



Citizen attitudes towards present and future beef consumption before and after the COVID-19 pandemic

Valentina Mansky de la Fuente^{a,b}, María José Hötzel^b, Dayane Lemos Teixeira^{c,**}, Rafael Esteban Larraín^{a,b,d}, Daniel Enriquez-Hidalgo^{e,f,*}

^a Facultad de Agronomía e Ingeniería Forestal, Pontificia Universidad Católica de Chile, Santiago, Chile

^b Laboratório de Etologia Aplicada, Universidade Federal de Santa Catarina, Florianópolis, Brazil

^c Hartpury University, Department of Animal and Agriculture, Gloucester, United Kingdom

^d Center of Applied Ecology and Sustainability (CAPEs)

^e Bristol Veterinary School, University of Bristol, Langford, North Somerset, United Kingdom

^f Rothamsted Research, Sustainable Agriculture Sciences, North Wyke, Okehampton, Devon, United Kingdom

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ABSTRACT

There's been a change in citizens' attitudes towards beef consumption in high-income countries, resulting in a decline in its consumption. The COVID-19 pandemic may have impacted citizens' attitudes and behaviours towards beef consumption. This study aimed to investigate Chilean citizens' attitudes towards beef consumption during the initial 18 months of the pandemic. Socio-demographic characteristics and attitudes towards beef consumption were asked in two questionnaires done in 2020 ($n = 1142$) and 2021 ($n = 1221$). Citizens' attitudes to beef eating and production did not change between the start and more than a year after the outbreak of the COVID-19 pandemic. Participants not related with animal production, female, young, and non-meat consumers demonstrated more negative attitudes towards beef consumption and production. Half of the participants agreed that beef is bad for the environment, but only 30% agreed that beef is bad for human health. Half of participants had reduced beef consumption and 48% expressed intentions to reduce beef consumption in the future, primarily motivated by concerns related to animal welfare, the environment, and human health. The majority of participants (80%) thought that their fellow citizens should reduce their beef consumption but only 50% had confidence that this will occur. We conclude that Chilean consumers' attitudes to beef eating did not change due to the outbreak of the COVID-19 pandemic. Participants expressed strong concern about beef consumption both individually and socially, due to environmental, animal and health concerns, and believed Chileans should reduce beef consumption in the future but had low confidence that this will happen.

1. Introduction

Meat and beef consumption have been increasing over the last two decades, reaching the highest levels in history (Whitton, Bogueva, Marinova, & Phillips, 2021). The increase in total world meat consumption since the 1960s accompanied the rising incomes and associated cultural changes of low and middle-income countries (LMIC), the main drivers of change in the last decades (FAO, 2009; Masters et al., 2016). Following meat consumption demand, meat production increased from 70 million tons per year in 1960 to >350 million tons per year in 2021, a 4-fold increase in almost 60 years. The increase in meat

production has resulted in an average yearly consumption of 43 kg of meat per capita in the world, with beef as the third most consumed meat, after pork and poultry (FAOstat, 2023). However, despite the considerable increase in total worldwide meat consumption, a recent assessment has shown some different trends in consumers' beef consumption habits. In LMIC the consumption of beef has been stable, while in high-income countries (HIC) beef consumption has decreased (Parlasca & Qaim, 2022; Resare Sahlin, Rööös, & Gordon, 2020; Vranken, Avermaete, Petalios, & Mathijs, 2014). The reduction of beef consumption largely among high-income consumers from developed countries, has been motivated mainly by ethical and health concerns (Sanchez-Sabate &

* Corresponding author at: Bristol Veterinary School, University of Bristol, Langford, North Somerset, United Kingdom.

** Corresponding author.

E-mail addresses: day.teixeira@hartpury.ac.uk (D.L. Teixeira), Daniel.enriquez@bristol.ac.uk (D. Enriquez-Hidalgo).

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Sabaté, 2019). The environmental impact of beef production systems is an emerging topic that remains the least likely reason for people to reduce or avoid beef consumption (Hötzel & Vandresen, 2022; Liu et al., 2023; Sanchez-Sabate & Sabaté, 2019). Moreover, some studies have shown that consumers are not aware of the interactions of livestock with the environment (i.e. de Boer, Schösler, & Boersema, 2013; Pohjolainen, Tapio, Vinnari, Jokinen, & Räsänen, 2016) and commonly do not see a link between beef consumption and climate change (Macdiarmid, Douglas, & Campbell, 2016). However, more recent media coverage of the potential contribution of meat-eating habits to the climate change crisis (Almiron & Zoppeddu, 2015; Mayes, 2016; Mountford et al., 2021; Shukla et al., 2019) may influence a change in consumption behaviour.

