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## Original Research

## Household food insecurity before and during the COVID-19 pandemic in Chile



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## ABSTRACT

**Objectives:** To compare food insecurity (FI) in Chile before and during the COVID-19 pandemic according to different household types and vulnerability indicators.

**Study design:** Longitudinal study based on two population-based surveys in Chile (CASEN 2017 and COVID 2020).

**Methods:** Descriptive analysis and multinomial regression models for FI through the Food Insecurity Experience Scale (FIES).

**Results:** FI levels increased significantly ( $P < 0.001$ ) between 2017 (30%) and 2020 (49%). There was increased FI in all households, but especially in those with economically dependent persons (i.e. children, adolescents and older adults). Household vulnerability indicators showed a statistically significant relationship with FI both before and during the pandemic. The pandemic has resulted in new population groups experiencing FI.

**Conclusions:** The COVID-19 pandemic has led to a significant increase in FI, which has also been seen in new population groups.

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## Introduction

The COVID-19 pandemic has resulted in significant morbidity and mortality, which is unprecedented in recent history.<sup>1</sup> This health crisis has had economic, social and psychological consequences.<sup>2,3</sup> Unemployment rates have increased,<sup>4</sup> while confinement measures affected markets, interpersonal relationships and the population's physical and mental health.<sup>2,5</sup> Furthermore, this crisis has impacted global and local food systems (i.e. production, distribution and purchasing).<sup>2,6</sup>

The COVID-19 pandemic has had a huge impact in Chile. This country, which is part of the Organisation for Economic Co-operation and Development (OECD), has one of the highest per capita incomes in Latin America and has significantly reduced poverty in recent decades.<sup>7</sup> However, it is also a country with high inequality.<sup>7</sup> This relative economic success is reflected in one of the lowest food insecurities in the region,<sup>8</sup> which coexists with a high prevalence of obesity (highest in women and groups with low education).<sup>9</sup> The country's economic performance has slowed down

due to the COVID-19 outbreak.<sup>7</sup> In Chile, the pandemic began just after the October 2019 revolution (an extensive political mobilisation in Chile);<sup>10</sup> nevertheless, as the Central Bank data show,<sup>11</sup> the pandemic was the phenomenon that has heavily shaken the economy.

The first wave of the COVID-19 pandemic showed high morbidity and mortality. The government implemented focused lockdowns, which was stricter in the municipalities and regions with the highest number of contagions and deaths. During the first pandemic wave, the Metropolitan Region, which includes more than 40% of the population, was the area to be most severely impacted by the virus and where the lockdown was most severe and lengthy. The confinement measures produced a significant increase in unemployment rates.<sup>11,12</sup>

International organisations warned about the threat to food security posed by COVID-19,<sup>13</sup> estimating that the number of critically food insecure people could double globally.<sup>14</sup> Experts suggest that the food insecurity (FI) problem is caused by both the pandemic negative economic impact, limiting household food resources and their ability to acquire food, in addition to disruptions to the supply chain because of mobility restrictions.<sup>15–17</sup> The current health crisis affects the following four pillars of food security: availability, access, use and stability.<sup>16</sup> The poor, women, children

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and migrants experience amplified effects stemming from these issues.<sup>15</sup>

Research analysing social and economic factors affecting FI indicates that the most vulnerable households are the most likely to suffer.<sup>18</sup> Research in the US, New Zealand and Finland shows that low income is a crucial FI predictor,<sup>19–21</sup> and identifies other variables associated with household vulnerability (including poverty, single-parent households, unemployment, low educational attainment of the head of household, children, rural area, economic problems during childhood and lack of social support). The association between household vulnerability and FI is also present in Mexico, another OECD country with similar economic and health conditions to Chile, but with higher levels of FI.<sup>22,23</sup>

This research aims to compare FI in Chile before and during the COVID-19 health crisis in different households according to vulnerability indicators. Few studies have used population-based data to measure the consequences of COVID-19 on household FI. Therefore, this research generates valuable information for understanding this dimension of the current crisis in Chile. Population studies carried out in the US, Mexico and Australia reveal that FI increased significantly in these contexts due to the pandemic.<sup>24–26</sup> Chile presents an interesting case because, before the pandemic, it had a good level of food security,<sup>8</sup> so the changes may be more noticeable.

We tested the following three hypotheses in Chilean households: (1) FI will increase during the pandemic, in comparison to the pre-pandemic period; (2) the increase in FI will be greater in households with economically dependent persons than without; and (3) during the pandemic, the most vulnerable households (i.e. lower income, unemployment of some of its members, a female-headed household and less educated heads of household) will be more likely to experience mild to moderate–severe FI.

