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ORIGINAL RESEARCH



Food Insecurity and Overcrowding: The Concurrence Between Two Social Determinants of Health in Urban Chilean Households

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ABSTRACT

Household overcrowding and food insecurity are interconnected indicators of socioeconomic hardship linked to health inequities. Using data from 58,615 urban adults in Chile's 2022 CASEN survey, we mapped their national distribution and found overlapping hotspots in the north and metropolitan regions. Food insecurity was measured with FIES and overcrowding via the persons-per-bedroom ratio. Multivariable logistic regression showed that high overcrowding increased the odds of food insecurity by 31% (OR 1.31; 95% CI 1.04–1.65). Female sex, foreign nationality, unemployment, and poverty raised risk, while older age and higher income were protective. The findings emphasize the need for coordinated, rights-based approaches that transcend traditional sectoral boundaries, advocating for integrated housing and food policies.

KEYWORDS

Food insecurity; overcrowding; social determinant of health; household income

Introduction

Affordable, healthy, and environmentally sustainable diets are necessary for human and planetary health.¹ Still, over 3.1 billion people worldwide cannot afford a healthy diet.¹ This lack of access is often described as food insecurity (FI), in which people have limited or uncertain access to a nutritionally adequate and culturally acceptable food supply in quantity, quality, and availability.² Understanding food insecurity requires moving beyond simple measurements of food purchases or availability to capture the lived experience and psychosocial aspect of food access challenges.³ The Food and Agriculture Organization (FAO) developed the Food Insecurity Experience Scale (FIES) to measure food access at the household level, recognizing that food security is

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fundamentally a household phenomenon shaped by collective resources, decision-making processes, and shared vulnerabilities.² Because the household represents the primary unit where food acquisition, distribution, and consumption decisions occur, household composition and the number of people per home become critical factors in understanding food insecurity dynamics and informing effective policy interventions.³

Literature review shows a high correlation between FI and the social determinants of health, e.g., poverty, gender inequality, educational level, and employment insecurity.^{4,5} These determinants often cluster and reinforce one another, forming profiles of multidimensional vulnerability.⁴ Studies have shown that housing insecurity, including overcrowded conditions, contributes to stress, reduces mental well-being, and limits a household's capacity to secure nutritious food.^{6–8}

Overcrowding is a housing condition where the number of residents exceeds acceptable spatial thresholds (e.g., persons per room), affecting privacy, health, and quality of life.^{9,10} While studies have demonstrated associations between overcrowding and adverse health outcomes,^{11,12} few have analyzed its potential role as a structural determinant of food insecurity, especially in contexts with strong urban segregation and rising living costs.

At the same time, housing inequality remains a key public health issue in Latin America, where over 80% of the population resides in urban areas.¹³ In Latin America, living arrangement is a persistent phenomenon characterized by structural economic constraints.¹⁴ These living arrangements undermine health through increased disease transmission, poor mental health, and reduced access to health-promoting behaviors such as preparing healthy meals.^{12,15} In Chile, 116,453 households lived in overcrowded conditions in 2022.¹⁶

Despite international evidence relating to food and the environment, there remains a limited understanding of how housing conditions intersect, particularly in urban Latin America, regarding overcrowding. The growing recognition that FI is a substantial public health issue in low- and middle-income nations, where rapid and unplanned urbanization generates neighborhoods highly concentrated among poor people with limited resources to afford healthy food.^{17,18} Literature has focused on housing instability and food insecurity^{19–21} whereas quasi-experimental evidence indicates that rental assistance decreases food insecurity.²² However, some studies^{23,24} explore the idea that the connection between overcrowding and food insecurity goes beyond lack of income; family organization, available food storage, and inadequate dining spaces in overcrowded homes can also prevent resources from being converted into nutritious meals.

In 2022, 29.6% of the global population experienced moderate or severe FI, disproportionately affecting women (27.8%) and rural populations (33.3%).²⁵ This gap is relevant in Chile, where despite economic growth,

inequalities in access to housing and food persist.^{26,27} In Chile, moderate or severe FI rose from 16% in 2017 to 20% in 2022. Despite its economic prosperity, Antofagasta reported 7.1% severe FI, one of the country's highest rates.²⁸ This paradox reflects local structural inequalities, including high housing costs, limited fresh food access, and geographic isolation.