Another factor that might have had an impact on citizens' meat and beef consumption is the COVID-19 pandemic (i.e., Font-i-Furnols & Guerrero, 2022; Quevedo-Silva, Freire, & Spanhol-Finocchio, 2019). The meat industry was one of the most affected sectors worldwide as a result of the pandemic (Hashem, González-Bulnes, & Rodríguez-Morales, 2020). Some of the reasons were the reductions in cattle slaughter and beef production, which altogether resulted in a supply deficit in the market (Peel, 2021; Rizou, Galanakis, Aldawoud, & Galanakis, 2020), quarantines, city closures and lockdowns and restaurant closures. Furthermore, there was an increase in meat prices (Fleming, 2021), which added to the loss of income in many places as a consequence of sanitary measures (Meixner & Katt, 2020). Besides meat consumption, citizens' attitudes towards beef consumption may have been modified with the COVID-19 outbreak (Attwood & Hajat, 2020). For example, there has been abundant commentary and media coverage on the possible zoonotic root of the pandemic (Das, 2020; Rodríguez-Morales et al., 2020) and the associations between the current animal production systems and the development of new diseases and pandemics (Magouras et al., 2020; Meurens et al., 2021). Therefore, this study aimed to investigate if the attitudes of Chilean citizens towards beef consumption changed during the first 18 months of the COVID-19 pandemic.

2. Materials and methods

2.1. Survey

This study was carried out in Chile and consisted of a survey applied to 2363 participants during two different recruitment periods. Data collection was conducted using a self-administered questionnaire carried out through Google Forms Online platform. The first participants' recruitment period was done between April and May 2020, at the beginning of the COVID-19 outbreak, and the second recruitment period was done 18 months later, between October and November 2021. In both periods participants were recruited through social networks such as WhatsApp, Instagram, Facebook and by email messages sharing the questionnaire link and inviting participants to respond and share the survey. Participants were invited to complete a survey about animal production, with no specification of the nature of the issue, to reduce self-selection bias. Only participants who were at least 18 years old and had Chilean nationality could participate in the study. The identity of the participants was not required. The set of participants from the recruitment periods were independent but given that similar recruitment processes were used in both instances, there is a chance that some people may have participated in both surveys.

The 15 first responses of the questionnaire, which were not included in the final analysis, were conducted as a pilot study and answers and comments were discussed among the research team, reviewed and refinements were made to the questionnaire. The final questionnaire included 11 questions. Participants who agreed to participate in the survey were asked to read an informed consent and accept it before starting the questionnaire. The text clarified the purpose of the investigation, the anonymity of the participation, the fact that participants would not be identifiable even to the research team, and how the

information collected was going to be used, i.e., for scientific research only. It also explained that participants did not have any risk by participating in the investigation, that there was no compensation for doing so and that they could withdraw at any point if they wished, by not sending the form, without any repercussion. The Research Ethics and Safety Board at the Pontificia Universidad Católica de Chile approved the study and granted a Certificate of Exemption (n. 170,906,008) due to the type of questions and the anonymity of the participants.

2.2. Participants' socio-demographics and characterization

The first questions addressed participants' socio-demographic information relating to their gender (female or male), age (18–25; 26–35; 36–45; 46–55; 56–65; over 66 years old) and education (No university education or Complete or Incomplete university education). They were also asked their consumption habits in relation to meat (Omnivore; Vegetarian; Vegan or Other). Then, all the participants were asked if they had any type of relationship with animal production (Yes, I currently have some kind of relationship and/or I grew up in a place related to animal production; or No).

2.3. Statements about the impacts of beef consumption

In the first set of questions, all participants were asked to rank how much they agreed (0: Totally disagree; 1: Disagree; 2: Neither agree, nor disagree; 3: Agree; 4: Totally agree; or I do not know) with the following sentences: "Beef consumption is bad for human health" and "Beef consumption is bad for the environment".

2.4. Beef consumption attitudes and habits

Participants who declared themselves as meat consumers were asked how they considered their level of beef consumption to be (1: Very low; 2: Low; 3: Normal; 4: High or 5: Excessive), if they had reduced their meat consumption in the last year (Yes; No or I do not remember), and what they planned to do with their beef consumption in 3 to 5 more years (Maintain; Reduce or Increase). Participants who declared not consuming beef were asked to state the main reason(s) (Price; Health; Religion; Environment; I do not like the taste; I do not know how to cook beef; The animals or Other).

2.5. Prospective beef consumption

All participants were asked what they believed the Chilean population was going to do about their beef consumption in the future (Maintain; Reduce or Increase), what they thought the Chilean population should do regarding their beef consumption in the future (Maintain; Reduce or Increase) and which was the main reason(s) for their answer, with the possibility to choose more than one option (Economics; Environment; Animals; Human Health; Production level or Other). Participants were asked which meat or meat substitute they believed that Chileans will eat most in the future, where they could choose one or more options (Beef; Pork; Poultry; Fish; Lamb; Vegetable meat substitutes; Cultured meat; Insects or Other).

