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Are beliefs and attitudes about COVID-19 associated with self-perceived changes in food consumption? Results from a nationwide survey during lockdown

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ABSTRACT

This study aimed to understand how beliefs and attitudes regarding COVID-19 are associated with self-perceived changes in food consumption during lockdown between March 19 and May 2, 2020. We conducted a cross-sectional study with a non-probabilistic weighted sample of the Portuguese population. Data were collected using an online survey and telephone interviews. The association between agreement with sentences about food and COVID-19 and perceived changes in food consumption were assessed by multinomial logistic regression models. Overall, 5858 citizens were included, with a mean age of 38.2 (17.3) years. Exclusive agreement with the belief “SARS-CoV-2 can be transmitted by food” (27.5%) was associated with decreased odds of perceived positive changes (e.g., increased consumption of fruit and vegetables). Agreement only with the attitudinal sentence “I started to consume foods that may protect against COVID-19” (11.9%) was associated with positive perceived consumption changes (e.g., increasing fruit and vegetables, and decreasing soft drinks and snacks). Cumulative agreement (with both sentences; 10.6%) was also associated with mostly positive food consumption changes. Specific beliefs and attitudes regarding COVID-19 and food are associated with self-perceived changes in food consumption. Longitudinal research is needed to understand how beliefs and/or attitudes about the role of food in infectious diseases act as determinants of eating behavior modification.

1. Introduction

In response to the alarming levels of spread and severity of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, the World Health Organization characterized coronavirus disease 2019 (COVID-19) as a pandemic on March 11, 2020 (WHO, 2020b). Soon

after, with the new coronavirus outbreak in Portugal and a rapid increase in the number of confirmed cases, on March 19, 2020, the President of the Portuguese Republic decreed the first State of Emergency. One of the measures introduced during the first wave of COVID-19 cases (from March 19 to May 2, 2020) to control infections by SARS-CoV-2 was a social lockdown: the civic duty to stay home, except for buying

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basic necessities, physical activity, and dogs' short promenades (Previdência do Conselho de Ministros, 2020).

During the lockdown, health authorities disseminated information aiming to improve health literacy, including how to maintain/adopt healthy food habits during the pandemic (PNPAS, 2020; Zarocostas, 2020). However, there was also abundant disposal of misinformation and conspiracy theories on social media platforms (Rathore & Farooq, 2020; Zarocostas, 2020), which is worrisome, since the belief in conspiracy theories (Allington & Dhavan, 2020; Freeman et al., 2020) and the use of social media as a source of information is negatively associated with health-protective behaviors (Allington et al., 2020).

According to most cognitive models of decision-making, beliefs are key determinants for behavioral activation and any effective health promotion strategy requires a sound understanding of communities' shared beliefs (Michie et al., 2011). It is therefore important to characterize food- and eating-related beliefs and how they relate to dietary changes so that effective health communication initiatives may be well defined and implemented. This paper focuses on beliefs and attitudes about the relationship between food and COVID-19 in two dimensions: the belief about the potential transmission of SARS-CoV-2 through food items; and the attitude related to the consumption of specific foods that respondents consider having a protective role against SARS-CoV-2 transmission.

SARS-CoV-2 can remain viable for several hours or days on surfaces, which is considered a transmission route, although apparently less significant than others (Anelich et al., 2020; Chan et al., 2020; Chia et al., 2020; Colaneri et al., 2020; Doremalen et al., 2020; Falahi & Kenarkoobi, 2020; Guo et al., 2021; Leung, 2021; Marquês & Domingo, 2021). Regarding food products, the current consensus is that there is no evidence that SARS-CoV-2 may be transmitted by food, thus not representing a food safety risk (Anelich et al., 2020; EFSA, 2020; WHO & FAO, 2020). This does not collide with the recommendations to adopt health-protective behaviors, such as maintaining and strengthening good hygiene and food safety practices during food handling and preparation, as a measure to minimize the risk of potential fomite transmission, without the need to limit the consumption of certain foods as a way to avoid contracting COVID-19 (Eslami & Jalili, 2020; FAO, 2020; WHO, 2020a; WHO & FAO, 2020).