## Methods

### Sample and database

We analysed secondary data from two national surveys: CASEN (*Encuesta Nacional de Caracterización Socio-Económica de Chile*, which translates to Chilean National Socioeconomic Characterisation Survey) 2017 and COVID-19 Social Survey 2020 (first application). CASEN is a longitudinal study that compares similar data and samples but without following the same individuals.

The CASEN is an in-person cross-sectional household survey that the Chilean government has conducted since 1987 to characterise the socioeconomic situation of Chilean households. This survey is representative at the national, urban, rural and regional levels; it has a probabilistic, stratified, clustered and multistage sample design. We worked with the CASEN 2017 Survey (CASEN 2017), conducted between 2 November 2017 and 4 February 2018.<sup>27</sup> The unweighted sample size was 70,677.

The COVID-19 Social Survey (COVID 2020) sought to obtain information on the social and economic consequences of the COVID-19 pandemic in Chilean households.<sup>28</sup> It was representative at the national level and by macro-zone with a two-phase sample design. We worked with the first application, which was telephone-based during the earliest wave of the pandemic in Chile (between 24 June and 7 August 2020), when the government had implemented strict confinement measures. The unweighted sample size was 4425.

It is important to mention that there are some differences between the two samples: COVID-2020 had fewer household heads with lower educational attainment and more with higher educational attainment; COVID 2020 had more household heads aged between 30 and 44 years and fewer aged >60 years; and COVID 2020 had more households who received state assistance.

## Variables

The dependent variable is FI constructed from the Food Insecurity Experience Scale (FIES).<sup>29</sup> This scale has eight questions about people's food access experience and applies to the individual and household level; in this study, we used the latter (i.e. data for households). In CASEN 2017, the question that examined food access concerned the last 12 months, while in COVID 2020, the same question related to the previous month.

Following the FIES scale's general guidelines, we created a composite indicator to categorise households into different FI levels: mild, moderate or severe.<sup>30</sup> In our analysis, we merged moderate and severe categories due to their low prevalence.

For the independent variables, we used four household vulnerability indicators: quintile household income, unemployment of a household member, household head's gender and household head's education.

We should clarify that we used different unemployment indicators for each survey. In CASEN 2017, we created a dichotomous variable for identifying households where at least one member was unemployed. However, in COVID 2020, we used two dichotomous indicators; first, we considered whether there were household members that had lost their job or other economic activity and second, if they were receiving unemployment insurance during a temporary suspension of their employment contract (Employment Protection Law<sup>31</sup>).

Additionally, we used five control variables: geographic macro-zone, urban/rural area, age of household's head, state assistance and type of household. We included area variables as a control because the government implemented different lockdown measures by region.

## Statistical analyses

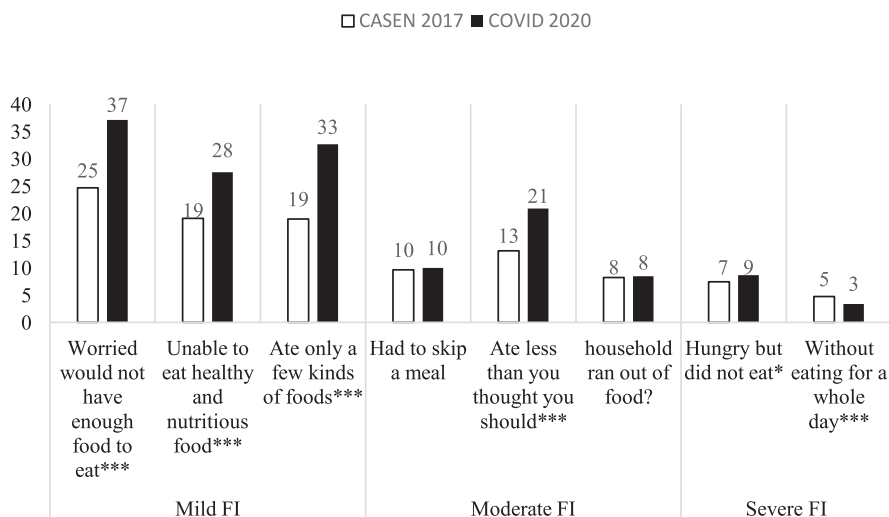
First, we used descriptive analyses of variations in FI by household type. We calculated these data with weighted samples.

Second, we elaborated a multinomial logistic regression model to estimate the probability of a household experiencing some FI level associated with independent and control variables. 'No FI' became the reference category in all estimated models. Furthermore, we estimated models for total households, households with children and adolescents, older adults and single-person households by age. These analyses used IBM-SPSS Statistics 26 program with unweighted databases.

