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## To fear the unknown: Covid-19 confinement, fear, and food choice

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### ABSTRACT

The coronavirus outbreak in December 2019 completely changed the dynamic of consumption in different sectors of industry. The food and beverage industries have been profoundly affected, from production, to modifications in consumers' choices. Among the different reasons behind those modifications is confinement, which forces consumers to stay at home for an extended period and just go out to perform essential tasks, such as going to the supermarket. We hypothesized that this new dynamic of consumption could create a situation of fear that changes food choice. To test this hypothesis, two studies were conducted in three countries with a different degree of confinement: Mexico (flexible), Spain (strict), and Peru (hard). Study one consisted of a free association task with 60 participants in each country with the inductor word "coronavirus and food". The different associations served as the basis to build a structured questionnaire, which was used in the second study focused on fear and food choice. The second study was applied to 450 participants in the same three countries. Results showed that fear can be separated into nine dimensions: social, emotional, food supply, government, basic needs, food-delivery, overeating, immunity, and family conflicts. The participants could also be clustered into four different groups that differ in their country of origin and sex, but also in their food choice. Overall, the results showed that fear influenced consumer's food choices during a confinement period.

### 1. Introduction

Since the coronavirus outbreak in December 2019, humans have been facing an unprecedented pandemic that dramatically changed our social interactions, the dynamic of consumption, and the entire food service chain and retail system. Although pandemics seem like something new to most of today's consumers, human pandemics have existed for centuries, the oldest of which, to our knowledge, was in Northern China some 5000 years ago (Stanciu et al., 2020), and the latest being the H1N1 in 2009 (WHO, 2009). But no previous pandemic had affected so many countries in such a short period of time. The closest pandemic is the Spanish flu, killing fifty million people between 1918 and 1920 (Davis, 2013), however, the spread of the virus was not as fast as the COVID-19 pandemic.

To prevent the quick spread of COVID-19, most of the countries have taken measures such as home confinement, travel bans and business closures to control the rate of infection, first in China and then worldwide. Travel restriction has affected every stage of the food supply chain, with a major impact on food distribution (Poudel et al., 2020). The degree of confinement varied significantly across different countries and depended on multiple variables such as number of persons infected, population density and government mean to prevent contagion by the virus. Confinement and social isolation not only disrupt local markets and complete economies, but also the individuals that are in such confinement. The World Health Organization (WHO) has expressed its concern over the pandemic's mental health and psycho-social consequences (World Health Organization, 2020a). It speculates that new measures such as self-isolation and confinement have affected usual

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activities, routines, and livelihoods of people that may lead to an increase in loneliness, anxiety, depression, insomnia, harmful alcohol and drug use, and self-harm or suicidal behaviour (World Health Organization, 2020b).

The critical control measures of confinement, as cited above, substantially mitigated the spread of COVID-19, with conceivable impacts on people's daily life (Zhu et al, 2020). The confinement effect shut down thousands of restaurants all over the world, forcing consumers to restrict their meals to home-made food. Besides the huge economic impact (consumer food service valued in USD 2913.0 billion; Euro-monitor International, 2020), most of the food consumption during confinement found its origin in supermarkets, and to a lesser extent in delivery apps (e.g., Rappi, UberEats, etc.), or restaurant collection, which depends to a great extent on the degree of confinement that a government establishes in a country or specific city.

The confinement may be an important strategy to break the chain of transmission, but it has also created boredom and monotony among office workers and children. In many households, children who end up staying indoors become restless and, in some cases, violent (Kumar & Nayar, 2020). These human effects have already been documented, for example Wang et al. (2020) reported elevated levels of stress, anxiety, and depression among the Chinese population during the first outbreak, with no significant reductions in anxiety and depression levels four weeks later at its peak. Colizzi et al. (2020) recently warned that the fear of infection may exacerbate pre-existing mental health disorders or elicit extreme anxiety reactions. Their results revealed a unidimensional factor structure of fear of COVID-19, related to pre-existing mental health vulnerabilities. In their article, Colizzi et al (2020) suggest that Fear of COVID unfolds in three main manifestations: increasing anxiety, increasing somatic and obsessive symptoms. If we take into consideration that fear is having an impact on today's consumers and that consumers have changed their everyday food consumption dramatically, then how can we understand what the effect of fear on food choice is during COVID-19 lockdown?

### 1.1. Fear

The first research question can be: What are the main consumer fears regarding coronavirus and food? And we can start by defining fear, which is considered as "an adaptive animal defence mechanism that is fundamental for survival and involves several biological processes of preparation for a response to potentially threatening events" (Ornell et al, 2020). Fear is therefore an emotional experience (LeDoux, 2014), which can be measured, as the conscious awareness that you are in harm's way (Mobbs et al, 2019). The experience of fear is mediated through two different routes: a shorter, rapid, and subcortical route, which goes directly through the amygdala, and a longer, slower, and more complex route that includes hippocampal and cortical participation (Damasio, 1999; Emanuel, 2004; Pally & Olds, 2000). Each route has an identical output: a fear response. However, the shorter route lacks the benefit of contextual information provided by the longer route. As a result, the shorter route produces a direct and simple fear response, which can be tempered or even entirely inhibited by the longer route. We assume the fear experienced due to COVID-19, to be mediated by both the longer and slower route, as it is a fear directly influenced by context, and which can be linked to other reactions associated with food consumption phenomena. In the current scientific literature, fear reactions associated with food have scarcely been studied, except for neophobia, or fear of novel or unfamiliar food (see: Damsbo-Svendsen et al, 2017 for a review). The concept of fear and its relationship to food consumption and choice has not been studied much in the area of sensory and consumer research. There are, however, some examples. Harvey et al (2002) studied the relationship between fear, disgust, and abnormal eating attitudes. Their findings suggest that fear and disgust were correlated in women with abnormal eating attitudes. Wansink et al (2014) studied the relationship between ingredient-based food fears and

avoidance.

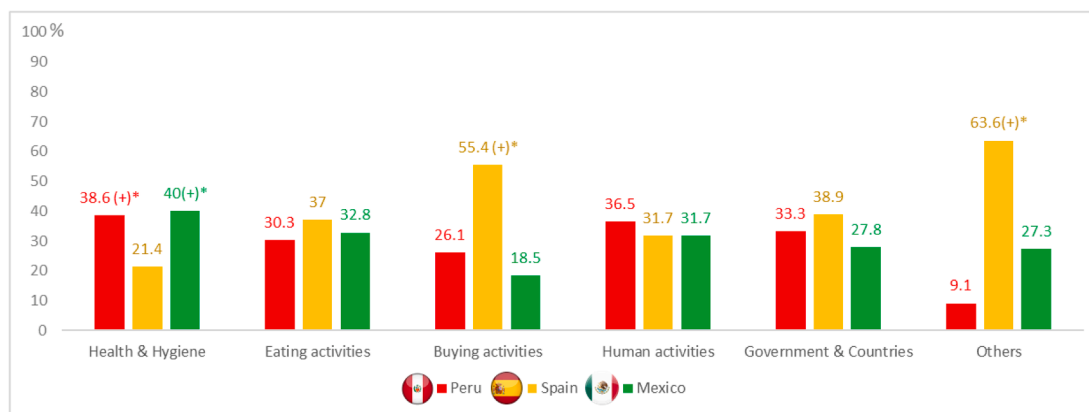
The emotion of fear is of particular interest, not only because it is assumed to be a universally recognizable basic emotion (Ekman, 1992), but also because emotions such as fear (or anger and joy) can be considered as utilitarian emotions, in the sense of facilitating our adaptation to events that have important consequences for us (Scherer, 2005). In other words, fear prepares our body to carry out an action, in our case the action can be oriented to food choice.