2.6. Participants' self-assessment of COVID-19 pandemic influence in their responses

Then, participants were asked if they considered that their responses had been influenced by the COVID-19 outbreak (with options Yes; No; or I'm not sure), and to justify this answer.

2.7. Statistical analysis

Descriptive statistics for the responses were calculated using Microsoft® Excel for Mac and all other statistical analyses were conducted

Table 1
Socio-demographic information of survey participants for the 2020 ($n = 1142$) and the 2021 recruitment ($n = 1221$).

Variable	2020		2021		Total		INE, 2018
	n	(%)	n	(%)	n	(%)	(%)
Gender							
Female	762	67	813	67	1575	67	51
Male	380	33	408	33	788	33	49
Age							
18 to 25 years old	390	34	437	36	827	35	13
26 to 35 years old	275	24	215	18	490	21	16
36 to 45 years old	168	15.3	135	11	303	13	14
46 to 55 years old	171	14.7	161	13	332	14	13
56 years old and over	138	12.2	273	22	411	17	20
Meat consumption							
Yes	905	80	898	74	1803	76	
No	237	20	323	26	560	24	
Involvement with animal production							
No	1009	88	1019	83	2028	86	
Yes	133	12	202	17	335	14	
Education							
No university education	214	19	244	20	458	19	
University education complete or ongoing	928	81	977	80	1905	81	

using SAS 9.3. Age categories '56–65' and 'over 66 years old', were grouped due to the low number of participants in these categories. Similar grouping was undertaken for the 'professional involvement' and 'grew up in a place related to animal production' categories for the same reason. For the purpose of the analysis, participants were classified as meat consumers if they consumed beef, pork, poultry, or small ruminants, if not, they were classified as not meat consumers.

Multinomial logistic regression models were used to analyse associations between the socio-demographic data and opinions regarding agreement with statements about beef consumption effects on human health and the environment. For the purpose of the analysis, totally disagree (0) and disagree (1) were grouped as one single disagreement category and agree (3) and totally agree (4) as an agreement category. Gender, age, educational level, meat consumption, involvement with animal production, year of participation and influence of the COVID-19 outbreak in the answers were included in the model as explanatory variables. For the associations between socio-demographic data and participants' prospective beef consumption the explanatory variables initially considered in the multinomial regression model were the socio-demographic variables and self-assessment of beef consumption, reduction in beef consumption last year, year of participation and influence of the COVID-19 pandemic in the answers. For the question about what Chileans will do and should do about their prospective beef consumption as for the question about which meat or meat substitute participants considered that Chileans will eat most in the future, the explanatory variables included in the analyses were gender, age, education level, involvement with animal production, meat consumption, year of participation and influence of the COVID-19 pandemic in the answers.

Predictor variables with $P < 0.20$ were initially used to build multivariate models, followed by backward selection to eliminate predictor variables until only those with $P < 0.05$ remained in the models. The results for categorical and ordinal variables are expressed in terms of odds ratios (OR) and 95% confidence interval (95% CI). Statistical associations were reported when $P < 0.05$.

3. Results

3.1. Socio-demographic characterization

Socio-demographic data are shown separately for the 2020 ($n = 1142$) and the 2021 recruitment ($n = 1221$) and the National Census (INE, 2018) in Table 1. Most participants were female, younger than 35 years old, meat consumers, not involved with animal production, and had ongoing or completed university education. When compared to the National Census data, our data sample had proportionally more females and younger than 25 years old participants.

3.2. Assessment of beef attributes

Forty seven percent of participants disagreed and 30% agreed with the statement "Beef is bad for human health", while the rest were in between (20%) or did not know (3%). Instead, for the statement "Beef is bad for the environment", 51% of participants agreed, 30% disagreed, 17% were in between and 2% did not know.

The level of participants' agreement with the statements "Beef is bad for human health" and "Beef consumption is bad for the environment" are presented in Table 2 and Table 3, respectively. Neither the year of participation nor the participants' belief that COVID-19 had influenced their responses affected the participants' level of agreement with the two sentences related to beef consumption. Female participants had higher odds of agreeing with both statements than males ($P < 0.001$). There were higher odds of participants who did not consume meat agreeing with both statements than those who did not consume meat ($P < 0.001$). Participants over 35 years old had lower odds of agreeing that beef is bad for the environment compared to the younger participants ($P < 0.001$), but only participants between 26 and 35 years old had higher odds than younger participants of agreeing that beef is bad for human health ($P < 0.05$). Participants with university education had higher odds of agreeing that beef consumption is bad for the environment compared to participants without university education ($P < 0.05$). In contrast, participants involved with animal production had lower odds of agreeing with both statements when compared to the participants without involvement ($P < 0.001$).