Specific foods and supplements have been widely promoted on social media as possible pathways to reduce consumers' likelihood to be infected with SARS-CoV-2 (Ball, 2020). Their consumption aiming to improve the immune system, prevent disease, and maintain or promote health has been observed in previous outbreaks of infectious diseases (Hwang et al., 2020). However, current evidence does not support the hypothesis that specific foods or supplements, or that even the overall nutritional status, can prevent, by itself, viral infections (Briguglio et al., 2020). Likewise, the European Food Safety Authority (EFSA) has not authorized any health claims for a food or food component to be labeled as protective against infection or related to the immune system (EFSA, 2018). Nevertheless, it is known that a healthy diet with an adequate intake of energy and nutrients is essential for a competent immune system (Aune et al., 2017; Calder & Kew, 2002; Gombart et al., 2020).

Given the exceptional nature of lockdowns and its potential influence on lifestyle, the REACT-COVID nationwide survey was developed to assess self-perceived changes in physical activity and eating behaviors, food security, and beliefs and attitudes about the relationship between food and COVID-19 in the Portuguese population during the first lockdown. This study aimed to understand how beliefs and attitudes about the transmission of SARS-CoV-2 through food items and specific foods conferring protection from SARS-CoV-2 are associated with self-perceived changes in food consumption during lockdown, mandated in response to the first wave of COVID-19 cases.

2. Materials and methods

The REACT-COVID study, promoted by the Portuguese Directorate-

General of Health, followed a cross-sectional observational study design, with a nationally based non-probabilistic sample of individuals aged 16 years or older who were compliant with lockdown rules, imposed due to the COVID-19 pandemic. Data collection was carried out with an online self-administrated questionnaire and telephone structured interviews (with the same data collection instrument), between April 9 and May 4, 2020.

2.1. Ethical standards disclosure

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Ethics Committee of Centro Académico de Medicina de Lisboa. Informed consent was obtained from all subjects. Only participants who indicated to have read the informed consent information (included in the welcome page of the online questionnaire) could complete the questionnaire. Regarding telephone interviews, phone holders were asked to participate in the study after the verbal presentation of the detailed information about the study, and only upon verbal consent (formally recorded by the interviewer), the interview was conducted.

2.2. Population and sampling

The population under study included female and male citizens with 16 or more years of age living in Portugal (mainland and Azores and Madeira islands) in lockdown (during the first wave of COVID-19 cases, from March 19 to May 2, 2020), not being allowed to leave home, except for some legally regulated purposes, including the acquisition of essential goods and services, physical activity, or walking pets, for, at least, one week before answering the questionnaire.

Data collection followed two sampling strategies: a) snowball sampling, activated by dissemination on institutional websites, social media platforms (Facebook, Instagram, Twitter, and LinkedIn), and media, and b) computer-assisted telephone interview (CATI system) to holders of mobile or landline numbers generated randomly and proportionally to the prevalence of national landline and mobile telephone numbers. The CATI system was conducted to cover population strata not achieved (or less represented) through snowball sampling, such as older people (over 60-years-old) and/or with a lower education level (below 12 years of formal education).

Considering an equal share for positive or negative agreement with the belief and attitude under study and a confidence interval of 95%, the estimated minimum sample size was 400 individuals per nomenclature of territorial units for statistics level II (NUTS II) Portuguese regions of residence (North, Centre, Lisbon Metropolitan Area, Alentejo, Algarve, Azores Autonomous Region, and Madeira Autonomous Region), corresponding to an overall minimum sample size of 2800 individuals. The criteria for snowball sampling (and strategies of survey dissemination) were adapted throughout the fieldwork period, according to the socio-demographic database profile, aiming to have all strata represented, considering sex, decennial age groups, education level (secondary education and lower or higher education) and NUTS II Portuguese regions of residence.