Thus, the current research addresses this knowledge gap by analyzing the intersection of food insecurity and overcrowding in an urban Latin American context, identifying groups exposed to socioeconomic and territorial inequalities. Through this lens, the study contributes a more comprehensive understanding of how intersecting structural factors shape food access and informs policy debates on urban health and equity.

Addressing this gap is crucial to informing the design of public policies and programs that address health inequities through intersectoral approaches²⁹ at the household level, rather than relying solely on individual clinical interventions. Accordingly, this study aims to examine the distribution and association of food insecurity and overcrowding prevalence in Chilean households, focusing on social determinants and regional disparities.

Methods

We conducted a cross-sectional analysis using publicly available data from the 2022 Chilean National Socioeconomic Survey (CASEN), a nationally representative household survey employing a multistage stratified cluster design with urban/rural and regional strata. Trained interviewers collected information via face-to-face interviews with a knowledgeable adult (≥ 18 years) in each household, covering demographic, economic, housing, and health-related domains. Survey weights, primary sampling units, and strata variables supplied by the Ministry of Social Development were used to obtain unbiased national and regional estimates.

Sample

The fieldwork for the 2022 CASEN survey was conducted between November 1, 2022, and February 2, 2023. The survey included a sample of 72,056 households occupying 70,751 dwellings across 335 communes in all 16 regions of the country, collecting data from 202,231 individuals. For this study, we restricted to one respondent per household (the designated informant), aged ≥ 18 years, residing in urban areas, and with valid values on overcrowding and food-insecurity measures, yielding an analytical sample of 58,615 individuals (26,465 men; 32,150 women).

Table 1. Variables descriptives.

Variable	Description	Values
Food insecurity Severe	Food insecurity (FIES raw score ≥ 4 out of 8)	0 = No; 1 = Yes
Food insecurity score (continuous)	FIES raw score	Mean = 1.45; SD = 2.30, Min = 0, Max = 8
Food insecurity category	Any food insecurity	0 = No; 1 = Yes
Overcrowding category	Recode household crowding level (persons per bedroom)	No overcrowding (<2.5 ppb); Medium (2.5–3.49 ppb); High (3.5–4.99 ppb); Critical (≥ 5 ppb)
Overcrowding (continuous)	Household crowding level (persons per bedroom)	Mean = 1.10; SD = 0.62, Min = 0, Max = 8
Binary Indicator of Overcrowding	Any level of overcrowding (≥ 2.5 ppb)	0 = No; 1 = Yes
Binary Indicator of Severely Overcrowded	Overcrowding severity based on housing size (m^2 -specific thresholds)	0 = No; 1 = Yes
Gender	Respondent's gender	Man; Woman
Age group	Respondent's age bracket	18–24; 25–44; 45–64; 65+
Indigenous identity	Self-identified Indigenous status	No; Yes
Nationality	Country of birth	Native; Foreign
Employment status	Current labor force status	Employed; Unemployed; Not in the labor force
Income quintile	Per-capita household income quintile	Q1 Lowest; Q2; Q3; Q4; Q5 Highest
Zone	Urban versus rural residence	Rural; Urban
Multidimensional poverty	Household multidimensional poverty status (5-dim CASEN index)	No Poverty; Poverty
Region	Administrative region of residence	1 Tarapacá; 2 Antofagasta; ...; 16 Ñuble

Variables

We operationalized the primary outcome, food insecurity, through the Food Insecurity Experience Scale (FIES),³⁰ an eight-item self-report index measuring households' experiences of constrained access to adequate food over the prior 12 months. Items capture psychological anxiety about food access (item 1), compromised diet quality (items 2–3), reduced food quantity (items 4–5), and severe food shortage (items 6–8), with affirmative responses (yes = 1, no = 0) summed to yield a raw FIES score (0–8); a threshold of ≥ 4 denotes moderate – severe food insecurity. This sample's internal consistency was excellent (Cronbach's $\alpha = 0.82$). Our key exposure, household overcrowding, was computed following the CASEN methodological manual¹⁶ as the ratio of total household members to the number of exclusive-use bedrooms; informed by UN-Habitat guidelines, we then categorized this continuous measure into four strata: no overcrowding (< 2.5 persons/bedroom), medium (2.5–3.49), high (3.5–4.99), and critical (≥ 5). Additional covariates comprised respondent sex (man, woman), age group (18–24, 25–44, 45–64, ≥ 65 years), Indigenous identity (yes/no), nationality (native/foreign), employment status (employed, unemployed, not in the labor force), household income quintile (Q1 lowest through Q5 highest, per CASEN's "qaut" variable), multidimensional poverty status (yes/no), and geographic region (1 = Tarapacá through 16 = Ñuble). [Table 1](#) provides full definitions and coding details for each variable included in our models.

