleaner Production, 63*, 33–44. https://doi.org/10.1016/j.jclepro.2013.08.045

Lusk, J. L., & Coble, K. H. (2005). Risk perceptions, risk preference, and acceptance of risky food. *American Journal of Agricultural Economics, 87*(2), 393–405.

Macdiarmid, J. I. (2013). Is a healthy diet an environmentally sustainable diet? *Proceedings of the Nutrition Society, 72*(1), 13–20.

Maharjan, K. L., & Joshi, N. P. (2011). Determinants of household food security in Nepal: A binary logistic regression analysis. *Journal of Mountain Science, 8*(3), 403–413. https://doi.org/10.1007/s11629-011-2001-2

Ma, Y., Ratnasabapathy, R., & Gardiner, J. (2017). Carbohydrate craving: Not everything is sweet. *Current Opinion in Clinical Nutrition and Metabolic Care, 20*(4), 261. https://doi.org/10.1097/MCO.0000000000000374

McCarthy, B., Liu, H.-B., & Chen, T. (2014). Trends in organic food consumption in China:opportunities and challenges for regional Australian exporters. *ResearchOnline@JCU, 8*–10.

Olivas, R., & Bernabéu, R. (2012). Men's and women's attitudes toward organic food consumption. A Spanish case study. *Spanish Journal of Agricultural Research, 2*, 281–291. https://doi.org/10.5424/sjar/2012102-507-11

Orduño Torres, M. A., Kallas, Z., & Ornelas Herrera, S. I. (2019). Analysis of farmers' stated risk using lotteries and their perceptions of climate change in the Northwest of Mexico. *Agronomy, 9*(1), 4.

Osborne, J., & King, J. E. (2011). Binary logistic regression. *Best Practices in Quantitative Methods*, 358–384. https://doi.org/10.4135/9781412995627.d29

Pappalardo, G., Cerroni, S., Nayga, R. M., & Yang, W. (2020). Impact of covid-19 on household food waste: The case of Italy. *Frontiers in Nutrition, 7*, 291. https://doi.org/10.3389/fnut.2020.585090

Pejman, N., Kallas, Z., Dalmau, A., & Velarde, A. (2019). Should animal welfare regulations be more restrictive? A case study in eight European Union countries. *Animals, 9*(4), 195. https://doi.org/10.3390/ani9040195

Pennings, J. M. E., & Garcia, P. (2001). Measuring producers' risk preferences: A global risk-attitude construct. *American Journal of Agricultural Economics, 83*(4), 993–1009.

Peschel, A., Grebitus, C., Steiner, B., & Veeman, M. (2016). How does consumer knowledge affect environmentally sustainable choices? Evidence from a cross-

country latent class analysis of food labels. *Appetite, 106*, 78–91. https://doi.org/10.1016/j.appet.2016.02.162, 69864.

Power, M., Doherty, B., Pybus, K., & Pickett, K. (2020). How COVID-19 has exposed inequalities in the UK food system: The case of UK food and poverty. *Emerald Open Research, 2*, 11.

Pu, M., & Zhong, Y. (2020). Rising concerns over agricultural production as COVID-19 spreads: Lessons from China. *Global Food Security, 26*, 100409. https://doi.org/10.1016/j.gfs.2020.100409

Reardon, T., Bellemare, M. F., & Zilberman, D. (2020). How COVID-19 may disrupt food supply chains in developing countries. *IFPRI Book Chapters*, 78–80.

Rodríguez-Martín, B. C., & Meule, A. (2015). Food craving: New contributions on its assessment, moderators, and consequences. *Frontiers in Psychology, 6*, 21. https://doi.org/10.3389/fpsyg.2015.00021

Rodríguez-Pérez, C., Molina-Montes, E., Verardo, V., Artacho, R., García-Villanova, B., Guerra-Hernández, E. J., & Ruíz-López, M. D. (2020). Changes in dietary behaviours during the COVID-19 outbreak confinement in the Spanish COVIDiet study. *Nutrients, 12*(6), 1–19. https://doi.org/10.3390/nu12061730

Rohrmann, B. (2008). *Risk perception, risk attitude, risk communication, risk management: A conceptual appraisal*, 15th Internaional Emergency Management Society (TIEMS) Annual Conference (Vol. 2008).