The causes of fear are multiple, and they are culturally dependent, and vary across ages and situations. Lovecraft wrote in 1927, that the "oldest and strongest emotion of mankind is fear, and the oldest and strongest kind of fear is fear of the unknown". While the concept of fear and its relationship to food consumption and choice has not been studied much in the area of sensory and consumer research, the concept of fear has been discussed in other fields for many years and is as old as humankind itself. We hypothesize that the type of fear triggered by the coronavirus is not only the fear of death, but also the fear of the unknown. In scientific literature, the fear of the unknown is defined as "an individual's propensity to experience fear caused by the perceived absence of information at any level of consciousness or point of processing" (Carleton, 2016). The link between different types of fear and the coronavirus has already been studied, Colizzi et al (2020) claim that the outbreaks of emerging infections such as COVID-19 can elicit strong fear reactions in the general population. Tzur Bitan et al (2020) developed a "Fear of COVID-19 self-report questionnaire" and assessed fear in an Israeli population of 649 participants, who were instructed to answer a set of questions related to fear in a 5-point, agree – disagree, Likert scale. The authors found that fear can be explained by two main factors pertaining to emotional fear reactions and symptomatic expressions of fear.

Fear of death and fear of contagion have been assessed in a previous study in China (Ahmed et al, 2020). Casale and Flett (2020) also focused on the concept of fear but with an interpersonal basis, such as fear of missing out (the pervasive apprehension that others might be having rewarding experiences from which one is absent), and fear of not mattering to other people. Regardless of the geographical region, as the death toll and hardships due to COVID-19 continue to rise, the number of people who are experiencing elevated and prolonged fear and anxiety appears to be growing as well (Lee, 2020). These cultural differences in fear reaction can lead us to a second research question: Is there a relationship between type of confinement (flexible – strict - hard), and the fears that the consumers have? But we also want to understand the relationship between fear and the consumer's choice related to food and beverages. This link with food can lead us to our third research question: What is the relationship between consumers' fear of coronavirus and food choice?

### 1.2. Food choice

Although several publications already relate coronavirus and fear (e.g., Ornell et al, 2020; Mertens, Kryptos & Engelhard, 2020; Casale & Flett, 2020; Tzur Bitan et al, 2020), none of them, to the best of our knowledge, relates the effect of fear of coronavirus on food choice. The concept of food choice is an important aspect of both marketing strategy and product development, and a large body of research has focused on understanding consumer food choices, including why consumers choose and consume specific food products. But the relationship between food choice and COVID-19 is not yet known. It seems evident that regular food choices and habits have been completely disrupted. Some consumers might search for functional ingredients or better-quality products. For example, Galanakis (2020) mentioned that because consumers are looking to protect themselves and their immune system by adopting healthier diets, the availability of bioactive ingredients of food and functional foods may become critical, as the demand for these products may increase. But, on the other hand, there are also more vulnerable consumers. On the 11th of April 2020, the Food Foundation reported the



**Fig. 1.** Percent per country of the six categories. (+) \* Indicate significant differences across countries: Health & Hygiene (higher in Perú and Mexico), Buying activities (Higher in Spain), and Others (Higher in Spain).

results of their commissioned YouGov survey which found that more than three million people reported going hungry in the first three weeks of the UK's COVID-19 confinement (Loopstra, 2020). In a recent article Laguna et al (2020) studied the effect of confinement on food priorities, showing that some consumers purchased more frequently pasta and vegetables, while decreasing the purchase of short-life such as seafood; as an effect of COVID-19 confinement in Spain.

For other consumers, there can be panic buying behaviour due to supply disruption and mistrust in institutions. As the pandemic persists, the shortage in the supply of labour for transportation and logistics, for food processing, and for other areas of the supply chain could prove to be a challenge. Border measures that limit the free movement of people might hurt food processing (Hailu, 2020), and that depends on the type of confinement.

To sum up, the objective of this study is to understand the main consumer fears linked to food and COVID-19 through a cross-cultural perspective. The research questions are 1) What are the main consumer fears regarding coronavirus and food? 2) Is there a relationship between type of confinement (flexible – strict - hard), and the fears that the consumers have? And 3) What is the relationship between consumers' fear of coronavirus and food choice?

Two studies were conducted in three different countries that varied in confinement type during the month of April 2020: flexible confinement– Mexico (Consumers could easily go out to shop and perform leisure activities. *Secretaría de Salud, 2020*), strict confinement – Spain (Consumers were not allowed to perform leisure activities and shopping was controlled. *Ministerio de Sanidad, Consumo y Bienestar Social, 2020*), and hard confinement – Peru (Consumers were not allowed to perform any activity, shopping was restricted to 15 min, and there was a military presence in the streets. *Ministerio de Salud, 2020*). Study one aimed at exploring the main consumer fears regarding coronavirus and food, and study two aimed to define the fear dimensions of coronavirus and food and its relationship with the type of confinement in the three countries.

As additional information for the readers, at the starting date of the fieldwork (April 23, 2020. *Johns Hopkins Center for Systems Science and Engineering, 2020*) the total number of COVID-19 cases were: Mexico 11,508 (89.1 cases per million); Spain 23,024 (490.5 cases per million); Peru 20,914 (650.1 cases per million).

## 2. Study 1: Exploring the association between fear of coronavirus and food consumption

The objective of study 1 was twofold: Providing some insights into our first research question “What are the main consumer fears regarding coronavirus and food?” and listing the main categories of fears regarding coronavirus and food to be used in study 2.

## 3. Material & methods

### 3.1. Participants

A total of 180 adults from Mexico (60), Spain (60), and Peru (60) with equal demographic characteristics (Mean age 34.5, 50% men and 50% women) participated in the study. The demographic quotas were predefined in order to avoid differences across countries linked to differences in participants' demographics and are an average of the demographics found in the three countries. The participants were recruited via a snowball technique until the desired quotas were reached.

### 3.2. Procedure

After recruitment, participants were invited to answer an online questionnaire that consisted of a free-word association task. Participants were instructed to write the first four words that came to mind in response to an inductor word. As a warm-up, the first inductor word shown to consumers was “sky”. After finishing the warm-up, the participants were instructed to perform the task in the same way, but now using the inductor words: “coronavirus and food”, “coronavirus”, “lock-down”, and “fear”.

### 3.3. Data analysis

The words from the three countries were analysed together. A preliminary frequency analysis was performed for the four inductor words. As the inductor word “coronavirus and food” led to the highest variety of responses with 720 different words, only the results from this inductor word are presented in this article to avoid unnecessary information.

The corpuses obtained in the three countries were first pre-processed. The first step of this pre-processing was to verify typing and/or spelling mistakes in the original language (Spanish). The second step was to operate a lemmatization which converts every word into its standardized form called lemma (Bécue-Bertaut, Álvarez-Esteban, & Pagès, 2008). The lemmatization is the reduction of the verbs, nouns, adjectives into their root form. For example: fears, with fear, afraid, they can all be reduced to “fear”. The third step was to detect synonyms using a thesaurus, which helped to identify the evident synonyms in the database and regroups terms in categories and subcategories. This step was performed by three different researchers. A fourth experimenter centralized the results and built the final list of categories and subcategories of terms based on common results. When discrepancies were observed, they were discussed until the four experimenters achieved a final consensus. Once the final list of consensual categories, subcategories and evoked words was obtained, their frequency of occurrence was computed in each country. A Chi-square per cell was

**Table 1**

Frequency of elicitation of categories related to coronavirus and foods. “\*\*\*” indicate significance according to the chi-square per cell. Chi-square computed for frequencies higher than 5.

Categories and sub-categories	Peru	Spain	Mexico
Health & Hygiene	<b>108 (+)</b> ***	<b>60</b>	<b>112 (+)</b> ***
Health (e.g., immune system)	71 (+) **	31	68 (+) *
Hygiene (e.g., extra clean)	20	19	29
Vitamins & Minerals (e.g., vitamin C or D)	10	5	12
Medical situations (e.g., in observation)	2	4	0
Eating activities	<b>72</b>	<b>88</b>	<b>78</b>
Food & Beverages (e.g., fruits)	30	39	27
Food extrinsic characteristics (e.g., price)	13	18	17
Scarcity (e.g., shortage)	12	6	13
Cooking experience (e.g., planning meals)	6	14 (+) **	4
Eating experience (e.g., eating hot)	2	1	7
Food intrinsic characteristics (e.g., AntiOx)	6	4	6
Animals (e.g., Pangolin)	2	4	4
Buying activities	<b>24</b>	<b>51 (+)</b> ***	<b>17</b>
Buying experience (e.g., agglomeration)	16	40 (+) ***	10
Commercial & Economic activities (e.g., economic crisis)	8	11	7
Human activities	<b>23</b>	<b>20</b>	<b>20</b>
Emotions & Moods (e.g., anxiety)	12	6	9
Family living (e.g., coexistence)	4	6	7
Inequality & Poverty (e.g., hunger)	4	3	4
Government & Countries	<b>12</b>	<b>14</b>	<b>10</b>
Confinement (e.g. confinement)	9	9	6
Meaningless (e.g., improbable)	0	4	2
Others	1	7	3
Others (e.g., critics)	1	7	3

(+) or (-) indicate that the observed value is higher or lower than the expected theoretical value.