## Results

In Chile, FI levels increased significantly ( $P < 0.001$ ) between 2017 and the first peak of the pandemic in 2020, rising from 30% to 49%. This increase is visible in both mild FI levels (from 14% to 26%) and moderate–severe FI levels (from 16% to 24%).

Fig. 1 shows significant variation in six of the eight questions from the FIES scale between the 2017 and 2020 measurements. We found significant increases (based on interval confidences,  $P < 0.010$ ) in FI from the responses to the three mild FI questions. Concern about not having enough food rose from 25% to 37%; eating little variety of food, from 19% to 33%; and not being able to eat healthy and nutritious food, from 19% to 28%. There was only one statistically significant difference in moderate FI. In 2017, 13% of households reported eating less than they thought they should, which rose to 21% in 2020. Although the prevalence of severe FI was low in both surveys, there were significant differences between the two measures. The variation concerning food deprivation for a whole day was contrary to expectations. We found a reduction in



\*\*\* Sig. < 0.01 \*\*Sig. < 0.05 \*Sig. < 0.1  
 Unweighted N CASEN 2017: 70,677 ; Weighted N CASEN 2017: 5,794,096  
 Unweighted N COVID 2020: 4,425 ; Weighted N COVID 2020: 5,963,775.  
 Source: Own elaboration based on CASEN Survey 2017 and COVID-19 Survey 2020 Survey

Fig. 1. Questions of the Experience of Food Insecurity in the Household scale, CASEN 2017 and COVID 2020 (%).

households reporting this situation during the pandemic compared with prepandemic measurements.

Table 1 provides descriptive data to compare FI levels in the independent and control variables.

Regarding the distribution of FI by household type, there were three noteworthy aspects. First, in almost all households, the FI increase from 2017 to 2020 was approximately 20%, except for single-person households, which increased by about 10%. Second,

Table 1 Food insecurity (FI) levels according to independent and control variables.

Variable (% CASEN 2017; % COVID 2020) <sup>a</sup>	Without FI <sup>b</sup>		Mild FI <sup>b</sup>		Moderate–severe FI <sup>b</sup>	
	2017	2020	2017	2020	2017	2020
<b>Total households</b>	70.4%	50.9%	13.9%	25.5%	15.7%	23.6%
<b>Household type</b>						
Household w/children under 18 years of age (43.5%; 45.6%)	65.6%	46.3%	16.1%	29.2%	18.4%	24.5%
Household w/older adults (41.9%; 39.6%)	73.6%	52.6%	13.5%	26.5%	12.9%	20.9%
Single-person household - Under 60 years old (7.5%; 8.4%)	72.1%	61.0%	9.6%	14.6%	18.3%	24.4%
Single person household - 60+ years old (7.9%; 5.4%)	72.4%	63.1%	12.7%	16.3%	14.9%	20.6%
<b>Independent variables</b>						
Quintile 1 (19.5%; 20.6%)	53.0%	26.3%	18.1%	30.2%	28.8%	43.5%
Quintile 2 (20.6%; 21.7%)	62.1%	36.7%	17.7%	31.9%	20.1%	31.4%
Quintile 3 (19.9%; 17.6%)	70.1%	39.7%	15.3%	30.7%	14.7%	29.6%
Quintile 4 (20.0%; 20.5%)	78.5%	59.9%	11.6%	26.1%	9.9%	14.0%
Quintile 5 (20.0%; 19.6%)	88.1%	84.3%	6.6%	12.2%	5.3%	3.5%
At least one unemployed member in the household (10.3%; -)	57.5%		17.0%		25.6%	
At least one household member suspended (-; 9.3%)		48.0%		29.0%		23.0%
At least one household member lost job (-; 34.5%)		33.5%		32.2%		34.3%
Female household head (42.4%; 42.5%)	66.0%	46.6%	14.9%	26.0%	19.1%	27.5%
Household head w/primary education (30.9%; 22.9%)	64.3%	40.3%	16.0%	28.0%	19.7%	31.7%
Household head w/secondary education (41.8%; 39.6%)	68.0%	45.0%	14.9%	28.4%	17.1%	26.6%
Household head w/incomplete higher education (6.0%; 5.5%)	70.9%	52.8%	12.8%	20.5%	16.2%	26.7%
Household head w/higher education or plus (21.3%; 32.0%)	83.8%	65.4%	9.0%	21.1%	7.2%	13.6%
<b>Control variables</b>						
North region (11.5%; 12.1%)	71.1%	49.4%	13.8%	25.4%	15.1%	25.2%
Centre region (22.1%; 21.6%)	69.0%	47.0%	15.8%	28.4%	15.1%	24.6%
South region (25.2%; 25.3%)	70.2%	49.2%	15.1%	24.9%	14.8%	25.8%
Extreme south region (1.5%; 1.7%)	76.1%	59.7%	14.3%	21.9%	9.6%	18.5%
Metropolitan region (39.6%; 39.4%)	70.9%	54.1%	12.0%	24.6%	17.1%	21.3%
Rural area (12.6%; 11.4%)	70.1%	46.5%	15.7%	27.2%	14.2%	26.3%
Household head age: under 30 years (8.0%; 4.8%)	66.7%	45.3%	13.1%	27.3%	20.2%	27.4%
Household head age: 30–44 years (24.4%; 30.4%)	68.2%	50.1%	14.4%	24.7%	17.4%	25.2%
Household head age: 45–59 years (31.4%; 32.2%)	68.7%	49.4%	14.4%	26.3%	16.9%	24.3%
Household head age: 60+ years (36.3%; 32.6%)	74.2%	53.8%	13.2%	25.3%	12.6%	20.9%
State assistance (34.8%; 45.7%)	63.6%	42.2%	16.8%	28.5%	19.6%	29.3%