Table 2. Food insecurity, overcrowding and covariates by gender.

Variable	Overall N = 58 615 ^a	Gender		p-value ^b
		Man N = 26 465 ^a	Woman N = 32 150 ^a	
Food Insecurity Score (FI)	1.45 (2.30)	1.20 (2.14)	1.65 (2.41)	<0.001
FI: Moderate or Severe	9 833 (17%)	3 541 (13%)	6 292 (20%)	<0.001
FI: Any Level	20 647 (35%)	8 035 (30%)	12 612 (39%)	<0.001
Overcrowding (continuous)	1.10 (0.62)	1.08 (0.59)	1.11 (0.64)	<0.001
Binary Indicator of Overcrowding	2 128 (3.6%)	821 (3.1%)	1 307 (4.1%)	<0.001
Binary Indicator of Severely Overcrowded	2 573 (4.4%)	979 (3.7%)	1 594 (5.0%)	<0.001
Overcrowding Categories (PPB)				<0.001
No overcrowding (<2.5 PPB)	56 487 (96%)	25 644 (97%)	30 843 (96%)	
Medium overcrowding (2.5 to 3.49 PPB)	1 705 (2.9%)	668 (2.5%)	1 037 (3.2%)	
High overcrowding (3.5 to 4.99 PPB)	343 (0.6%)	129 (0.5%)	214 (0.7%)	
Critical overcrowding (≥5 PPB)	80 (0.1%)	24 (<0.1%)	56 (0.2%)	
Age Group				<0.001
18–24	1 128 (1.9%)	454 (1.7%)	674 (2.1%)	
25–44	17 157 (29%)	7 324 (28%)	9 833 (31%)	
45–64	22 993 (39%)	10 577 (40%)	12 416 (39%)	
65+	17 337 (30%)	8 110 (31%)	9 227 (29%)	
Ethnic Identity	50 777 (87%)	23 043 (87%)	27 734 (86%)	0.004
Nationality				<0.001
Native	55 541 (95%)	24 975 (94%)	30 566 (95%)	
Foreign	3 074 (5.2%)	1 490 (5.6%)	1 584 (4.9%)	
Employment Status				<0.001
Employed	34 356 (59%)	18 265 (69%)	16 091 (50%)	
Unemployed	2 178 (3.7%)	878 (3.3%)	1 300 (4.0%)	
Not in the labor force	22 081 (38%)	7 322 (28%)	14 759 (46%)	
Quintile Income				<0.001
Q1 Lowest	15 015 (26%)	5 394 (20%)	9 621 (30%)	
Q2	13 056 (22%)	5 231 (20%)	7 825 (24%)	
Q3	11 663 (20%)	5 283 (20%)	6 380 (20%)	
Q4	10 699 (18%)	5 669 (21%)	5 030 (16%)	
Q5 Highest	8 182 (14%)	4 888 (18%)	3 294 (10%)	
Zone				<0.001
Rural	12 097 (21%)	6 572 (25%)	5 525 (17%)	
Urban	46 518 (79%)	19 893 (75%)	26 625 (83%)	
Multidimensional Poverty				0.11
No Poverty	48 948 (85%)	22 183 (85%)	26 765 (85%)	
Poverty	8 763 (15%)	3 890 (15%)	4 873 (15%)	
Region				<0.001
1 Region de Tarapacá	2 382 (4.1%)	1 009 (3.8%)	1 373 (4.3%)	
2 Region de Antofagasta	2 433 (4.2%)	1 096 (4.1%)	1 337 (4.2%)	
3 Region de Atacama	2 564 (4.4%)	1 116 (4.2%)	1 448 (4.5%)	
4 Region de Coquimbo	2 412 (4.1%)	1 109 (4.2%)	1 303 (4.1%)	
5 Region de Valparaíso	5 766 (9.8%)	2 570 (9.7%)	3 196 (9.9%)	
6 Region del Libertador Gral. Bernardo O'Higgins	4 087 (7.0%)	1 817 (6.9%)	2 270 (7.1%)	
7 Region del Maule	4 226 (7.2%)	1 921 (7.3%)	2 305 (7.2%)	
8 Region del Biobío	5 871 (10%)	2 694 (10%)	3 177 (9.9%)	
9 Region de La Araucanía	3 824 (6.5%)	1 674 (6.3%)	2 150 (6.7%)	
10 Region de Los Lagos	2 984 (5.1%)	1 332 (5.0%)	1 652 (5.1%)	
11 Region de Aysén del Gral. Carlos Ibáñez del Campo	1 274 (2.2%)	562 (2.1%)	712 (2.2%)	
12 Region de Magallanes y de la Antártica Chilena	1 561 (2.7%)	734 (2.8%)	827 (2.6%)	
13 Region Metropolitana de Santiago	10 846 (19%)	4 990 (19%)	5 856 (18%)	
14 Region de Los Ríos	3 290 (5.6%)	1 595 (6.0%)	1 695 (5.3%)	
15 Region de Arica y Parinacota	2 318 (4.0%)	964 (3.6%)	1 354 (4.2%)	
16 Region de Ñuble	2 777 (4.7%)	1 282 (4.8%)	1 495 (4.7%)	