\*\*\*  $p < 0.001$ , \*\*  $p < 0.01$  and \*  $p < 0.05$ ; effect of the chi-square per cell.

Grey lines indicate that sub-category contains frequencies minor to 5, and chi-square test was not performed.

calculated on the contingency table to estimate the differences between countries for a given category or sub-category (Symoneaux et al., 2012). The salient categories were identified and used subsequently for the construction of the questionnaire for study 2.

### 3.4. Results

From the initial corpus of 720 words, 120 words were obtained in Mexico after lemmatization, 166 in Spain and, 150 in Peru. The words were initially grouped into thirty sub-categories, and subsequently into six main categories: Health & Hygiene, Eating activities, Buying activities, Human activities, Government & Countries, and Others (Fig. 1). The Health & Hygiene category obtained the highest frequency amongst the three countries, however, there is a significantly lower frequency in Spain with 21.4% of the mentions ( $\chi^2(2,60) = 11.9$ ,  $p < 0.001$ ), compared to Peru and Mexico. This category consists of the sub-categories: Health, Hygiene, Vitamins & Minerals, Medical situations, Diet, Leisure & Sports, Virus, and Assistance. All sub-categories have a similar frequency in the three countries, except Health, which is also significantly lower in Spain ( $\chi^2(2,31) = 11.6$ ,  $p < 0.001$ ).

The second category is Eating activities, which has a similar frequency of elicitation across the three countries. The sub-categories present are: Food & Beverages, Food extrinsic attributes, Scarcity, Cooking experience, Eating experience, Food intrinsic characteristics, Animals, Consumer characteristics, and Herbs & Spices. Among those sub-categories, Cooking experience has a significantly higher frequency in Spain ( $\chi^2(2,14) = 4.5$ ,  $p < 0.01$ ) than in the other two countries, and Eating experience is significantly higher in Mexico ( $\chi^2(2,7) = 4.1$ ,  $p < 0.05$ ).

**Table 2**

Demographic characteristics of the participants for study 2.

Country	Sex (%)		Age groups (%)			
	Men	Women	18–29	30–39	40–49	50–59
Mexico	42.7	57.3	22.7	38.0	23.3	16.00
Spain	42.7	57.3	23.3	22.0	20.7	34.00
Peru	42.7	57.3	32.0	28.7	28.7	10.7

The third category in frequency importance is Buying activities, which includes: Buying experience, and Commercial & Economic activities. The sub-category of Buying experience is significantly higher in Spain with 55.4% of the mentions ( $\chi^2(2,51) = 14.7$ ,  $p < 0.001$ ), than in Peru and Mexico. The fourth category is Human activities, which presents no significant difference in the frequency among countries. This category is made up of the sub-categories: Emotion & Moods, Family living, Inequality & Poverty, Information, Places, and Education. The fifth category is Government & Countries, also with a similar frequency of elicitation across countries. It consists of the sub-categories: Confinement, Meaningless, Government & Country and Rules. Finally, the Others category is only composed of 11 words that were not possible to merge with any other category. Table 1 shows the details of the frequency per country, as well as an example of word/phrase to illustrate each sub-category.

## 4. Study 2: Relationship between COVID-19 fear, confinement type across countries, and food choice

The objective of study 2, was to address our three research questions: 1) What are the main consumer fears regarding coronavirus and food? 2) Is there a relationship between type of confinement (flexible – strict – hard), and the fears that the consumers have? And 3) What is the relationship between consumers’ fear of coronavirus and food choice? The results section is organized around these three questions.

## 5. Materials & methods

### 5.1. Participants

One hundred and fifty participants from each country were interviewed (450 total participants), during the last week of April 2020. Participants in study 2 were different from the ones that participated in the first study, to reflect each country’s own demography. A snow-ball technique was also used to recruit the participants. The snowball recruitment was used until the desired quotas were reached for age and sex. The demographic characteristics of participants are shown in Table 2. The differences of ages across countries reflect the differences in the age distributions of the three countries, to reflect each countries’ demographics (Mexico: INEGI, 2020; Spain: INE, 2020; Peru: INEI, 2020), with a maximum difference of 1.57% between the age of the participants of the study and each country’s age distribution.

### 5.2. Procedure

Participants had to fill out a questionnaire including two parts. In the first part participants rated their level of agreement with 42 fear statements using a five-point Likert scale ranging from (1) “completely disagree” to (5) “completely agree”. The 42 statements were written based on the results of study 1. Each statement referred to one of the six fear categories presented in Table 2. The numbers of statements representing the categories varied to cover all the different ideas that emerged from study 1. The categories with higher frequency had a higher number of statements in the final questionnaire: Health & Hygiene (10 statements), Eating Activities (11 statements), Buying Activities (6 statements), Human Activities (10 statements), Government & Countries (4 statements), and Others (1 statement). As an example of the construction