CASEN 2017, Chilean National Socioeconomic Characterisation Survey 2017; COVID 2020, COVID-19 Social Survey 2020.

<sup>a</sup> In this column, the percentages in parentheses correspond to the value of each category in CASEN 2017 and COVID 2020.

<sup>b</sup> All percentages are calculated in the weighted databases. Weighted N CASEN 2017: 5,794,096. Weighted N COVID 2020: 5,963,775.

and linked to the previous point, single-person households of older adults were the least affected by FI (37%). Third, households with children aged under 18 years experienced the most FI, both before and during the pandemic.

For the household income quintile, Table 1 shows that in both surveys, FI was highest in quintile I: from 47% in 2017 to 74% in 2020. The increase was more notable in moderate and severe FI. Table 1 also reveals that FI increased the most in quintile III, which experienced a rise of 30% between 2017 and 2020.

Although the unemployment variables were not the same, Table 1 shows that households with some unemployed members were more susceptible to some degree of FI. FI was seen in more than two-thirds of households where one of their members had lost a job during the pandemic.

In both surveys, female-headed households experienced slightly higher FI than households in general. Regarding the household head's educational attainment, higher attainment was associated with less FI, but notably, the gap between primary and higher educational attainment grew in the COVID 2020 survey.

Finally, Table 1 reveals regional variations for the control variables, especially in moderate–severe FI. Moderate–severe FI in 2017 was higher in households in the Metropolitan Region, while households in the north, centre and south zones experienced higher moderate–severe FI than those in the Metropolitan Region during the pandemic. During the pandemic, FI was slightly higher

in rural households. FI was slightly lower in households headed by older adults and higher in households who received some assistance from the State.

The multinomial regression model is presented in Table 2 (households in general and with dependents) and in Table 3 (single-person households by age). The odds ratios (ORs) and P-values are reported here.

We found a difference regarding the household income quintile between 2017 and 2020. In CASEN 2017, all quintiles had a significantly lower probability of having mild and moderate–severe FI than quintile I (all  $P = 0.000$ ). Single-person households of older adults formed the exception, where only quintile IV and V had lower probabilities of mild insecurity than quintile I (all  $P = 0.000$ ). In COVID 2020, the general model revealed that quintile IV and V were still less likely to experience mild and moderate–severe FI than quintile I ( $p$  between 0.000 and 0.008). Meanwhile, quintiles II and III were significantly more likely to experience mild FI than quintile I ( $OR_{QII\_mild} = 1.331, P = 0.013$ ;  $OR_{QIII\_mild} = 1.267, P = 0.037$ ) and had no statistically significant difference for moderate–severe FI. It is important to note that quintile II was more likely to show mild FI among single-person households of older adults than quintile I ( $OR_{QII\_mild} = 4.830, P = 0.025$ ). Furthermore, moderate–severe FI was more likely to occur in quintile II compared to quintile I among under 60 years old single-person households ( $OR_{QII\_mod} = 7.904, P = 0.029$ ). Moderate–severe FI

**Table 2**  
Multinomial regression model to mild and moderate–severe food insecurity (FI) odds ratios in total households and households with economic dependents persons (Beta).