2.3. Measures

The questionnaire was built in the Limesurvey® platform. It included questions regarding self-perceived changes (increase, maintenance, or decrease) in food consumption during lockdown of 14 food groups that correspond to expected dietary behavioral changes in the context of the pandemic and/or foods with high prevalence of inadequate consumption by the Portuguese population (Lopes et al., 2017) that contribute to the main dietary risk factors associated with the development of non-communicable diseases, as well as to the increase of the disability-adjusted life years and mortality rates (Global Burden of

Disease Collaborative Network, 2020): fruit; vegetables; meat; fish/seafood; canned fish; other canned foods; sweet snacks (e.g., cookies, biscuits, chocolate); salty snacks (e.g., French fries/chips); pre-prepared meals (e.g., pizzas, lasagna); takeaway/home delivery; water; fruit juices; soft drinks; and alcoholic beverages. The questionnaire assessed agreement with two sentences, one regarding a belief and another related to an attitude about food and COVID-19 (“*The new coronavirus can be transmitted by food*” and “*I started to buy/consume some specific food items because they can protect me from the new coronavirus*”, respectively) through a 5-point scale of answer (“*totally disagree*”, “*disagree*”, “*partially agree*”, “*strongly agree*”, “*totally agree*”) and a “*do not know*” option. Sociodemographic variables addressed respondents’ sex, age, education level, NUTS II Portuguese regions of residence, employment status, and self-perceived household income situation.

2.4. Data analysis

Data cleaning was performed by eliminating cases when contact information was provided in duplicate (if sociodemographic variables did not match) or when the response time was unrealistic (too quick), considering the mean and standard deviation time that it took for respondents to complete the whole questionnaire or each block of questions (i.e., each online page of the questionnaire), as described by Leiner (2019).

Age, collected as a continuous variable, was recoded into three groups: 16–34 years, 35–54 years, and 55 or more years. Education level groups were defined according to the compulsory education level (secondary or lower education; or higher education). Self-perceived household income situation (asked as one single question, with five options of answer and a “*prefer not to answer*” option) was recoded into “*comfortable or very comfortable*”, “*enough for household needs*”, and “*difficult or very difficult*”. Respondents who indicated to prefer not to answer were considered missing values. Regarding the belief/attitude statements, the answers “*partially agree*”, “*strongly agree*”, and “*totally agree*” were pooled together and considered as agreement, whereas the answers “*totally disagree*”, “*disagree*” and “*do not know*” were also pooled together (for dichotomizing the variables). Participants were divided into four independent groups according to their agreement with the belief and/or with the attitude: 1) “*does not agree with the belief nor with the attitude (or does not know)*”, 2) “*agrees with the belief, but not with the attitude*”, 3) “*agrees with the attitude, but not with the belief*”, and 4) “*agrees with the belief and the attitude*”. This way, we assessed the interaction between the belief and the attitude in a way closer to the real-life scenario, where the individual can have different sets of opinions on both issues when making food choices.

Data were weighted according to the distribution of the Portuguese population (INE, 2012) for sex, age group (16–34 years; 35–54 years; 55 or more years), education level (secondary education and lower; higher education), and NUTS II Portuguese regions of residence.

Descriptive statistics were used to report the relative and absolute frequencies of each categorical variable. The relationships between the belief and/or attitude and sociodemographic characteristics were explored using chi-square tests of independence. If the overall chi-square test was significant, standardized adjusted residuals for the cell percentage of each subcategory were examined to determine which cell differences contributed to the chi-squared test results. An adjusted residual score greater than 1.96 (or lower than –1.96) for a given subcategory percentage indicated that the subcategory differed significantly from what would be expected if the variables were independent. Multinomial logistic regression models were used to calculate the adjusted OR and the respective 95% confidence interval (CI) for the associations between the belief and/or attitude and self-perceived changes in food consumption. OR were adjusted for sex, age group, education level, and self-perceived house income situation. Statistical analyses were performed with IBM SPSS® Statistics for Windows (version 25.0, 2017, Armonk, NY: IBM Corp) and R Software for

Windows (version 3.6.3, 2020, Vienna, Austria: The R Foundation). Results were based on two-sided tests, and statistical significance was considered when $p < .05$.

3. Results

In total, 6191 individuals responded to the questionnaire, of which 2.7% ($n = 170$) were interviewed by telephone (response rate of 38.3%). After data cleaning, 5858 were included in the analyses. Participants were aged between 16 and 88 years old (with a mean age of 38.2 (13.8) years) and female respondents represent 74.6% ($n = 4369$) of the sample. Unweighted and weighted data regarding sex, age, education level, self-perceived household income situation, employment status, and NUTS II Portuguese regions of residence of the respondents are reported in Table 1.