^aMean (SD); n (%).^bWilcoxon rank sum test; Pearson's Chi-squared test.

Table 3. Household overcrowding indicators by food insecurity status (moderate/severe and any level).

Variable	FI Moderate/Severe			p-value ^b
	Overall N = 58 615 ^a	No N = 48 782 ^a	Yes N = 9 833 ^a	
Overcrowding (People per Bedroom)	1,10 (0.62)	1,07 (0.58)	1,26 (0.74)	<0.001
Binary Indicator of Overcrowding	2 128 (3.6%)	1 396 (2.9%)	732 (7.4%)	<0.001
Binary Indicator of Severely Overcrowded	2 573 (4.4%)	1 656 (3.4%)	917 (9.3%)	<0.001
Overcrowding Level (Categorical)				<0.001
No overcrowding (<2.5 PPB)	56 487 (96%)	47 386 (97%)	9 101 (93%)	
Medium overcrowding (2.5 to 3.49 PPB)	1 705 (2.9%)	1 145 (2.3%)	560 (5.7%)	
High overcrowding (3.5 to 4.99 PPB)	343 (0.6%)	205 (0.4%)	138 (1.4%)	
Critical overcrowding (≥5 PPB)	80 (0.1%)	46 (<0.1%)	34 (0.3%)	
Variable	FI Any Level			p-value ^b
	Overall N = 58 615 ^a	No N = 37 968 ^a	Yes N = 20 647 ^a	
Overcrowding (People per Bedroom)	1,10 (0.62)	1,03 (0.57)	1,22 (0.68)	<0.001
Binary Indicator of Overcrowding	2 128 (3.6%)	928 (2.4%)	1 200 (5.8%)	<0.001
Binary Indicator of Severely Overcrowded	2 573 (4.4%)	1 104 (2.9%)	1 469 (7.1%)	<0.001
Overcrowding Level (Categorical)				<0.001
No overcrowding (<2.5 PPB)	56 487 (96%)	37 040 (98%)	19 447 (94%)	
Medium overcrowding (2.5 to 3.49 PPB)	1 705 (2.9%)	757 (2.0%)	948 (4.6%)	
High overcrowding (3.5 to 4.99 PPB)	343 (0.6%)	132 (0.3%)	211 (1.0%)	
Critical overcrowding (≥5 PPB)	80 (0.1%)	39 (0.1%)	41 (0.2%)	

^aMean (SD); n (%).^bWilcoxon rank sum test; Pearson's Chi-squared test.