Table 2

Factors influencing participants' level of agreement towards "Beef is bad for human health". Totally disagree or disagree were the reference category*.

	Totally disagree or disagree*	Neither agree, nor disagree			Agree or Totally agree			P - value	
	(%)	(%)	OR	95% CI	(%)	OR	95% CI		
Gender								<0.001	
Male	62	18			20				
Female	44	22	1.62	1.28	2.06	34	1.88	1.47	2.41
Age								<0.05	
18–25	49	21			30				
26–35	45	20	1.08	0.8	1.48	35	1.76	1.29	2.42
36–45	56	17	0.72	0.5	1.04	27	1.26	0.87	1.83
46–55	53	21	0.86	0.61	1.22	26	1.23	0.86	1.77
56 or more	51	21	0.86	0.62	1.18	28	1.11	0.79	1.55
Meat consumption								<0.001	
Yes	61	21			18				
No	15	18	3.25	2.3	4.6	67	18.6	13.7	25.2
Animal production involvement								<0.001	
No	47	21			32				
Yes	27	38	0.43	0.31	0.61	35	0.27	0.18	0.4

OR = Odds ratio.

CI = Confidence interval.

Rank from 0 to 4 (0: Totally disagree; 1: Disagree; 2: Neither agree, nor disagree; 3: Agree; to 4: Totally agree).

Table 3

Factors influencing participants' level of agreement towards "Beef consumption is bad for the environment". Totally disagree or disagree were the reference category*.

	Totally disagree or disagree*	Neither agree, nor disagree			Agree or Totally agree			P - value	
	(%)	(%)	OR	95% CI	(%)	OR	95% CI		
Year of participation								<0.05	
2020	31	19			50				
2021	33	15	0.81	0.62	1.04	52	1.11	0.89	1.39
Gender								<0.001	
Male	41	21			38				
Female	28	15	1.16	0.89	1.51	57	2.1	1.67	2.65
Age								<0.001	
18–25	20	17			63				
26–35	24	19	0.86	0.59	1.24	57	0.74	0.54	1.02
36–45	40	15	0.41	0.27	0.62	45	0.37	0.26	0.52
46–55	43	18	0.43	0.29	0.64	39	0.27	0.19	0.38
56 or more	50	17	0.36	0.25	0.52	33	0.17	0.12	0.23
Meat consumption								<0.001	
Yes	40	20			40				
No	6	8	2.92	1.78	4.8	87	13.2	8.72	19.9
Animal production involvement								<0.001	
No	28	17			55				
Yes	55	17	0.4	0.28	0.57	28	0.17	0.12	0.24
Education								<0.05	
No university education	39	18			43				
With university education	30	17	1.11	0.81	1.52	53	1.56	1.18	2.06

OR = Odds ratio.

CI = Confidence interval.

Rank from 0 to 4 (0: Totally disagree; 1: Disagree; 2: Neither agree, nor disagree; 3: Agree; to 4: Totally agree).

3.3. Attitudes and habits to beef consumption

Among the 1803 meat consumer participants, 38% perceived their own beef consumption as low, 45% as intermediate and 17% as high. Fifty two percent of participants answered that they had reduced beef

consumption during the previous year, while 44% had not, and 6% did not know or did not remember. Half of the participants intended to maintain their beef consumption level in the future, 48% intended to reduce it and only 2% were willing to increase their beef consumption.

The responses of the participants who intended to reduce their beef

Table 4

Factors influencing participants' intention to reduce beef consumption in 3 to 5 more years. Maintain beef consumption in the future was the reference category*.

	Maintain beef in the future*	Reduce beef in the future			P - value
	(%)	(%)	OR	95% CI	
Year of participation					<0.05
2020	49	51			
2021	53	47	1.04	0.85	1.28
Gender					<0.001
Male	59	41			
Female	46	54	1.34	1.08	1.67
Age					<0.05
18–25	44	56			
26–35	51	49	0.73	0.55	0.98
36–45	57	43	0.66	0.47	0.92
46–55	51	49	0.74	0.54	1.02
56 or more	57	43	0.57	0.42	0.77
Animal production involvement					<0.001
No	48	52			
Yes	68	32	0.44	0.33	0.60
Animal consumption self-perception					<0.001
Intermediate	57	44			
Low	43	57	0.83	0.65	1.06
High	55	45	1.66	1.22	2.25
Reduced beef consumption last year					<0.001
No	74	26			
Yes	33	67	6.48	5.09	8.26
Do not remember	41	59	4.06	0.44	2.42

OR = Odds ratio.

CI = Confidence interval.