Participants were asked if they agreed with the belief that “*The new coronavirus can be transmitted by food*” and/or with the attitude “*I started to buy/consume some specific food items because they can protect me from the new coronavirus*”. Overall, 27.5% ($n = 1605$) of the respondents agreed exclusively with the belief, 11.9% ($n = 694$) agreed solely with the attitude, and 10.6% ($n = 619$) agreed with both sentences (Table 2). Agreement with the belief and/or attitude was associated with sex, age group, and self-perceived household income situation. Male participants agreed in greater proportion exclusively with the belief and female participants with the attitude. Participants aged up to 34 years agreed in a greater proportion exclusively with the belief and participants aged between 35 and 54 years exclusively with the attitude and with both sentences. Participants that perceived their income situation as difficult or very difficult agreed exclusively with the belief in higher proportion and exclusively with the attitude in lower proportion.

Table 1
Sociodemographic characterization of the sample (unweighted and weighted).

	Unweighted sample (N = 5858), % (n)	Weighted sample ^a (N = 5840), % (n)
Sex (<i>female</i>)	74.6 (4369)	53.0 (3097)
Age, mean (SD)	38.2 (13.8)	45.9 (16.5)
16–34 years	45.9 (2686)	27.9 (1627)
35–54 years	41.6 (2439)	34.9 (2039)
55+ years	12.5 (733)	37.2 (2174)
Education level (<i>higher education</i>)	68.0 (3985)	18.4 (1074)
Self-perceived household income situation		
Very comfortable	4.0 (235)	2.9 (172)
Comfortable	34.8 (2037)	26.1 (1524)
Enough for household needs	48.1 (2817)	49.4 (2885)
Difficult	9.1 (536)	13.6 (795)
Very difficult	2.3 (132)	4.3 (253)
Prefer not to answer	1.7 (101)	3.6 (210)
Employment status		
Professionally active	67.4 (3950)	54.2 (3167)
Students	16.6 (972)	4.2 (830)
Unemployed	4.6 (269)	6.4 (373)
Retired	4.6 (268)	16.5 (962)
Homemakers	1.4 (84)	3.2 (186)
Other situations	5.4 (315)	5.5 (323)
NUTS II Portuguese regions of residence		
North	24.1 (1410)	34.9 (2039)
Centre	21.4 (1251)	22.4 (1310)
Lisbon Metropolitan Area	41.7 (2443)	26.6 (1554)
Alentejo	5.1 (298)	7.3 (427)
Algarve	4.5 (263)	4.3 (250)
Autonomous Region of the Azores	1.7 (101)	2.3 (131)
Autonomous Region of Madeira	1.6 (92)	2.2 (127)

SD, standard deviation.

^a Weighted data by sex, age groups, education level, and NUTS II Portuguese regions of residence.

Table 2

Agreement with food and COVID-19 related belief and/or attitude, by sex, age group, education level, and self-perceived household income situation.

	Neither agrees with the belief nor with the attitude (or does not know), % (n)	Agrees with the belief, but not with the attitude, % (n)	Agrees with the attitude, but not with the belief, % (n)	Agrees with the belief and with the attitude, % (n)	p
Total	50.0 (2922)	27.5 (1605)	11.9 (694)	10.6 (619)	
Sex					
Female	52.6 (1628) ^a	24.4 (755) ^b	12.8 (396) ^a	10.2 (317)	< .001
Male	47.2 (1294) ^b	31.0 (850) ^a	10.9 (298) ^b	11.0 (301)	
Age Group					
16–34 years	46.7 (760) ^b	34.2 (556) ^a	9.8 (159) ^b	9.4 (153)	< .001
35–54 years	46.5 (949) ^b	26.7 (544)	13.9 (283) ^a	12.9 (262) ^a	
55+ years	55.8 (1213) ^a	23.2 (505) ^b	11.6 (253)	9.4 (203) ^b	
Education level					
Primary or secondary education	49.8 (2374)	27.3 (1302)	12.1 (578)	10.7 (512)	.545
Higher education	51.0 (548)	28.2 (303)	10.8 (117)	10.0 (107)	
Self-perceived household income situation*					
Comfortable or very comfortable	53.9 (914) ^a	23.7 (403) ^b	11.9 (202)	10.4 (177)	< .001
Enough for household needs	47.7 (1377) ^b	28.3 (817)	13.2 (382) ^a	10.7 (310)	
Difficult or very difficult	48.3 (506)	32.2 (337) ^a	8.7 (91) ^b	10.9 (114)	

Note: Belief - “The new coronavirus can be transmitted by food”; Attitude - “I started to buy/consume some specific food items because they can protect me from the new coronavirus”.