Reference category: without FI	Total households		Household w/children under 18 years old		Household w/older adults	
	CASEN 2017	COVID 2020	CASEN 2017	COVID 2020	CASEN 2017	COVID 2020
<b>Mild FI</b>						
Quintile II <sup>1</sup>	−0.227***	0.286*	−0.269***	0.086	−0.144**	0.424**
Quintile III <sup>1</sup>	−0.433***	0.237*	−0.492***	−0.004	−0.401***	0.279
Quintile IV <sup>1</sup>	−0.725***	−0.304**	−0.830***	−0.480*	−0.698***	−0.402*
Quintile V <sup>1</sup>	−1.316***	−1.041***	−1.517***	−1.394***	−1.278***	−1.191***
At least one household member suspended		0.245		0.037		0.402
At least one household member lost job		0.510***		0.370**		0.505***
At least one unemployed in the household	0.222***		0.215***		0.249***	
Female Household head	0.130***	0.135	0.142***	0.272*	0.111**	−0.035
Household head w/secondary education <sup>2</sup>	−0.110***	−0.166	−0.140***	0.165	−0.142***	−0.139
Household head w/incomplete higher education <sup>2</sup>	−0.182**	−0.223	−0.131*	−0.111	−0.304**	−0.016
Household head w/higher education <sup>2</sup>	−0.372***	−0.488***	−0.331***	−0.319	−0.334***	−0.405*
Household head age 30–44 years <sup>3</sup>	−0.049	0.025	−0.040	−0.026	−0.054	0.294
Household head age 45–59 years <sup>3</sup>	−0.128**	−0.144	−0.135*	−0.019	−0.153	0.187
Household head age 60+ years <sup>3</sup>	−0.449***	−0.518	−0.370***	−0.277	−0.424	−0.078
<b>Moderate or severe FI</b>						
Quintile II <sup>1</sup>	−0.502***	0.086	−0.556***	−0.147	−0.450***	0.250
Quintile III <sup>1</sup>	−0.928***	−0.035	−1.068***	−0.422*	−0.891***	0.143
Quintile IV <sup>1</sup>	−1.299***	−0.785***	−1.622***	−1.339***	−1.357***	−0.683***
Quintile V <sup>1</sup>	−1.923***	−2.186***	−2.392***	−3.143***	−1.831***	−2.248***
At least one household member suspended		0.254		0.088		0.368
At least one household member lost job		0.739***		0.845***		0.457***
At least one unemployed in the household	0.410***		0.415***		0.427***	
Female Household head	0.325***	0.346***	0.417***	0.594***	0.195***	0.111
Household head w/secondary education <sup>2</sup>	−0.313***	−0.400***	−0.265***	−0.071	−0.281***	−0.574***
Household head w/incomplete higher education <sup>2</sup>	−0.329***	−0.397	−0.317***	0.043	−0.162	−0.153
Household head w/higher education <sup>2</sup>	−0.780***	−1.017***	−0.567***	−0.650**	−0.584***	−0.972***
Household head age 30–44 years <sup>3</sup>	−0.256***	−0.152	−0.176***	−0.304	0.029	−0.324
Household head age 45–59 years <sup>3</sup>	−0.327***	−0.230	−0.268***	−0.224	−0.225	−0.301
Household head age 60+ years <sup>3</sup>	−0.889***	−0.796***	−0.737***	−1.000**	−0.492*	−0.757
Cox and Snell	0.091	0.170	0.102	0.194	0.066	0.145
Nagelkerke	0.113	0.195	0.124	0.221	0.084	0.169

\*\*\* $P < 0.01$  \*\* $P < 0.05$  \* $P < 0.1$ .

Blank cells correspond to categories that did not present cases.

Unweighted N CASEN 2017: 70,677; unweighted N COVID 2020: 4425.

All models control for: geographic area, urban/rural area, household receives state transfer.

Reference categories: <sup>1</sup> Quintile I; <sup>2</sup> Head of household with primary education or less; <sup>3</sup> Head of household under 30 years old.

CASEN 2017, Chilean National Socioeconomic Characterisation Survey 2017; COVID 2020, COVID-19 Social Survey 2020.

Source: Own elaboration based on CASEN 2017 and COVID 2020.

**Table 3**  
Multinomial regression model to mild and moderate–severe food insecurity (FI) odds ratios in single-person households (Beta).