Ruiz-Roso, M. B., Knott-Torcal, C., Matilla-Escalante, D. C., Garcimartín, A., Sampedro-Nuñez, M. A., Dávalos, A., & Marazuela, M. (2020). Covid-19 lockdown and changes of the dietary pattern and physical activity habits in a cohort of patients with type 2 diabetes mellitus. *Nutrients, 12*(8), 1–16. https://doi.org/10.3390/nu12082327

Schroeder, T. C., Tonsort, G. T., Pennings, J. M. E., & Minter, J. (2007). Consumer food safety risk perceptions and attitudes: Impacts on beef consumption across countries. *The B.E. Journal of Economic Analysis & Policy, 7*(1). https://doi.org/10.2202/1935-1682.1848

Serrano-Cruz, M. R., Espinoza-Ortega, A., Sepúlveda, W. S., Vizcarra-Bordi, I., & Thomé-Ortiz, H. (2018). Factors associated with the consumption of traditional foods in central Mexico. *British Food Journal, 120*(11), 2695–2709. https://doi.org/10.1108/BFJ-11-2017-0663

Sharma, H. B., Vanapalli, K. R., Cheela, V. S., Ranjan, V. P., Jaglan, A. K., Dubey, B., Goel, S., & Bhattacharya, J. (2020). Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. *Resources, Conservation and Recycling, 162*, 105052. https://doi.org/10.1016/j.resconrec.2020.105052

Sidor, A., & Rzymski, P. (2020). Dietary choices and habits during COVID-19 lockdown: Experience from Poland. *Nutrients, 12*(6), 1–13. https://doi.org/10.3390/nu12061657

Smidts, A. (1997). The relationship between risk attitude and strength of preference: A test of intrinsic risk attitude. *Management Science, 43*(3), 357–370.

Smith, S., & Paladino, A. (2010). Eating clean and green? Investigating consumer motivations towards the purchase of organic food. *Australasian Marketing Journal, 18* (2), 93–104. https://doi.org/10.1016/j.ausmj.2010.01.001

Taufique, K. M. R., Vocino, A., & Polonsky, M. J. (2017). The influence of eco-label knowledge and trust on pro-environmental consumer behaviour in an emerging market. *Journal of Strategic Marketing, 25*(7), 511–529. https://doi.org/10.1080/0965254X.2016.1240219

Tversky, A. (1995). The psychology of decision making. In *Behavioural finance and decision theory in investment management* (Vol. 4, pp. 2–6). AIMR Publication. https://doi.org/10.1016/B978-0-12-800278-0.00006-3

Ureña, F., Bernabéu, R., & Olmeda, M. (2008). Women, men and organic food: Differences in their attitudes and willingness to pay. A Spanish case study. *International Journal of Consumer Studies, 32*(1), 18–26. https://doi.org/10.1111/j.1470-6431.2007.00637.x

Velavan, T. P., & Meyer, C. G. (2020). The COVID-19 epidemic. *Tropical Medicine and International Health, 25*(3), 278–280. https://doi.org/10.1111/tmi.13383

Wang, X., Lei, S. M., Le, S., Yang, Y., Zhang, B., Yao, W., Gao, Z., & Cheng, S. (2020). Bidirectional influence of the COVID-19 pandemic lockdowns on health behaviors and quality of life among Chinese adults. *International Journal of Environmental Research and Public Health, 17*(15), 1–17. https://doi.org/10.3390/ijerph17155575

Wang, X., Pacho, F., Liu, J., & Kajungiro, R. (2019). Factors influencing organic food purchase intention in developing countries and the moderating role of knowledge. *Sustainability, 11*(1), 209.

von Meyer-Höfer, M., Juarez Tijerino, A. M., & Spiller, A. (2015). *Sustainable food consumption in China and India*. GlobalFood Discussion Papers, No. 60, Georg-August-Universität Göttingen, Research Training Group (RTG) 1666 - GlobalFood, Göttingen.

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, R. S., Choo, F. N., Tran, B., Ho, R., Sharma, V. K., & Ho, C. (2020). A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain, Behavior, and Immunity, 87*, 40–48. https://doi.org/10.1016/j.bbi.2020.04.028

Yau, Y. H. C., & Potenza, M. N. (2013). Stress and eating behaviors. In *Minerva Endocrinologica* (p. 255).

Yu, X., & Abler, D. (2009). The demand for food quality in rural China. *American Journal of Agricultural Economics, 91*(1), 57–69.

Zakari, S., Ying, L., & Song, B. (2014). Factors influencing household food security in West Africa: The case of southern Niger. *Sustainability, 6*(3), 1191–1202. https://doi.org/10.3390/su6031191

Zhu, H., & Deng, F. (2020). How to influence rural tourism intention by risk knowledge during COVID-19 containment in China: Mediating role of risk perception and attitude. *International Journal of Environmental Research and Public Health, 17*(10), 3514.