Weighted data by sex, age groups, education level, and NUTS II Portuguese regions of residence.

Bold indicates statistical significance ($p < .05$).

*“Prefer not to answer” cases were excluded from analysis ($n = 210$).

^a Adjusted standardized residuals > 1.96 , indicating that the subcategory was observed more frequently than expected if the variables were independent; ^b Adjusted standardized residuals < -1.96 , indicating that the subcategory was observed less frequently than expected.

Regarding eating changes during lockdown, 91.1% ($n = 5319$) of individuals reported having perceived a change in the consumption of at least one of the listed food groups.

Multinomial logistic regression models showed that those who agreed with the belief that “The new coronavirus can be transmitted by food”, but not with the attitude, had decreased odds of having perceived an increase in their consumption, rather than maintenance, of fruit, vegetables, water, fruit juices, and alcoholic beverages when compared with participants that did not agree with either sentence (or did not know), as shown in Table 3. Exclusive agreement with the belief was also associated with decreased odds of having decreased (rather than maintained) the consumption of other canned foods and pre-prepared meals and of having perceived a change in both directions of their consumption of fish and takeaway/home delivery.

Agreement with the attitude “I started to buy/consume some specific food items because they can protect me from the new coronavirus”, but not with the belief was positively associated with self-perceived increased consumption (rather than maintenance) of fish/seafood, canned fish, and water, and self-perceived decreased consumption of other canned

foods, sweet and salty snacks, pre-prepared meals, takeaway/home delivery, soft drinks, and alcoholic beverages, when compared with participants that did not agree with either sentence (or did not know). Regarding fruit and vegetables, exclusive agreement with the attitude was associated with increased odds of having perceived increased consumption, together with decreased odds of having perceived a decreased consumption, rather than maintenance. Lastly, participants that agreed exclusively with the attitude had increased odds of having increased or decreased, rather than maintained, their consumption of fruit juices, when compared with participants that did not agree with either sentence (or did not know).

As presented in Table 3, those who agreed with both the belief and the attitude had increased odds of having perceived an increase (rather than maintenance) of their consumption of fruit, canned fish, salty snacks, and fruit juices, as well as a decrease of fish/seafood, sweet snacks, pre-prepared meals, soft drinks, and alcoholic beverages, in comparison to those who did not agree with the belief nor with the attitude (or did not know). Agreement with both sentences was associated with increased odds of having perceived an increase or a decrease (rather than maintenance) in vegetables and other canned foods and was associated with decreased odds of having perceived a decrease in water when compared with participants that did not agree with either sentence (or did not know).

4. Discussion

The main aim of this paper was to understand how beliefs and/or attitudes about the potential transmission of SARS-CoV-2 through food items and about the protective role of specific foods against SARS-CoV-2 were associated with self-perceived changes in food consumption during lockdown, issued in response to the first wave of COVID-19 cases in Portugal (between March 19 and May 2, 2020).

In total, 38.1% of the respondents agreed (exclusively or not) with the belief that “The new coronavirus can be transmitted by food”. In a cross-sectional online survey, Sidor and Rzymiski (2020) found that 27.5% reported fear of being infected with SARS-CoV-2 when having direct contact with food. Our data do not allow us to infer the basis on which this belief emerged, but we may speculate that it might have arisen from concerns that the virus could be present on the surface of both unpackaged and packaged food. Research conducted under laboratory-controlled conditions evaluating the viability of SARS-CoV-2 on different surfaces detected the virus up to 24–72 h on cardboard and plastic, materials frequently used in food packaging (Doremalen et al., 2020). Nevertheless, as mentioned before, based on current evidence, SARS-CoV-2 is not considered a food safety risk (EFSA, 2020; WHO & FAO, 2020).