The 2% of meat-eating participants who said they intended to increase their meat consumption were not considered within this table.

consumption in the future were not affected by the year of assessment nor by the participants' belief that COVID-19 had influenced their responses (Table 4). Female participants had higher odds of intention to reduce their beef consumption in the future. There were lower odds that participants involved with animal production intended to reduce beef consumption in the future than those who did not have any type of relation with animal production. Similarly, there were lower odds that the participants older than 25 years old intended to reduce beef consumption compared to younger participants. Participants who perceived their beef consumption level as high had higher odds to intend to reduce their beef consumption in the future than those who perceived their beef consumption level as intermediate. Participants who said that they had already reduced beef consumption in the past had higher odds to intend to further reduce it in the future than those who did not. Despite the overall low number of participants who intended to increase their beef consumption in the future, those from 2021 were more than twice as likely to choose this option than participants from 2020 (n 2020 = 10; n 2021 = 27; OR = 2.8; 95% CI = 1.32–5.94; $P < 0.05$).

The three main reasons cited by the 560 participants to justify not eating beef were concerns with the animals (33%), the environment (30%) and human health (23%). The other reasons were taste (6%), other (6%) and price (2%).

3.4. Prospective beef consumption

The percentage of participants who considered that Chileans should maintain, reduce or increase their beef consumption were 18, 80 and 2%, respectively. However, 46, 48 and 7% of the participants considered that Chileans will effectively maintain, reduce and increase their beef consumption, respectively. The year of assessment had no effect on participants' prospective beef consumption.

Participants who said that Chileans should either increase or reduce their beef consumption were more likely to perceive that their responses were influenced by the COVID-19 pandemic than those who did not. Participants who did not know if their responses were influenced by the COVID-19 pandemic also had higher odds of saying that Chileans should reduce their beef consumption than those who thought that their responses were not influenced by the COVID-19 pandemic (Table 5). Participants not related to animal production had higher odds of saying that Chileans should reduce beef consumption than participants related to animal production, as did females compared to males. At the same time, participants involved with animal production had higher odds of saying that Chileans should increase beef consumption than participants not related to animal production. In contrast, females had lower odds of saying that Chileans should increase beef consumption compared to males. Participants who were not meat consumers had higher odds of saying that Chileans should increase and also reduce beef consumption, than participants who declared themselves as meat consumers.

The main reasons given by participants for saying that Chileans should reduce beef consumption were concerns with the environment (46%), human health (21%) and the animals (either ethical or welfare concerns, 17%, Table 5).

The most popular future proteins chosen by participants were poultry (25%) vegetable meat substitutes (23%) and fish (20%), followed by beef (11%) and pork (10%). The least popular options were cultured meat (5%), lamb (3%), insects (1%) and other sources (1%). Some participants chose exclusively non-animal protein sources (21% of the participants in both years), exclusively animal protein sources (43% of the 2020 participants and 45% of the 2021 participants) and mixed protein sources (35% of the 2020 participants; 32% of the 2021 participants).

There was no influence of the year of assessment on participants'

Table 5

Factors influencing participants' attitudes towards what Chileans should do in the future about their beef consumption level (Q10) and the main reasons for it. Chileans should maintain beef consumption was the reference category*.

	Maintain beef consumption*	Increase beef consumption			Reduce beef consumption			P - value		
	(%)	(%)	OR	95% CI	(%)	OR	95% CI			
COVID-19 pandemic influence										
No	19	3			78			<0.001		
Yes	14	4	2.53	1.06	6.02	82	1.86		1.14	3.06
Do not know	5	3	2.00	0.67	5.99	92	2.21		1.22	4.01
Gender										
Male	27	6			67			<0.001		
Female	13	1	0.55	0.31	0.99	86	2.11		1.62	2.74
Animal production involvement										
No	16	1			83			<0.001		
Yes	30	13	5.38	3.06	9.47	57	0.42		0.29	0.59
Meat consumption										
Yes	23	3			74			<0.001		
No	0	0	11.02	1.75	69.30	100	62.26		15.29	253.54
Reasons										
Animals	0	0			100			<0.001		
Environment	1	0	0.67	0.05	8.81	99	1.93		0.77	4.85
Production amount	26	1	1.10	0.12	10.02	63	0.05		0.02	0.12
Human health	17	5	0.87	0.10	7.48	78	0.08		0.04	0.17
Economics	23	8	0.69	0.08	6.27	69	0.05		0.02	0.12
Other	26	7	0.75	0.08	6.83	67	0.04		0.02	0.10

OR = Odds ratio.

CI = Confidence interval.

Table 6

Factors influencing participants' choices about protein sources that Chileans will eat the most in the future (Q11). Responses that included an animal source and a non-animal source was the reference category*.