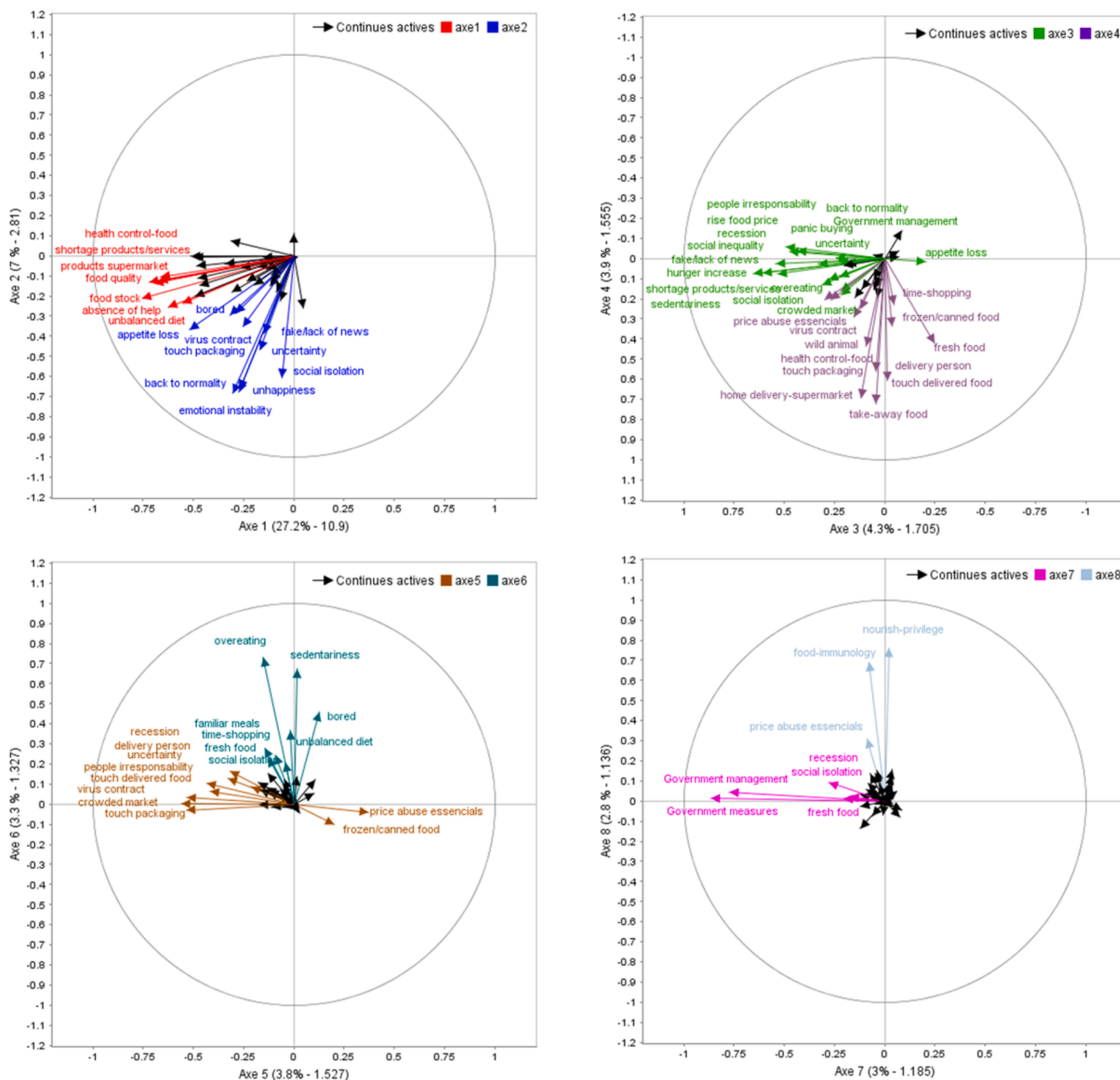


Fig. 2. Varimax PCA: The nine PC with an eigenvalue greater than 1. To facilitate the interpretation, only statements with a contribution higher than the average statement and a squared cosine of at least 0.5 are labeled. The variables are colored differently according to their correlation to Axe 1 or 2, 3 or 4, etc.

of the statements: “I am afraid of losing my appetite” was built from the Health & Hygiene category, and the words obtained in study 1 was “lose appetite”. The detailed list of the forty-two statements can be found in Annexe 1.

The second part of the questionnaire consisted of a CATA questionnaire of the food and beverages consumed during the past two weeks, with a list of forty-five different items such as: eggs, bread, beer, fresh fruit, flavoured water, etc. Items were randomized for each participant, to avoid a carry-over effect or an order-bias in participants’ responses.

5.3. Data analysis

A correlation matrix-based principal component analysis (PCA) was performed on the individual score of each statement, considering sex, age, and country, as supplementary variables. A varimax rotation with the first nine PCs (eigenvalues greater than 1 of the PCA and Kaiser normalization were used to obtain an easy-to-interpret representation of the PCA variables and individuals, as well as the identification of the fear

dimensions. The varimax rotation was used to better separate the variables in the PCA and identify more easily the groups of variables that form different fear dimensions. After performing the PCA, a hierarchical cluster analysis (HCA) was performed on the first nine varimax-rotated dimensions of the PCA (using Euclidean distance and Ward’s agglomeration criteria) aiming to identify consumer clusters with similar patterns of fear behaviour.

Uni-dimensional analyses were performed to characterize the clusters yielded by the HCA using each question in the survey as variables. One-way ANOVAs with cluster as between-subject factor were used for continuous variables, and Z-test of proportions for the demographic characteristics of the consumers (country of origin, sex, and age). The statistical analyses were performed with XLSTAT software version 2020.1.

The results of the CATA questions were arranged in a contingency table and aggregated according to each cluster. The variables with more than 1% of elicitation were then submitted to a correspondence analysis (CA) using chi-square distance. The confidence ellipses were obtained by

**Table 3**

Summary of the contributions (%) of the main fear items to the first nine varimax-rotated principal components of the fear items. Complete table is in Annexe 2.

Statement	D1	D2	D3	D4	D5	D6	D7	D8	D9
Price abuse essentials	1.37	0.03	0.77	0.39	<b>20.54</b>	0.18	0.02	5.11	0.03
Frozen/canned food	0.64	0.50	0.70	0.02	<b>20.68</b>	2.00	0.07	0.37	4.77
Family meals	0.33	0.41	0.25	0.15	1.54	0.00	4.16	0.68	<b>23.70</b>
Government measures	0.18	0.04	0.00	<b>44.50</b>	0.10	0.00	0.07	0.00	0.00
Take-away food	0.08	0.11	0.22	0.06	1.92	<b>15.69</b>	0.00	0.16	0.27
Nourish-privilege	0.12	0.28	0.16	0.04	0.06	0.60	0.04	<b>45.61</b>	0.95
Food-immunology	0.18	0.36	0.00	0.29	0.36	0.00	0.07	<b>28.78</b>	9.75
Overeating	1.94	0.12	0.51	0.12	0.45	0.57	<b>27.12</b>	0.08	3.70
Food stock	0.03	1.30	<b>8.98</b>	0.00	0.14	1.40	0.27	0.23	0.07
Rise of food prices	<b>8.42</b>	0.01	3.87	0.30	1.85	0.01	0.84	0.88	1.24
Shortage products/services	1.31	0.51	<b>8.09</b>	0.41	1.09	0.86	0.14	0.68	0.01
Hunger increase	<b>11.94</b>	0.67	0.64	0.12	0.01	0.21	0.14	1.01	0.33
Touch delivered food	0.06	1.13	1.61	0.01	1.25	<b>15.42</b>	0.03	0.54	1.15
Unhappiness	0.00	<b>13.58</b>	1.38	0.09	1.56	0.56	0.23	0.00	0.94
Social inequality	<b>12.70</b>	1.97	0.04	0.33	0.49	0.04	1.32	0.15	2.10
Recession	<b>9.26</b>	1.23	0.18	4.81	6.69	0.01	0.92	1.44	0.13
Back to normality	1.67	<b>12.64</b>	1.19	0.40	0.19	0.08	0.25	0.30	0.00
Sedentariness	2.95	1.37	0.04	0.51	0.11	0.45	<b>24.69</b>	0.29	0.28
Government management	1.79	0.79	0.21	<b>35.53</b>	0.01	0.00	0.02	0.09	0.12
Emotional instability	1.09	<b>13.29</b>	1.19	0.06	0.10	0.10	1.42	0.01	0.59
Social isolation	2.21	<b>10.29</b>	0.04	1.65	0.36	0.32	2.62	0.00	0.05

parametric bootstrap at 95% confidence. The CA and confidence ellipses were obtained with R version 4.0.2, using FactoMineR (Lê, Josse, & Husson, 2008).

5.4. Results

5.4.1. What are the main consumer fears regarding coronavirus and food?

To respond to this question, a varimax-rotated PCA of the forty-two statements was carried out (Fig. 2, A). The PCA (Fig. 2, B) of the forty-two fear items of the survey conducted in the three countries gave rise to nine dimensions with an eigenvalue greater than one (Kaiser law). These nine dimensions accounted for 57% of the total variance. Table 3 shows the loadings of the main fear items on the nine dimensions after varimax rotation. To interpret the dimensions, for a given dimension the

average loading across items was computed. An item was considered important when the loading was higher than average (corresponds to a contribution higher than 8%) and the correlation coefficient between the item and the dimension was higher than 0.5. The loadings of important items are highlighted in bold in Table 3 and were used to interpret each dimension.

Fig. 2 and Table 3 show that dimensions 1, 3 and 4 are related to socio/economic items. Dimension 1 presented a higher contribution of social related (Social inequality, Hunger increase, Recession, Rise in food prices) and therefore it was labelled “Social fears”. The third dimension had a higher loading of the items linked to the scarcity of food products (Food stock, Shortage products/services) and was thus labelled “Food supply fears”. Dimension 4 included items reflecting the lack of confidence in government (Government measures, Government