Additionally, 22.5% of participants (exclusively or not) stated to have started to buy or consume specific food items that they consider having a protective role against the new coronavirus. It is known that malnutrition negatively impacts the immune system due to an inadequate intake of nutrients and a lack of nutritional signals (e.g., leptin) that are critical for fueling immune cell proliferation and function (Alwarawrah et al., 2018; Calder & Kew, 2002; Conde et al., 2014; Fernández-Riejos et al., 2010; Saucillo et al., 2014). A recent study concluded that plant-based diets or pescatarian diets were associated with lower odds of having moderate-to-severe COVID-19 (Kim et al., 2021). Still, no evidence supports that consuming any specific food item improves immune function (Aune et al., 2017; EFSA, 2018; Wu et al., 2019).

Agreement with the belief that “The new coronavirus can be transmitted by food”, but not with the attitude, was negatively associated with self-perceived increased consumption of fruit, vegetables, and water and decreased consumption of pre-prepared meals and takeaway, rather than maintenance—changes that could be beneficial considering that more than half (56.0%) of the Portuguese population consumes less than the recommended 400 g per day of fruits and vegetables and that the

Table 3

Multinomial logistic regression models for the association between agreement with food and COVID-19 related belief and/or attitude and self-perceived changes in food consumption during lockdown.

Food groups	Agrees with the belief, but not with the attitude		Agrees with the attitude, but not with the belief		Agrees with the belief and with the attitude	
	Increase OR (95% CI)	Decrease OR (95% CI)	Increase OR (95% CI)	Decrease OR (95% CI)	Increase OR (95% CI)	Decrease OR (95% CI)
Fruit	0.69 (0.59–0.80)	1.01 (0.81–1.26)	1.37 (1.15–1.64)	0.32 (0.20–0.53)	1.50 (1.24–1.81)	0.82 (0.58–1.18)
Vegetables	0.73 (0.62–0.87)	1.08 (0.88–1.32)	1.82 (1.50–2.20)	0.44 (0.30–0.66)	1.71 (1.39–2.10)	1.68 (1.29–2.20)
Meat	0.93 (0.73–1.18)	0.91 (0.75–1.11)	1.10 (0.80–1.50)	1.00 (0.77–1.30)	1.31 (0.96–1.78)	0.76 (0.56–1.02)
Fish/seafood	0.64 (0.53–0.78)	0.65 (0.54–0.78)	1.78 (1.44–2.20)	0.90 (0.70–1.15)	0.86 (0.65–1.13)	1.54 (1.24–1.91)
Canned fish	0.81 (0.66–1.00)	0.85 (0.71–1.03)	1.55 (1.22–1.96)	0.87 (0.67–1.14)	1.88 (1.49–2.39)	1.00 (0.76–1.31)
Other canned foods	0.88 (0.71–1.10)	0.70 (0.58–0.85)	1.23 (0.93–1.63)	1.40 (1.12–1.75)	1.57 (1.20–2.06)	1.33 (1.05–1.69)
Sweet snacks	1.08 (0.93–1.25)	0.94 (0.79–1.12)	1.20 (0.98–1.47)	1.66 (1.34–2.05)	1.14 (0.93–1.41)	1.40 (1.12–1.76)
Salty snacks	0.95 (0.77–1.18)	0.93 (0.81–1.08)	0.81 (0.57–1.14)	1.93 (1.62–2.31)	0.65 (0.45–0.93)	1.16 (0.95–1.41)
Pre-prepared meals	0.86 (0.65–1.15)	0.84 (0.74–0.96)	1.41 (0.95–2.10)	1.62 (1.36–1.93)	0.65 (0.40–1.07)	1.29 (1.08–1.55)
Takeaway/home delivery	0.68 (0.53–0.87)	0.86 (0.75–0.98)	1.03 (0.72–1.47)	1.91 (1.60–2.29)	0.77 (0.53–1.10)	1.15 (0.95–1.38)
Water	0.79 (0.68–0.91)	0.83 (0.68–1.00)	1.66 (1.38–2.00)	0.83 (0.62–1.11)	1.03 (0.84–1.25)	0.72 (0.53–0.97)
Fruit juices	0.74 (0.60–0.92)	1.12 (0.94–1.33)	1.76 (1.38–2.25)	1.63 (1.30–2.04)	1.96 (1.54–2.48)	0.94 (0.71–1.23)
Soft drinks	0.83 (0.60–1.13)	0.90 (0.78–1.03)	0.93 (0.56–1.55)	2.41 (2.02–2.87)	0.46 (0.25–0.85)	1.43 (1.19–1.73)
Alcoholic beverages	0.77 (0.61–0.96)	0.86 (0.74–1.00)	1.01 (0.75–1.37)	1.42 (1.17–1.73)	0.80 (0.58–1.11)	1.25 (1.02–1.53)

Note: Belief - “The new coronavirus can be transmitted by food”; Attitude - “I started to buy/consume some specific food items because they can protect me from the new coronavirus”.