	Animal and non-animal sources*	Exclusively non-animal protein sources			Exclusively animal protein sources			P - value		
	(%)	(%)	OR	95% CI	(%)	OR	95% CI			
COVID-19 pandemic influence										
No	35	20			45			< 0.05		
Yes	43	19	0.93	0.63	1.38	38	0.80		0.58	1.11
Do not know	34	28	1.64	1.08	2.49	38	0.88		0.60	1.29
Gender										
Male	33	16			51			< 0.05		
Female	34	24	1.18	0.91	1.54	42	0.86		0.70	1.06
Age										
18–25	47	18			35			<0.001		
26–35	36	23	1.91	1.40	2.60	41	1.47		1.13	1.92
36–45	25	23	2.90	1.97	4.29	52	2.26		1.63	3.13
46–55	25	24	3.10	2.12	4.54	51	2.13		1.55	2.94
56 or more	19	21	3.05	2.10	4.44	60	3.35		2.46	4.56
Meat consumption										
Yes	32	16			52			<0.001		
No	2	61	2.21	1.70	2.87	37	0.49		0.38	0.63
Education										
No university	24	20			56			< 0.001		
With university education	36	22	0.77	0.56	1.05	42	0.54		0.41	0.70
What should Chileans do with their beef consumption										
Maintain	22	13			65			< 0.001		
Increase	32	11	0.57	0.23	1.46	57	0.67		0.37	1.23
Reduce	37	23	0.89	0.61	1.31	40	0.52		0.39	0.69

OR = Odds ratio.

CI = Confidence interval.

selection of future protein sources, but there were higher odds that those participants who chose exclusively non-animal protein sources did not know if the COVID-19 pandemic outbreak influenced their responses compared to those who said their responses were unchanged (Table 6). Participants' responses about future protein sources were influenced by their age, meat consumption, education, their opinion of what Chileans should do about their beef consumption in the future, and their perception of whether or not the COVID-19 pandemic influenced their answers. Participants older than 26 years had higher odds of choosing exclusively non-animal future protein sources and exclusively animal products compared to participants who were 18 to 25 years old. Participants who did not consume meat had lower odds of choosing exclusively animal protein sources and higher odds of choosing exclusively non-animal protein sources compared to participants who consumed meat. Participants with a university education had lower odds of choosing exclusively animal protein sources compared to those without a university education. Participants who said that Chileans should reduce their beef consumption had lower odds of choosing exclusively animal protein sources than those who said that Chileans should maintain their level of beef consumption.

3.5. Participants' self-assessment of COVID-19 pandemic influence in their responses

Of the total 2363 participants, 83% said that their responses had not been influenced by the COVID-19 pandemic, 7% said they did not know, and 10% said that the COVID-19 outbreak had influenced their responses. When compared to 2021, the 2020 participants had lower odds of saying that their answers were influenced by the COVID-19 pandemic (2020 = 97; 2021 = 132; OR = 0.75; 95% CI = 0.57–0.98; $P < 0.05$) and also that they did not know (2020 = 71; 2021 = 101; OR = 0.71; 95% CI = 0.52–0.98; $P < 0.05$).

4. Discussion

Chilean citizens participating in this study expressed interest in reducing beef consumption at an individual and collective level, both at the beginning and after a year of the COVID-19 pandemic. However, we found almost no differences between the responses according to the year of recruitment of the participants, except for an increase in the number of participants who perceived that the COVID-19 pandemic had influenced their responses; these respondents had stronger beliefs that Chileans should reduce their beef consumption. Therefore, we must reject our hypothesis that the COVID-19 pandemic modified the attitude and behaviours of Chilean consumers towards beef consumption.

While the potential connection between the COVID-19 pandemic and the consumption of animals is recent, other factors related to meat consumption such as concerns about the environment, animal welfare, ethics, and human health have had a marked influence on shaping beef consumption habits during the last years (Ramírez et al., 2021). Indeed, participants had a clear position that Chileans should reduce their beef consumption in the future. The sudden outbreak of the pandemic and the subsequent sanitary measures such as quarantines, restrictions on movement and the need for social distancing changed the way people normally consumed meat and how they source it (Attwood & Hajat, 2020). The lack of apparent effect of the COVID-19 influence on the meat-consuming behaviour of participants of our study was also identified in a recent review (Johnson et al., 2023) that found meat consumption remained stable in most studies in different countries, decreasing in a few (Sasaki, Motoyama, Watanabe, & Nakajima, 2022). Another study found that Colombian consumer's preferences and beliefs towards beef have remained stable through the COVID-19 pandemic (Ramírez et al., 2021). Moreover, it is possible that the effect of the COVID-19 pandemic on beef consumption will be seen in the long term (Attwood & Hajat, 2020).