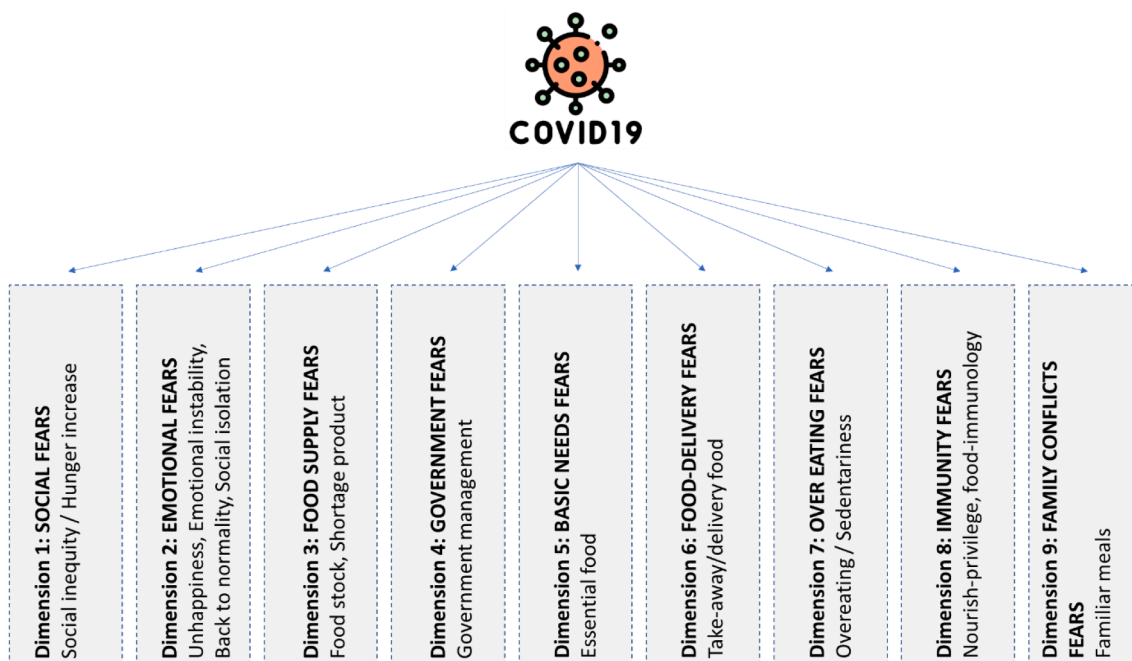
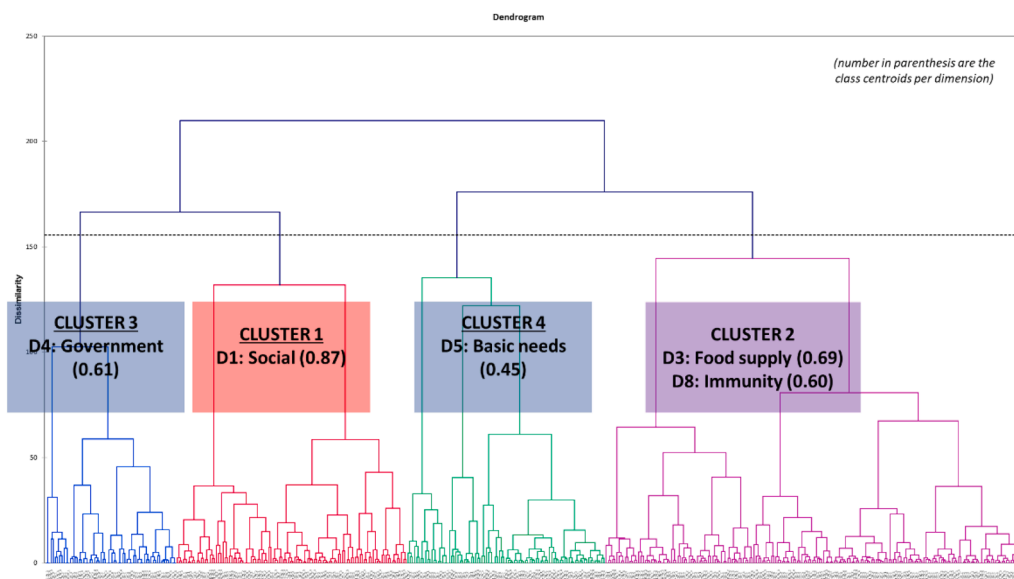


Fig. 3. Summary of the nine dimensions of fear to COVID-19, related to food and drinks.



**Fig. 4.** Dendrogram showing the central objects that characterize each cluster, and their dimension. Cluster 3 (Dimension 4 – Government), Cluster 1 (Dimension 1 – Social), Cluster 4 (Dimension 5 – Basic needs), and Cluster 2 (Dimension 3 - Food Supply, and Dimension 8 – Immunity).

management) and was labelled “Government fear”. An example of an item in this dimension is “I am afraid of the consequences of the government’s mismanagement of the crisis” (see Table 3).

Dimension 2 presented a higher contribution for: Unhappiness, Back to normality, Emotional instability, and Social isolation. Some of these items might not be related to food and beverages at first sight but taking “back to normality” as an example of these dimensions, the complete item in the questionnaire was “It scares me not being able to return to normal”. And therefore, back to normality can affect the participants, or their return to normal to restaurants, shopping, etc. This dimension was named “Emotional fears”. Dimension 5, 6, 7 and 8 are linked to foods. Dimension 5 and 6 reflect food supply fears and dimension 7 and 8 health fears. Dimension 5 represents essential food items (Frozen/canned food”, Price abuse - essentials) and so it was labelled “Basic needs fear”. Dimension 6 is linked to deliver food items (Take-away food, Touch delivered food, Home delivery - supermarket, Delivery person, Touch packaging) and was therefore labelled “Food-delivery fear”. “Unhealthy habits” (Overeating, Sedentariness, Boredom) contributes more to the seventh dimension which was labelled “Overeating fear”. The eighth dimension represents food positive cues (Nourish privilege, Food immunology). It was named “Immunity fears”. Finally, the items related to the contact with people from outside (Family meals, People’s irresponsibility) contribute more to the ninth dimension, which was labelled “Family conflicts fears”. A recap of the nine fear dimensions, and the items with the higher loading for each dimension is shown in Fig. 3, which responds to our first research question (What are the main consumer fears regarding coronavirus and food?).

**5.4.2. Is there a relationship between type of confinement (flexible – strict – hard), and the fears that the consumers have?**

To address our second research, question a Hierarchical Cluster Analysis (HCA) was performed on the coordinates of the participants on the nine first dimensions of the PCA. Our hypothesis was that with the type of lockdown being country dependent, some fear dimensions might be more salient in some countries than others because of the different rules imposed by the governments. To check this hypothesis, the clusters yielded by the HCA were characterized based on consumers’ country of origin, and demographic information (sex, and age). Additionally, a one-way ANOVAs with cluster as between-subject factor and fear statements as dependent variables were performed to evaluate whether fears differed across clusters.

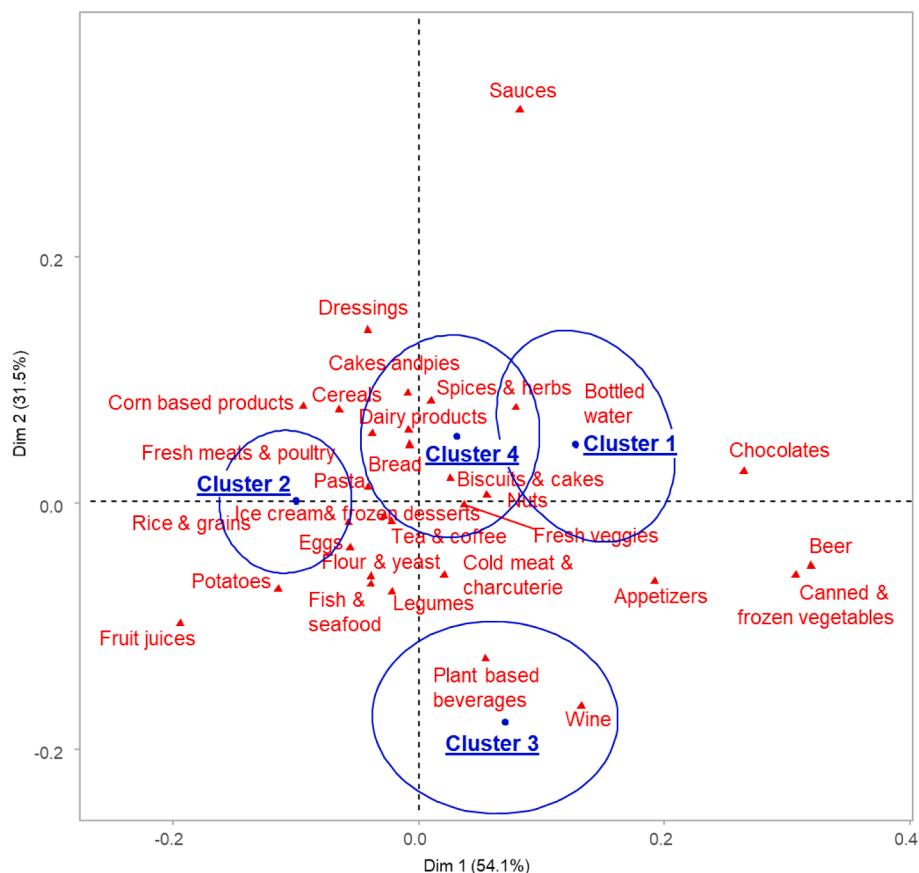
The segmentation of the participants by fear dimensions revealed four different clusters (Fig. 4). Cluster 1 is mainly related to the dimension of Social fears. Cluster 2 is related to the dimensions of Food supply, and Immunity fears. Cluster 3 is related to Government fears, and finally Cluster 4 is related to Basic needs fears. These results on the segmentation of the consumers highlight the dominant fear and how participants can be classified depending on their dominant fear with regards to coronavirus and food.