	Single-person household under 60 years old		Single-person household 60+ years old	
	CASEN 2017	COVID 2020	CASEN 2017	COVID 2020
<b>Reference category: without FI</b>				
<b>Mild FI</b>				
Quintile II <sup>1</sup>	−0,187	1,573	−0,115	1,575***
Quintile III <sup>1</sup>	−0,267	0,173	−0,184	0,431
Quintile IV <sup>1</sup>	−0,726***	1,088	−0,527***	−0,235
Quintile V <sup>1</sup>	−1,120***	−0,109	−1,293***	−1,142*
At least one household member suspended		0,359		0,022
At least one household member lost job		1,753**		0,049
At least one unemployed in the household	0,128		0,643	
Female Household head	0,059	0,713	−0,035	−0,174
Household head w/secondary education <sup>2</sup>	−0,103	−1,287	−0,046	0,094
Household head w/incomplete higher education <sup>2</sup>	−0,331	−0,723	−0,531	0,590
Household head w/higher education <sup>2</sup>	−0,524**	−0,659	−0,142	0,476
Household head age 30–44 years <sup>3</sup>	−0,127	−0,731		
Household head age 45–59 years <sup>3</sup>	−0,086	−0,414		
Household head age 60+ years <sup>3</sup>				
<b>Moderate or severe FI</b>				
Quintile II <sup>1</sup>	−0,124	2,067*	−0,417***	2,022**
Quintile III <sup>1</sup>	−0,574***	−0,058	−1,023***	1,456**
Quintile IV <sup>1</sup>	−1,049***	0,814	−1,463***	0,937
Quintile V <sup>1</sup>	−1,772***	−1,260*	−2,055***	−0,869
At least one household member suspended		−0,864		0,779
At least one household member lost job		1,950***		0,885*
At least one unemployed in the household	0,496**		1,329***	
Female Household head	0,080	0,212	−0,267**	−0,579
Household head w/secondary education <sup>2</sup>	−0,348**	−1,321*	−0,268**	−0,662*
Household head w/incomplete higher education <sup>2</sup>	−0,418**	−1,575	−0,256	−1,238
Household head w/higher education <sup>2</sup>	−1,176***	−2,120**	−0,499**	−0,946
Household head age 30–44 years <sup>3</sup>	−0,110	1,583		
Household head age 45–59 years <sup>3</sup>	−0,093	1,128		
Household head age 60+ years <sup>3</sup>				
Cox and Snell	0,115	0,394	0,077	0,226
Nagelkerke	0,146	0,458	0,098	0,268

\*\*\*P < 0.01 \*\*P < 0.05 \*P < 0.1.

Blank cells correspond to categories that did not present cases.

Unweighted N CASEN 2017: 70,677; unweighted N CASEN COVID 2020: 4425.

All models control for: geographic area. Urban/rural area. Household receives state transfer.

Reference categories: <sup>1</sup> Quintile I; <sup>2</sup> Head of household with primary education or less; <sup>3</sup> Head of household under 30 years old.

CASEN 2017, Chilean National Socioeconomic Characterisation Survey 2017; COVID 2020, COVID-19 Social Survey 2020.

Source: Own elaboration based on CASEN 2017 and COVID 2020 Survey.

was more likely to occur in quintile II and in quintile III in single-person households of older adults (OR<sub>QII\_mod</sub> = 7.556, P = 0.009; OR<sub>QIII\_mod</sub> = 4.290, P = 0.006, respectively).

We observed a significant association between unemployment and FI in both surveys. In CASEN 2017, households with at least one unemployed member had higher chances of experiencing FI (OR<sub>une\_mild</sub> = 1.249, P = 0.000; OR<sub>une\_mod</sub> = 1.506, P = 0.000). This was also true in the COVID 2020 survey when one household member had lost a job or other economic activity (OR<sub>lost\_mild</sub> = 1.666, P = 0.000; OR<sub>lost\_mild</sub> = 2.093, P = 0.000). In the case of job suspension, the association was not statistically significant.

The gender of the household head also predicted FI differences concerning household characteristics. Among households with children, the female-headed households had higher odds of experiencing mild and moderate–severe FI in both surveys (P-value between 0.000 and 0.026). Among households with older adults, the female-headed households had higher mild or moderate–severe FI in CASEN 2017 (OR<sub>fem\_mild</sub> = 0.117, P = 0.001; OR<sub>fem\_mod</sub> = 1.215, P = 0.000), but not in the COVID 2020 survey. There was no marked gender-related difference among single-person households under 60 years of age. However, among older single-person households, female households exhibited decreased odds of experiencing moderate–severe FI in CASEN 2017

(OR<sub>fem\_mod</sub> = 0.766, P = 0.001). This was also true in the COVID 2020 survey; however, this relationship was no longer statistically significant, which could be due to the smaller sample size.