There was consistency in the attitudes of participants who had

already reduced their beef consumption, intended to continue with this behaviour, and believed that other Chileans should also do the same. However, the discrepancy between participants' belief that Chileans should reduce their beef consumption and that they would in fact not do so shows a high expectation of change, but low confidence for an actual change to happen within society. The sociocultural factors associated with beef consumption reduction (e.g., culture, religion, and social norm; Stoll-Kleemann & Schmidt, 2017) and the known fact that beef consumption is rooted in the Chilean culture (Higgs & Ruddock, 2020), may explain why our participants perceived a strong resistance among Chileans to reduce beef consumption. Indeed, citizens of different countries differ in their belief that reducing meat consumption may help solve the negative impacts of livestock production (Liu et al., 2023), and such beliefs were better explained by cultural and socioeconomic reasons than by attitudes or ethical and environmental concerns. The lack of confidence in the Chilean population reducing their future beef consumption also agrees with beef and poultry being the most popular future protein sources chosen by the participants. However, despite the shared strong beef consumption habits in the region, the need to reduce beef consumption has recently been noted in other consumers from neighbouring countries as well (Bifaretti, Pavan, & Grigioni, 2023). In general, the intended and expected reduction in beef consumption reflects citizens' negative attitude towards beef consumption, even if this negative attitude was not so evident when the participants were asked about the beef attributes (Tables 2 and 3). Resare Sahlin et al. (2020) suggested that eating 'less but better' meat is often equated to sustainable diets and argued that the definition of both terms, less and better, is not clear. We argue that for our participants, a relative reduction in individual and collective consumption compared to current consumption means eating "less", whereas healthier beef, produced with high animal welfare and environmental standards, the main attributes mentioned by the respondents to support beef reduction means "better" (Mansky de la Fuente, Enriquez-Hidalgo, Lemos Teixeira, Larrain, & Hötzel, 2023).

A large portion of participants who expressed concern for the animals and the environment were nevertheless meat consumers. This contradiction has been discussed as the meat paradox (Loughnan, Haslam, & Bastian, 2010; Rothgerber, 2014). Such contradiction between attitude (caring for animals and, in this case, the environment) and behaviour (eating meat) is known as cognitive dissonance (Fishbein, Ajzen, & Ajzen, 1975). Psychologists have shown that people tend to look for consistency between their beliefs and behaviour (Heider, 1958; Panagiotou & Kadianaki, 2019). The willingness to look for consistency between beliefs and behaviour may also explain why the meat consumers in our survey did not agree that beef is bad for human health. Likewise, the participants that did not eat meat due to concerns for the animals are likely to have modified their behaviour in order to be consistent with their beliefs. When compared to omnivores, people who do not consume meat have a higher perception about the animals' ability to feel and suffer (Bilewicz, Imhoff, & Drogosz, 2011), which may explain the higher number of participants who said they did not eat meat due to either ethical or animal welfare concerns (33%) when compared to those that mentioned the animals as the reason why the Chilean population should reduce their beef consumption (17%). Effectively, the later participants mentioned other factors such as the environment and health as their main reasons to support their societal need to reduce their beef consumption.

Younger participants showed the greatest interest in beef consumption reduction, as has been seen recently in other studies (e.g. Gonera et al., 2021; Stewart, Piernas, Cook, & Jebb, 2021; Ueland, Rodbotten, & Varela, 2022). Moreover, they were more likely to believe that Chileans should reduce meat consumption. Both responses may be related to their perceived need to do something about the ethical and environmental disagreement they have regarding food products (Smith & Brower, 2012; Stewart et al., 2021), especially meat (Sanchez-Sabate & Sabaté, 2019; Stewart et al., 2021). In fact, such attitudes are also supported by

the high level of environmental concerns among younger participants (Yamane & Kaneko, 2021). Like age, gender also influences how people seek to avoid psychological dissonance when eating meat, which may explain why the female participants in our study were more likely to have reduced beef consumption and to think that others should also do so. Women have been shown to seek different alternatives to reduce dissonance compared to men (Dowsett, Semmler, Bray, Ankeny, & Chur-Hansen, 2018; Rothgerber, 2013). Some of the alternatives used by women are avoidance of the animal-meat connection, and under-reporting of meat eating (Dowsett et al., 2018; Liu et al., 2023). In contrast, men use other more direct strategies to deal with the paradox of meat consumption, such as minimization of animal suffering, health justifications, and human dominance (Rothgerber, 2013). Accordingly, male participants expressed a more positive attitude towards beef consumption and its effect on people's health. Such gender differences may also be explained by the fact that meat consumption is often associated with masculinity (Lax & Mertig, 2020; Rothgerber, 2014; Stanley, Day, & Brown, 2023).