Table 4 shows that Cluster 1 (Social fears) is composed of a higher proportion of Mexican (44%) and Spanish (40%) participants, with a higher number of persons between 30 and 39 years old (37%). The ANOVA carried out on original fear items indicates that Cluster 1 responses showed average scores amongst almost all fear statements. Cluster 2 (Food supply fears) is composed mainly of Peruvian

**Table 4**  
Participants clusters defined by their country, sex, and age group.

	Mexico	Spain	Peru	Men	Women	18–29 years	30–39 years	40–49 years	50–59 years
Cluster 1 “Social fears”	44%	40%	16%	46%	54%	20%	37%	25%	18%
Cluster 2 “Food supplies”	30%	15%	55%	42%	58%	31%	27%	24%	18%
Cluster 3 “Government fears”	18%	77%	5%	38%	62%	28%	20%	25%	27%
Cluster 4 “Basic needs”	37%	36%	26%	42%	58%	22%	31%	24%	22%





**Fig. 5.** Correspondence analysis of foods consumed during the last two weeks by participants in the four consumer clusters. Only variables with >1% of frequency of elicitation were considered for the CA.

participants (55%), with a higher number of women (58%), and with a lower proportion of consumers from those aged 50 – 59 years old. Participants in this cluster gave significantly higher scores ( $p < 0.001$ ) to the following fear statements: Price abuse, Home delivery, Frozen/canned foods, Fresh food, Family meals, Absence of help, Appetite loss, Food stock, and Food quality.

The third Cluster (Government fears) was composed mainly of Spanish participants (77%), with a higher proportion of women (62%) belonging to all age ranges. The number of Peruvian (5%) and Mexican (18%) participants was extremely low. Participants in this cluster gave significantly lower scores ( $p < 0.001$ ) than participants in other clusters to questions related to: Food quality, Health-control food, Rise in food prices, Delivery person, Panic buying, and Food stock.

The fourth Cluster (Basic needs fears) was composed of a similar number of participants from Mexico (37%), Spain (36%), and to a lesser extent Peru (26%). In this fourth cluster, the number of women was higher (58%) than the number of men. Participants in this cluster gave significantly lower scores ( $p < 0.001$ ) to the following items: Recession, Uncertainty, and Unemployment.

Overall, the fear clusters could be easily separated into: Food Supplies fear (Peru), and Government fears (Spain). Social fears were shared by Mexican and Spanish participants. The Basic needs cluster was shared by participants from all countries and may rely more on individual differences not measured in this study (e.g. personality traits, income level, etc.), rather than country (type of confinement).

#### 5.4.3. What is the relationship between consumers' fear of coronavirus and food choice?

The third and last research question was: What is the relationship

between consumer fear and food choice? To address this question, the second part of the questionnaire was analysed as a function of fear type. First, we computed the frequency of consumption of food and beverages during lock down in each of the fear clusters yielded by the HCA (Fig. 4). Then we carried out a Chi-square analysis to evaluate whether the patterns of food and beverage consumption differed between clusters (Annexes Table 3). A CA was finally carried out on the frequency table to visualize the results. Our rationale for this analysis was that because the clusters were associated with different types of fear, if there is a link between fear and food choice, participants in different fear clusters should have different food choices and so different consumption patterns should be associated with different clusters.

The first two dimensions of the CA explained 85% of the total variance (Fig. 5). Dimension 1 confronts beer, projected on the right to fruit juices on the left. Dimension 2 opposes wine and plant-based beverages at the bottom, to sauces and dressings in the top part of the plane.

The confidence ellipses around the fear clusters show a clear separation between Cluster 3 and the other clusters and an overlap between Clusters 1 and 4. Consumers from Cluster 3 (Government fears – Spain – Strict confinement) state they buy a significantly higher proportion of wine, beverages, and plant-based products than participants from the other clusters. Participants from cluster 2 (Social fears – Peru – Hard confinement) report buying a larger proportion of products such as ice-cream, rice/grains, fresh meat/poultry, potatoes, and eggs. In the Chi-test, Cluster 1 (Social fears – Mexico & Spain – Flexible & Strict confinement), consumed a significantly ( $p < 0.05$ ) higher proportion of beer and chocolates, and have a low consumption of fruit juices. Cluster 4 (Basic needs fears – all countries), falls in the middle of the CA, associated with products such as bread, dairy products, and biscuits. In

the Chi test, Cluster 4 had a significantly ( $p < 0.05$ ) higher consumption of sauces. These differences across clusters and food choices, help us to answer our third research question on the relationship between consumers' fear of coronavirus and food choice.

## 6. Discussion

The objective of this study was to understand the main consumer fears linked to food and COVID-19 through a cross-cultural perspective. Our first research question was: What are the main consumer fears regarding COVID-19 and food? We were able to separate the fears of coronavirus related to food and beverages into nine dimensions: social, emotional, food supply, government, basic needs, food-delivery, over-eating, immunity, and family conflicts. Even though there is still a limited number of publications on fear and COVID-19, a similar study conducted by Tzur Bitan et al. (2020) showed a uni-dimensional factor structure of fear in the Israeli population. This study performed a similar analysis, showing a factor analysis that explained 53.71% in two dimensions after a varimax rotation. The authors explained that the first dimension was related to emotional fear reaction (*"I am most afraid of the coronavirus"*), and *"It makes me uncomfortable to think about the coronavirus"*), and a second dimension of symptomatic expressions (*"My hands become clammy when I think about the coronavirus"*), and *"My heart races or palpitates when I think about getting the coronavirus"*). Additionally, the authors reported a gender effect (women reporting higher fear rates). In another online study on fear dimensions associated to COVID, Mertens et al. (2020) found that respondents reported a wide range of concerns relating to COVID, but after performing a multiple regression analysis, the main fear dimensions were four: intolerance of uncertainty, health anxiety, more media exposure, and risks for loved ones, which is in line with findings observed in the present work.

Our second research question was: Is there a relationship between type of confinement and the fear that consumers have around food? The answer is yes, for some participants. But we also need to take into consideration that the variable confinement type is confused with country, and results can also be influenced by culture and country of origin, regardless of the confinement type.

In a study with Spanish consumers, Laguna et al. (2020) concluded that COVID-19 confinement affected the products that were purchased more: pasta and vegetables (health motivations), others were purchased to improve their mood (nuts, cheese, and chocolates). In other words, the confinement amongst Spanish consumers changed their food choice, and our study is aligned with these findings. For example, the results of the consumer segmentation and dimensions of fear showed that the type of confinement has a different effect on fear of coronavirus and food choice for 3 out of 4 clusters. Social fears (cluster 1) are dominant in Mexicans (44%), and Spanish (40%) of 30–39 years (37%). Fears related to Food supply and Food immunity (Cluster 2) are higher in Peruvian (hard confinement) participants (55%) and women (58%). Fears related to government seems to be related to a bigger proportion of Spanish (strict confinement) participants (77%). Cluster 4 contains a mix of participants from different countries, and therefore this cluster is not related to any type of confinement, but perhaps to individual differences, not measured in the present work. These individual differences could be due to a wide range of reasons. One reason could be psychological crises, or higher levels of anxiety or depression. For example, in a study with Chinese participants, 22.4% experience higher levels of anxiety during quarantine (Zhang et al., 2020). There are some key groups that are more likely to experience food insecurity than others, including those with incomes that are at the very bottom of the income distribution, people who are unemployed or not working for other reasons, and people with disabilities (Loopstra, 2020). Additional research cannot be contrasted with our results; as to our knowledge, there are no publications that compare confinement types in different countries, for

COVID-19.