Educational attainment of the household head was also associated with FI, especially in specific household configurations. Moderate–severe FI decreased with higher educational attainment in the general sample in CASEN 2017 (OR<sub>sec\_mod</sub> = 0.731, P = 0.000; OR<sub>incom\_mod</sub> = 0.719, P = 0.000; OR<sub>high\_mod</sub> = 0.458, P = 0.000) and COVID 2020 (OR<sub>sec\_mod</sub> = 0.671, P = 0.000; OR<sub>incom\_mod</sub> = 0.673, P = 0.068; OR<sub>high\_mod</sub> = 0.362, P = 0.000). For mild FI, this association was observed in CASEN 2017 (OR<sub>sec\_mild</sub> = 0.895, P = 0.000; OR<sub>incom\_mild</sub> = 0.834, P = 0.001; OR<sub>high\_mild</sub> = 0.689, P = 0.000), but in COVID 2020 only for higher education (OR<sub>high\_mild</sub> = 0.614, P = 0.000). There were no evident education-related differences in mild FI among single-person households in either survey. However, the education of household heads in both surveys had the most significant effect on the incidence of moderate–severe FI.

The age of the household head was relevant only with children under 18 years old in both surveys. In CASEN 2017, as age increased, the chance of having both mild and moderate–severe FI decreased (OR<sub>30-44\_mild</sub> = 0.961, P = 0.487; OR<sub>45-59\_mild</sub> = 0.874, P = 0.024; OR<sub>60+\_mild</sub> = 0.691, P = 0.000; OR<sub>30-44\_mod</sub> = 0.838, P = 0.002; OR<sub>45-59\_mod</sub> = 0.765, P = 0.000; OR<sub>60+\_mod</sub> = 0.479, P = 0.000). In COVID

2020, the unique significant difference was from 60+ years old in comparison with less than 30 years ( $OR_{30-44\_mod} = 0.368$ ,  $P = 0.002$ ).

## Discussion

This research compares FI in Chile before and during the COVID-19 health crisis in different households and their association to vulnerability indicators. We tested three hypotheses. First, we proposed that FI will increase during the pandemic in comparison to the prepandemic period. Second, we estimated that the increase in FI would be greater in households with economically dependent persons than without. Third, we hypothesise that during the pandemic, the most vulnerable households (i.e. lower income, unemployment of some of its members, a female-headed household and less educated heads of household) will be more likely to experience mild to moderate–severe FI.

Regarding the first hypothesis, compared to the prepandemic period, we found a significant increase in FI in Chilean households during the pandemic. These results aligned with the expectations and studies in other areas on the subject.<sup>24–26</sup>

Mild and moderate–severe FI increased during the pandemic, with a markedly significant rise in mild FI. We attribute this augmentation to impacts from lockdowns and loss of employment since the October 2019 revolution, which has been augmented due to the pandemic.<sup>11</sup> The economic problems may have led to an increase in overall concern among the general population about not having enough food at home and the food that they did have being less nutritious and diverse. Meanwhile, severe FI remains low in the country, and the increase in FI seen may be statistically significant because of the large sample size.

In relation to the second hypothesis about the greater increase in FI in households with economically dependent persons than without, the evidence is also favourable. In fact, we observed a significant increase in FI among different types of households. The difference was more pronounced in households with an economically dependent person, especially those with children or adolescents. A recent study conducted in Mexico showed similar results.<sup>25</sup> These results show that having unwaged dependents is a risk factor for FI.

Regarding the third hypothesis, the most vulnerable households generally had a greater probability of experiencing both mild and moderate–severe FI before and during the pandemic. However, there were nuances in the relationship between vulnerability and FI due to the pandemic.

Higher income quintiles were less likely to experience FI than lower income quintiles, which is consistent with the literature.<sup>19,21,26</sup> However, COVID-19 changed this situation. Quintiles II and III did not differ markedly from quintile I, but they were even more likely to experience FI than the poorest households. One possible interpretation for this phenomenon is that quintile I had more access to food support during the measurement period. In fact, during COVID-2020's data collection period, local organisations had set up community soup kitchens in low-income neighbourhoods.<sup>32</sup> Non-governmental organisations also provided food aid to these sectors, and the government distributed food boxes.

Results confirm that unemployment consistently increased FI before and during the pandemic, indicating that it may depend more on declining incomes than food supply. Furthermore, during the COVID-19 crisis, job suspensions did not significantly increase FI. This could be because people in this situation continued to receive wages through the special law promulgated by the government to protect employment. This law allowed employers to use worker's

deposits in private employment insurance to finance their salaries. If these were insufficient, it was possible to use a state fund.<sup>33</sup>

Results of the current study also showed that having a female as the head of the household tended to be a risk factor for FI before the pandemic, especially in extended households. This finding was consistent with previous research that indicated that women faced more adverse conditions, for example, in employment and the creation of social networks.<sup>34</sup> However, during the pandemic, the female-headed households were less statistically relevant, even when maintaining the direction of the association. One possible interpretation of this phenomenon is that working from home could be protective regarding FI because people eat at home and save money rather than spending money on transport or eating out. However, studies also showed that the burden of household chores increased because of the pandemic, especially among women, thus negatively affecting gender equity.<sup>35,36</sup>

Interestingly, the situation in single-person households of older women is also noteworthy, given that they experienced significantly lower FI than households of older men alone. Gender and generational considerations possibly played a role here.