Poultry and vegetable meat substitutes were the most chosen future protein sources, while emerging proteins like insects, and cultured meat were mostly ignored. There are some possible explanations as to why these meat sources were the most chosen future protein sources by our participants. Poultry is the most consumed meat source nationally and internationally (FAOstat, 2023) and our participants may perceive it as a less harmful and accessible than other protein sources. 11% of our participants still believe that beef will be among the future protein sources, which is in line with their low confidence that Chileans will reduce their beef consumption, as already commented. A reduction in beef consumption, as envisioned by the participants, implies either an overall reduction in protein consumption or its substitution with other protein sources. Meat substitutes have had wide media coverage during the last years (Alae-Carew et al., 2022; Rubio, Xiang, & Kaplan, 2020). Even though almost 23% of the participants chose vegetable meat substitutes and 21% chose exclusively non-animal protein sources as the future sources of protein, the general acceptance of meat substitutes is still low, particularly for cultured meat (Chriki et al., 2021; Onwezen, Bouwman, Reinders, & Dagevos, 2021), though it appears to be increasing (Alae-Carew et al., 2022; He, Evans, Liu, & Shao, 2020). The perception of the environmental impact of meat boosts consumption of vegetable meat substitutes (Hagmann, Siegrist, & Hartmann, 2019), which may explain why the participants who had a more negative attitude towards beef consumption also had higher odds of choosing exclusively vegetable meat substitutes and the other non-animal protein sources. Cultured meat was one of the least selected future protein options among our participants (4%), which resonates with the resistance of citizens to this new product found by others (Rosenfeld & Tomiyama, 2023). However, our results contrast with findings from other studies indicating that cultured meat may have a relatively high level of acceptance (Bryant & Barnett, 2020; Chriki et al., 2021). It is possible that this discrepancy is related to the recent uncertainties raised about cultured meat animal welfare and environmental potential advantages when compared to traditional meat production (Chriki & Hocquette, 2020), the perceived aversion due to the lack of naturalness of this product (Bryant & Sanctorem, 2021; Siegrist & Sütterlin, 2017) or just an aversion to a new, unknown product (Pakseresht, Ahmadi Kaliji, & Canavari, 2022; Siegrist & Sütterlin, 2017).

Although only a small proportion of our participants considered their beef consumption to be high, half of them reported to have reduced their beef consumption and half intended to further reduce it in the future. Yet, beef consumption in Chile has been increasing since the 90's, driven not only by an increase in the population but also by an increase in per capita consumption (Ortega, Valdés, Foster, & Aguirre, 2020). This discrepancy between the high number of participants who said that had reduced their beef consumption and the trends in beef consumption in Chile is in agreement with the discrepancies observed between self-report and actual beef consumption found by others (e.g. Hagmann

et al., 2019; Rothgerber, 2014). Such discrepancies may be partly explained by the social bias that occurs in self-reported research (Sackett, 1979), i.e., participants may have responded aiming to present a favourable image of themselves (Higgs & Ruddock, 2020; van de Mortel, 2008), or reflect a strategy to reduce cognitive dissonance (Dowsett et al., 2018). These attitudes may be a response to the recent claims made by many organizations and institutions advertising beef consumption reduction as an alternative to increase food sustainability and to improve human health (see Borusiak, Szymkowiak, Kucharska, Gálová, & Mravcová, 2022; Kwasny, Dobernig, & Riefler, 2022; Resare Sahlin et al., 2020).

The greater percentage of young people and females in our convenience sample, a common bias with studies that have used online recruitment in similar subjects (e.g. Bollani, Bonadonna, & Peira, 2019; Graça, Calheiros, & Oliveira, 2015), is a limitation to the generalizability of our results to the Chilean population. However, given the large sample size of this study, we could identify differences in the participants' responses among groups with different socio-demographic characteristics. Although we found a minimal effect of COVID-19 on our participants' responses, it must be noted that the first survey was undertaken during the first months when the COVID-19 cases started to soar and sanitary restrictions were gradually implemented in Chile. Thus, there is a possibility that the consumers' attitudes have already been affected even at the early stages of the COVID-19 pandemic and we did not capture a full "pre-pandemic" condition.

5. Conclusion

Chilean consumers' attitudes to beef eating did not change between the start and 18 months after the outbreak of the COVID-19 pandemic. However, the participants who thought COVID-19 had influenced them had stronger beliefs that the population should reduce their beef consumption. Participants expressed strong concern about beef consumption both individually and socially, due to environmental, animal and health concerns. They believed Chileans should reduce beef consumption in the future, but had low confidence that this will happen.

Ethics statement

The Research Ethics and Safety Board at the Pontificia Universidad Católica de Chile approved the study and granted a Certificate of Exemption (n. 170,906,008) due to the type of questions and the anonymity of the participants.

CRediT authorship contribution statement

Valentina Mansky de la Fuente: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft. **María José Hötzel:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Dayane Lemos Teixeira:** Conceptualization, Funding acquisition, Methodology, Writing – review & editing. **Rafael Larrain:** Conceptualization, Methodology, Writing – review & editing. **Daniel Enriquez-Hidalgo:** Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Supervision, Visualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The datasets generated for this study are available on request to the corresponding authors.

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