Weighted data by sex, age groups, education level, and NUTS II Portuguese regions of residence.

N = 5630 (the “I don’t know” option for the self-perceived household income situation was excluded from the analyses).

Adjusted odds ratios (OR) and 95% Confidence Interval of having increased or decreased the consumption of each food listed (as opposed to having maintained) by those who agree with the belief and/or the attitude, compared with those who neither agree with the belief nor the attitude. OR adjusted for sex, age group, education level, and self-perceived household income situation.

Bold indicates statistical significance (p < .05).

average daily intake of sodium is above recommendations (Lopes et al., 2017; WHO, 2003).

On the other hand, agreement with the attitude “I started to buy/consume some specific food items because they can protect me from the new coronavirus”, but not with the belief “The new coronavirus can be transmitted by food”, was positively associated with the (self-perceived) adoption of, mostly, behaviors that could be considered health-protective in *lato sensu*, such as increasing the consumption of fruit, vegetables, fish, and water, and decreasing the consumption of sweet and salty snacks, pre-prepared meals, takeaway, soft drinks, and alcoholic beverages. In other words, preference for foods that contribute to a balanced nutritional status (Jayawardena et al., 2020). Nevertheless, the questions used in the survey about food behavior do not allow to infer the adequacy of participants’ dietary patterns because no data about baseline food consumption (before the pandemic), nor about food portions were collected (respondents only reported self-perceived changes in behavior, i.e., if they increased, maintained, or decreased consumption).

Lastly, except for an increased odds ratio for perceived decreased consumption of vegetables and fish, in opposition to maintenance, agreement with both the belief and the attitude was associated with potentially positive food consumption changes, similarly to what was observed with an exclusive agreement with the attitude. This finding suggests that the influence that the attitude exerts on food consumption choices prevails over the influence of the belief, indicating that public health strategies addressing dietary recommendations might benefit from giving greater focus to attitudes towards the relationship between food (or the overall dietary pattern) and immune system competence.

Optimal nutritional intake is a concern at the individual, community, national, and global levels. As Naja and Hamadeh (2020) stated, a multi-level framework of action, such as the ecological model of health behavior, is required to support adequate nutritional intake during the COVID-19 pandemic. Ensuring individuals’ health literacy is a crucial component of this ecological model (although it should not be taken as the unique relevant component) (Naja & Hamadeh, 2020). The COVID-19 “infodemic” highlighted that poor health literacy is an underestimated global public health problem (Paakkari & Okan, 2020), and being a relevant determinant of nonprotective health behaviors (Sørensen et al., 2015), it endangers the global fight against the

pandemic (Paakkari & Okan, 2020).

The gap between beliefs (either wrong or correct ones) and the adoption of behaviors is well known when individuals’ health behavior related decisions are required in non-critical situations (e.g., when coping with chronic conditions; Santos, 2010); but this information-behavior gap may be reduced when risk perception is high (e.g., in crises), when the information is delivered by a reliable authority, and when messages emphasize benefits (Bavel et al., 2020). This means that public health authorities need to effectively address and fight against non-evidence-based beliefs and attitudes that may activate unhealthy behaviors, while exploring beliefs that facilitate the adoption of adequate behaviors, namely food-related ones, taking advantage of the general population’s perception of high risk towards COVID-19, caused by the pandemic (Abrams & Greenhawt, 2020; Smith, 2006).