The educational attainment of the household head was a relevant factor before the pandemic; however, during the COVID-19 crisis, only higher or postgraduate education was relevant. This group possibly had a more stable economic situation during the crisis, while those with low and medium education were more vulnerable to suspension of labour, being less adaptable to remote working.<sup>37</sup>

It is important to note that the pandemic in Chile began after an extensive political mobilisation in October 2019.<sup>10</sup> However, as the Central Bank data show, for example, in terms of the unemployment rate,<sup>11</sup> the pandemic has been the primary phenomenon that has triggered the current economic crisis.

## Strengths and limitations

The main strength of our research is that data came from two nationally representative databases, both using the FIES scale, before and after the pandemic. Few studies, to date, have similar material. Thus, the valuable contribution of this research is to be able to provide population-based information on the effects of the pandemic on food security.

However, our study has some limitations. The first is that the surveys did not have the same sample size. The smaller size of COVID 2020 may explain why some associations were no longer significant compared with results from CASEN 2017. Nevertheless, the size of both samples is large, so the impact of this difference on the results is negligible.

A second limitation is that COVID 2020 was a telephone survey. This kind of survey may present biases in favour of the most educated and digitally connected.<sup>38,39</sup> For example, COVID 2020 household heads were younger and had higher educational attainment than CASEN 2017 household heads. However, the regression models allowed us to control for this limitation when analysing each variable's effect on FI while keeping the other factors constant.

A third limitation is a temporal difference between the FIES scale applied in CASEN 2017 (last 12 months) and COVID 2020 (previous month). Although the time horizon is not the same, we consider this to be an advantage because the question asked during the pandemic allows us to accurately capture the experience of households during the crisis and contrast it with that previously experienced in general. Moreover, we can hypothesise that if CASEN 2017 had asked about the previous month (as in the COVID 2020 survey), the estimated prevalence of FI would likely have been lower, given that the period covered would be shorter. In this sense,

the difference with COVID 2020 could be even more considerable than we observed. Beyond this point, the relevant descriptive result of the study is that FI increased with the pandemic, even with a narrower time measure than in the first survey.

Additionally, both surveys are cross-sectional. Therefore, a panel design would allow quantification of the proportion of households that experienced increased FI and their causal explanations.

## Conclusions

In conclusion, the COVID-19 pandemic led to a significant increase in FI, even in a country such as Chile, where prepandemic data showed that this problem was minor. FI affected the most vulnerable households significantly, but it also affected new social groups, such as quintiles II and III. We found that this crisis affected a large population by compromising food security. The FI affected the most vulnerable groups but also expanded to reach the middle strata. It is also worth noting that female-headed households and those with children and adolescents continue to be the most exposed to the threat of FI.

This research contributes to providing evidence of the impacts of the COVID-19 pandemic on a health dimension with limited research: FI. Investigations on this topic during this pandemic are still rare, and our national study in a country with low FI levels shows the significant impact of COVID-19.

The existence of some levels of FI in middle-income groups highlights the instability of the financial situation of these groups, who are left vulnerable to economic crises and without access to government benefits targeted to the poorest households. This phenomenon is especially critical in countries with a weak social security system, such as Chile.

The results can also shed light on the benefits of neighbourhood organisations in overcoming food crises. In Chile, community kitchens coordinated by civil society in poor areas appear to be an effective means of combating FI.

These results confirm that governments should subsidise low-income and middle-income households in the face of severe crises that impact the economy to ensure their access to primary supplies such as food. In the same vein, food delivery should also include middle-income households.

Future research should investigate more thoroughly the experience of FI in households of different income levels. To date, most studies have focused on the most vulnerable groups. Qualitative studies would provide a better understanding of experiencing FI in middle-income groups during crises and the strategies used by households to deal with it.

## Author statements

### Ethical approval

Not applicable; we used public survey databases.

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### Competing interests

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

## Availability of data and materials

The data that supports the findings of this study are public and available from the open data governmental platform (<http://observatorio.ministeriodesarrollosocial.gob.cl>).

## Authors' contributions

CG and PAA conceived and designed the study. PAA and MSH carried out the analysis. CG and PAA wrote the draft of the manuscript. CG and MSH critically read, revised, and wrote the final manuscript. All authors contributed to writing the article and agreed with manuscript results and conclusions.

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