The third and last research question was: What is the relationship between consumer fear and food choice? The results of the CA carried out in the food choice questionnaire revealed that participants from Cluster 2 (Social fears – Peru – Hard confinement) buy bigger proportions of: ice-cream, rice/grains, fresh meat / poultry, potatoes, and eggs; and it was different from Cluster 3. This latter cluster (Government fears – Spain – Strict confinement) buy a bigger proportion of wine, beverages, plant-based products. Clusters 1 and 4 were closer together, but we can see a difference in Cluster 1 being more related to beverages (water, carbonated soft drinks) and Mexican and Spanish participants were dominant in this cluster. Finally, Cluster 4 participants, corresponding to a mix of the three nationalities, bought more items related to basic needs such as bread, nuts, and some savoury products.

The food choice among different countries is always difficult to relate easily due to cultural reasons and product availability. However, the types of products used in the questionnaire are broad enough to see that Spanish participants buy a greater quantity of wine and plant-based beverages; and therefore, the type of fear and confinement (variable confused with country of origin) are variables affecting food choice. In a recent study with Spanish consumers, the authors reported that consumers drink almost the same number of alcoholic beverages, milk and dairy products, cereals, and eggs, while consuming more sweet products and fruits (Romeo-Arroyo et al., 2020). This can explain the difference in wine consumption, which is higher in Spanish consumers, compared to Peruvian ones.

A study from Bracale and Vaccaro (2020) in another European country reported an increase in consumption of certain products for Italian consumers during confinement: red meat (+8%), biscuits (+10.2%), pasta (+19.5%), and flour (+17.6%) and a strong reduction in the consumption of fresh goods. The authors suggested that the reason in the dynamics of consumption was due to a trend of bread, pizza and desserts being made at home, considered *"a pleasant way to spend time at home"*. In addition to these products, the authors also found an increase in consumption of what they refer to as *"comfort food"* for Italians, such as coffee (+15.2%), chocolate, snacks, and aperitifs. However, besides the immediate changes due to confinement, the food choices of the Italians during the crisis are closely intertwined with social motivations and create psychological resilience. In other words, the COVID confinement has a direct effect on food choice.

In our research, a within-country comparison can answer the question of the effect of type of fear and food choice; however, our database is of 150 participants in each country, and making a segmentation of 9-dimensions of fear with this sample is too risky to give a conclusive result. Besides, our objective was centred on fear type – confinement and food choice. Additional questions can be answered in upcoming research, as there still exist relevant questions to be answered.

## 7. Conclusions

Our results showed that fear could be segmented in nine different dimensions, and the clusters of participants according to the dimensions gave additional information on food choice. The results show that confinement type is also an important factor in food choice for most participants, but it leaves a proportion of participants that cannot be explained, based only on confinement type. We consider that this is due to individual differences such as psychological traits, or even psychological crises. However, these details fall outside the scope of our research.

The findings shown in this article are intended to be used by governments, but also by the food and beverage industry. Companies will have to focus on understanding the consumer's needs and adapt their product offer and distribution system to reduce the new consumption limits and to facilitate sales (Stanciu et al., 2020). The consumption

limitations are different depending on the type of confinement, and it affects consumers in a different way.

One limitation of the studies presented is that it was done in a specific moment of the pandemic, in which the three countries studied were in lockdown. However, other types of confinement or semi-confinement were established by the governments after the study fieldwork took place, and therefore the findings could change, specifically the respond to fear to COVID-19. The second limitation concerns the income level of the participants, in this study we did not assess different types of households (adults with disabilities (see: [Loopstra, 2020](#)), low-income consumers, migrants in vulnerable conditions, etc.).

### CRedit authorship contribution statement

**Carlos Gómez-Corona:** Conceptualization, Methodology, Investigation, Formal analysis, Visualization, Project administration. **Voni-mihaingo Ramarosan Rakotosamimanana:** Investigation, Formal

analysis, Data curation. **María Pilar Sáenz-Navajas:** Investigation, Formal analysis, Data curation. **Heber Rodrigues:** Conceptualization, Project administration. **Ernesto Franco-Luesma:** Formal analysis. **Erick Saldaña:** Formal analysis. **Dominique Valentin:** Methodology, Validation, Data curation, Supervision.

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### Appendix A

#### Tables A1 to A3

**Table A1**

Fear questions used in study 2. Participants answered using a 5-points scale of agree/disagree. Columns sub-category and Category were obtained from Study 1 analysis.

Questionnaire item for STUDY 2	Sub-category (Study 1)	Category (Study 1)
1. There is an abuse of prices in basic products	Commercial & economic activities	Buying activities
2. I am not inspired by the fact that they bring me grocery shopping to my house	Consumer characteristics	Eating activities
3. Frozen and canned foods do not inspire confidence	Food & beverages	Eating activities
4. Fresh foods do not inspire confidence	Herbs & Spices	Eating activities
5. I am uncomfortable with the increase in family dinners and meals	Family living	Human activities
6. I am very bored at home	Places	Human activities
7. I do not trust the government's measures	Meaningless	Government & Countries
8. I do not trust takeaways	Food extrinsic characteristics	Eating activities
9. Eating well is a privilege	Inequality & poverty	Human activities
10. Healthy eating will make my immune system strong	Food intrinsic characteristics	Eating activities
11. I am afraid of eating wild animals	Animals	Eating activities
12. I am afraid that someone cannot help me	Assistance	Health & Hygiene
13. I am afraid of people's irresponsibility	Education	Human activities
14. I am afraid of losing my appetite	Diet	Health & Hygiene
15. I am afraid of overeating during confinement / quarantine	Confinement	Government & Countries
16. I am afraid of not having enough time to go to the supermarket	Scarcity	Eating activities
17. I am afraid that my food reserves will run out	Eating experience	Eating activities
18. I am afraid of other people's panic purchases	Buying experience	Buying activities
19. I am afraid of crowds in the supermarket	Buying experience	Buying activities
20. I am afraid of the people / delivery people who bring the products home	Consumer characteristics	Eating activities
21. I am afraid of not finding the products I am looking for in the supermarket	Buying experience	Buying activities
22. I am afraid that food and drink prices will rise	Buying experience	Buying activities
23. I am afraid that there is a shortage of products and services	Scarcity	Eating activities
24. I am afraid that there are people with limited resources who are starving	Inequality & poverty	Human activities
25. I am afraid of the lack of sanitary control of food and drinks	Hygiene	Health & Hygiene
26. I am afraid of not following a balanced and healthy diet (in proteins, fruits, and vegetables)	Vitamins & Minerals	Health & Hygiene
27. I am afraid to touch the food that is sent to my house by the supermarket / app	Hygiene	Health & Hygiene
28. I fear the decline in the quality of food available to buy	Cooking experience	Eating activities
29. I am afraid of not being able to be happy again	Emotions and moods	Human activities
30. I am concerned that social inequality will increase	Inequality & poverty	Human activities
31. I'm scared of the global economic downturn	Government & Country	Government & Countries
32. It scares me not being able to return to normal	Emotions and moods	Human activities
33. I am afraid of contracting the virus	Virus	Health & Hygiene
34. I am afraid of fake news and lack of information	Information	Human activities
35. I am afraid of uncertainty	Others	Others
36. I am concerned with sedentary lifestyle and lack of exercise during this stage	Leisure & sports	Health & Hygiene
37. I am afraid of the consequences of the government's mismanagement of the crisis	Rules	Government & Countries
38. I am afraid of the emotional instability that the crisis can generate in my family and myself	Emotions and moods	Human activities
39. I am afraid of the distance and isolation from the rest of the people around me	Medical situations	Health & Hygiene
40. I am afraid of being infected when I touch the packaging of products or food	Health	Health & Hygiene
41. I am afraid of losing or not recovering my job	Commercial & economic activities	Buying activities
42. I am afraid of not having gel / alcohol for hand cleaning and masks to protect myself	Hygiene	Health & Hygiene

**Table A2**

Contributions (%) of the fear items to the first nine varimax-rotated principal components of the fear items. The items with a loading higher than the average loading (corresponding to contribution >8%) and with a correlation coefficient >0.5 with a given PC are represented in bold.