National and international authorities used health communication as a pivotal way to inform people about the COVID-19 pandemic, the virus, the disease, and how to avoid getting infected or spreading the infection (WHO & FAO, 2020). Most of the disseminated information targeted practical actions (e.g., how to wash hands or how to keep social distance) and had the goal to educate people to adopt protective health behaviors at a critical moment. The Portuguese National Program for the Promotion of Healthy Eating (PNPAS) endorsed several nutritional literacy efforts aiming to promote adequate food habits while in lockdown (PNPAS, 2020). Fighting fake news that spread on social media platforms regarding the association between specific foods or supplements and COVID-19 prevention was one of the main pillars of the Portuguese nutritional literacy strategy during the COVID-19 pandemic. The PNPAS communication strategy for the general population was to clarify that no food or supplement can “boost” the immune system and that a healthy diet is important to maintain its normal function. Another point of concern was to clarify the possible transmission of the new coronavirus via food and food safety rules, aiming to reduce the impact of non-evidence-based risk perceptions on the decrease of fruit and vegetable consumption (PNPAS, 2020). Identifying and understanding the beliefs and attitudes about the relationship between food and COVID-19, in particular, its negative impacts is therefore essential for the development of effective and strategic health communication.

Considering the limitations of this study, it is relevant to note that the collected sample is not probabilistic, which impairs its

representativeness. However, the sample size is large and, after being weighted, became similar to the Portuguese residents' population in terms of main sociodemographic characteristics. Thereby, these results provide valuable information about self-perceived changes in food consumption and beliefs and attitudes about COVID-19 and food among a sample of the Portuguese population living in lockdown. In this study, we did not objectively measure changes in food consumption but asked participants about their perceptions, which can differ from the actual changes. Also, two data collection strategies were used (telephone interviews aimed to cover population strata not achieved, or less represented, with the online survey), which could introduce heterogeneity in the collected answers; however, this is not expected to have greatly impacted the overall results, since telephone interviews only represent 2.7% of the sample. It is also important to highlight the fact that this is a cross-sectional study, which limits the understanding of the phenomena under study to the level of association between variables. The influence of beliefs and attitudes on food consumption choices (and vice versa) is mediated by several factors and could not be ascertained with a cross-sectional design.

In sum, the results of this survey show that, in a lockdown scenario, exclusive agreement with the belief that “*The new coronavirus can be transmitted by food*” (which may, potentially, refrain consumers from eating more fruits and/or vegetables, among others; an “anti-consumption” belief) was negatively associated with potentially beneficial changes in food consumption, whereas exclusive agreement with the attitude “*I started to buy/consume some specific food items because they can protect me from the new coronavirus*” (a “pro-consumption” attitude for specific food items) was positively associated with potentially beneficial changes in food consumption. When agreeing with both belief and attitude, the influence of the attitude on food consumption changes seems to prevail over the belief's influence. Further research, with longitudinal designs, is necessary to better understand how beliefs and, most importantly, attitudes regarding the role of food in infectious diseases related processes (as either health protectors or disease-vectors) might act as determinants of eating behavior modification, as well as how these associations might change over time. Health communication initiatives related to dietary recommendations during similar pandemic scenarios should clarify the role of food on virus transmission and (possibly with greater impact) individuals' immunity function, improving health literacy, and taking advantage of the possible influence of these beliefs and attitudes on food choices.

Ethical Statement for appetite

Hereby, I, Raquel Martins, consciously assure that for the manuscript “Are beliefs and attitudes about COVID-19 associated with self-perceived changes in food consumption? Results from a nationwide survey during lockdown” the following is fulfilled:

- 1) This material is the authors' own original work, which has not been previously published elsewhere.
- 2) The paper is not currently being considered for publication elsewhere.
- 3) The paper reflects the authors' own research and analysis in a truthful and complete manner.
- 4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
- 5) The results are appropriately placed in the context of prior and existing research.
- 6) All sources used are properly disclosed (correct citation).
- 7) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

I agree with the above statements and declare that this submission follows the policies of *Appetite* as outlined in the Guide for Authors and

in the Ethical Statement.

Author contributions

OS, RM, and CC formulated the research questions. OS, AV, MJG, PG, MS, and MA designed the study and carried it out. RM, CC, MF, and RFS also contribute to data collection and were responsible for data analyses. OS supervised statistical analyses and methodological details of the project. RM and CC wrote the first draft of the manuscript. All authors provided relevant contributions to the manuscript. All authors read and approved the final version of the manuscript.

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Data availability

The participants did not agree for their data to be shared publicly (it was not included in the informed consent), so supporting data is not available.

Declaration of competing interest

None.

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