Statement	D1	D2	D3	D4	D5	D6	D7	D8	D9
Price abuse essentials	1.37	0.03	0.77	0.39	<b>20.54</b>	0.18	0.02	5.11	0.03
Home delivery-supermarket	0.21	0.00	0.24	0.23	7.44	12.42	0.51	0.34	0.38
Frozen/canned food	0.64	0.50	0.70	0.02	<b>20.68</b>	2.00	0.07	0.37	4.77
Fresh food	1.40	0.18	1.53	2.44	0.29	6.79	2.84	0.03	0.00
Family meals	0.33	0.41	0.25	0.15	1.54	0.00	4.16	0.68	<b>23.70</b>
Boredom	0.29	1.80	1.26	0.10	0.01	0.75	13.55	2.40	0.33
Government measures	0.18	0.04	0.00	<b>44.50</b>	0.10	0.00	0.07	0.00	0.00
Take-away food	0.08	0.11	0.22	0.06	1.92	<b>15.69</b>	0.00	0.16	0.27
Nourish-privilege	0.12	0.28	0.16	0.04	0.06	0.60	0.04	<b>45.61</b>	0.95
Food-immunology	0.18	0.36	0.00	0.29	0.36	0.00	0.07	<b>28.78</b>	9.75
Wild animal	0.79	0.00	4.07	0.19	0.19	2.21	0.56	0.22	6.11
Absence of help	0.37	1.99	6.23	0.12	0.19	0.96	0.00	0.15	0.07
People's irresponsibility	6.98	0.25	2.19	0.09	1.92	0.12	0.08	0.23	11.02
Appetite loss	1.40	3.13	4.09	0.12	0.22	0.00	1.34	1.94	2.14
Overeating	1.94	0.12	0.51	0.12	0.45	0.57	<b>27.12</b>	0.08	3.70
Time-shopping	0.03	1.12	3.76	0.07	0.01	2.10	3.36	0.05	0.01
Food stock	0.03	1.30	<b>8.98</b>	0.00	0.14	1.40	0.27	0.23	0.07
Panic buying	6.92	0.16	3.85	0.39	0.05	0.00	0.24	0.88	0.75
Crowded market	2.58	1.09	4.03	0.06	5.85	3.30	0.28	0.38	5.56
Delivery person	0.16	0.39	3.56	0.01	0.07	11.23	0.35	0.01	0.00
Products supermarket	1.19	0.60	7.40	0.99	0.08	0.17	0.59	0.17	0.78
Rise of food prices	<b>8.42</b>	0.01	3.87	0.30	1.85	0.01	0.84	0.88	1.24
Shortage products/services	1.31	0.51	<b>8.09</b>	0.41	1.09	0.86	0.14	0.68	0.01
Hunger increase	<b>11.94</b>	0.67	0.64	0.12	0.01	0.21	0.14	1.01	0.33
Health control-food	0.67	0.45	6.99	0.35	1.30	3.32	0.00	0.01	2.92
Unbalanced diet	0.05	1.57	4.73	0.11	0.51	0.37	7.80	0.10	0.84
Touch delivered food	0.06	1.13	1.61	0.01	1.25	<b>15.42</b>	0.03	0.54	1.15
Food quality	0.44	0.68	7.52	0.54	2.79	1.26	0.40	0.12	3.17
Unhappiness	0.00	<b>13.58</b>	1.38	0.09	1.56	0.56	0.23	0.00	0.94
Social inequality	<b>12.70</b>	1.97	0.04	0.33	0.49	0.04	1.32	0.15	2.10
Recession	<b>9.26</b>	1.23	0.18	4.81	6.69	0.01	0.92	1.44	0.13
Back to normality	1.67	<b>12.64</b>	1.19	0.40	0.19	0.08	0.25	0.30	0.00
Virus contract	3.43	3.39	1.89	0.28	6.69	3.49	0.06	0.21	3.50
Fake/lack of news	7.04	4.91	0.31	0.94	3.35	0.07	0.29	1.36	1.36
Uncertainty	4.50	6.74	0.54	0.78	5.08	0.36	0.44	0.00	0.14
Sedentariness	2.95	1.37	0.04	0.51	0.11	0.45	<b>24.69</b>	0.29	0.28
Government management	1.79	0.79	0.21	<b>35.53</b>	0.01	0.00	0.02	0.09	0.12
Emotional instability	1.09	<b>13.29</b>	1.19	0.06	0.10	0.10	1.42	0.01	0.59
Social isolation	2.21	<b>10.29</b>	0.04	1.65	0.36	0.32	2.62	0.00	0.05
Touch packaging	0.68	4.52	1.20	0.09	3.40	9.82	0.44	0.02	4.69
Unemployment	1.31	2.63	1.67	1.98	0.31	0.47	1.45	4.77	0.78
Protection stuff	1.05	3.58	2.68	0.14	0.52	2.14	0.80	0.02	5.08

**Table A3**

Frequencies of products selection by cluster (N 450), and significant differences across clusters using a Chi-square test for frequencies above 5.

Products	Cluster 1 (n = 106)	Cluster 2 (n = 193)	Cluster 3 (n = 60)	Cluster 4 (n = 91)
Flour and yeast	27	61	19	26
Rice and grains	63	144	39	61
Potatoes	45	120	33	42
Corn-based products	28	64	12	26
Legumes	58	122	39	47
Cereals	39	84	17	36
Fresh vegetables	75	137	43	70
Canned and frozen vegetables	19	<b>18 (+) *</b>	10	11
Fresh fruits	68	129	37	63
Canned and frozen fruits	6	13	0	7
Bottled water	32	49	13	25
Flavoured water	7	13	4	8
Fruit juices	17	<b>63 (+) *</b>	17	23
Carbonated soft drink	15	20	6	12
Tea and coffee	57	117	33	49
Beer	<b>30 (+) *</b>	28	17	22
Wine	20	35	<b>20 (+) *</b>	25
Liquor and spirits	9	14	6	8
FAB's (Flavoured alcoholic beverages)	2	6	2	2
Fresh meats and poultry	65	139	33	69
Fish and seafood	35	81	26	36
Dairy products	68	130	31	60
Energy and protein bars	1	7	3	3
Cold meat and charcuterie	34	68	24	34
Ice cream and frozen desserts	14	29	8	12

(continued on next page)

Table A3 (continued)

Products	Cluster 1 (n = 106)	Cluster 2 (n = 193)	Cluster 3 (n = 60)	Cluster 4 (n = 91)
Cakes and pies	16	29	6	12
Appetizers	35	44	20	23
Jellybeans and chewing gums	9	18	6	5
Chocolates	37 (+) *	38	17	26
Nuts	31	55	18	31
Energy and vitamin drinks	1	6	1	3
Ready meals	8	15	2	4
Biscuits and sponge cakes	43	76	21	33
Bread	61	121	31	61
Spices and herbs	34	63	15	33
Canned soups and vegetables	14	24	4	7
Frozen burgers and nuggets	11	19	5	8
Vegetarian burgers and sausages	6	4	2	4
Plant-based beverages	17	29	11	9
Eggs	69	166	49	77
Dressings	18	33	5	12
Soups and stocks	8	18	4	9
PSD (Powdered soft drink)	2	13	0	4
Sauces	20	29	3	23 (+) *
Pasta	53	115	30	52

(+) or (-) indicate that the observed value is higher or lower than the expected theoretical value. \*\*\*  $p < 0.001$  \*\*  $p < 0.01$  and \*  $p < 0.05$ ; effect of the chi square per cell.

Grey lines contain more than one column with frequencies below 5, and therefore Chi-square test was not performed.

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