Data Analysis

All analyses were conducted in R 4.2 (R Core Team, 2022) using the survey package²⁸ to account for CASEN's complex design (strata, clustering, and sampling weights). We began by generating weighted descriptive statistics for FIES scores, overcrowding categories, and covariates, with results presented in Table 1. Next, we mapped regional prevalence of food insecurity and overcrowding and calculated Spearman's rank correlation to quantify the co-distribution of these two dimensions across Chile's 16 regions. For visual clarity, choropleth maps are arranged side by side in Figure 1, and regional scatterplots of overcrowding versus food insecurity prevalence are in Figure 2. In multivariable modeling, we fitted survey-weighted logistic regression to estimate odds ratios (OR) and 95% confidence intervals (CI) for moderate – severe food insecurity associated with each overcrowding category, using “no overcrowding” as the referent. All models were simultaneously adjusted for the full set of covariates listed above. In the supplementary material to estimate prevalence ratios for food insecurity, we employed multivariate Poisson regression models, which are particularly suited for infrequent events and cross-sectional study designs.³¹ Model fit and potential collinearity were assessed via design-based Wald tests and variance inflation factors. Statistical significance was determined using a threshold of $p < .05$ and 95% confidence intervals.

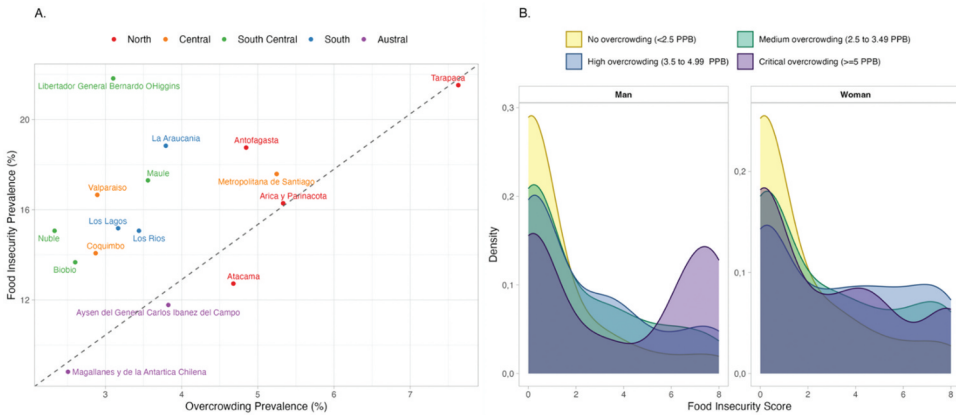


Figure 1. Overcrowding and food insecurity in Chile. **Note:** Panel A Scatterplot of regional prevalence rates (% of households) of overcrowding (x-axis) versus food insecurity (y-axis), colored by macrozone (North, Central, South Central, South, Austral), with a 45° reference line indicating equal prevalence. Panel B Kernel-density distributions of household food insecurity scores, stratified by four overcrowding levels (No overcrowding, Medium, High, Critical) and gender (Men vs. Women).

Results

The prevalence of food insecurity is significantly higher among women (18%) compared to men (13%) (see Table 2). Figure 1 illustrates that households without overcrowding have lower levels of food insecurity, whereas in higher overcrowding groups, the distribution of food insecurity shifts toward higher values, as indicated by the rightward skew in the figure.

At the regional level, Figure 1 reveals a positive correlation between the prevalence of food insecurity and overcrowding; Spearman's rank correlation rho was 0.44 ($p = .087$). Regions with higher overcrowding (OV) rates tend to exhibit greater food insecurity (FI) prevalence (Tarapacá 7.6% OV and 21.5% FI; Antofagasta 4.9% OV and 18.8% FI, and Metropolitana 5.3% OV and 17.6% FI, respectively). See Figure 2. Notably, Tarapacá (North) shows the highest prevalence of both food insecurity and overcrowding, whereas Magallanes and Antártica Chilena (Austral) report the lowest prevalence for both indicators (2.5% OV and 8.8% FI).

A. Map of food insecurity prevalence (%) in each municipality, defined as the percentage of households with a Food Insecurity Severe Experience. B. Map of overcrowding prevalence (%) in each municipality, defined as the percentage of households with more than 1 person per bedroom (PPB > 2.5). In Table 3 observed household overcrowding indicators by food insecurity status (moderate/severe and any level).

The multivariate logistic regression model (see Table 4) shows that after controlling for a comprehensive sociodemographic covariate, the positive association between household overcrowding and moderate – severe food

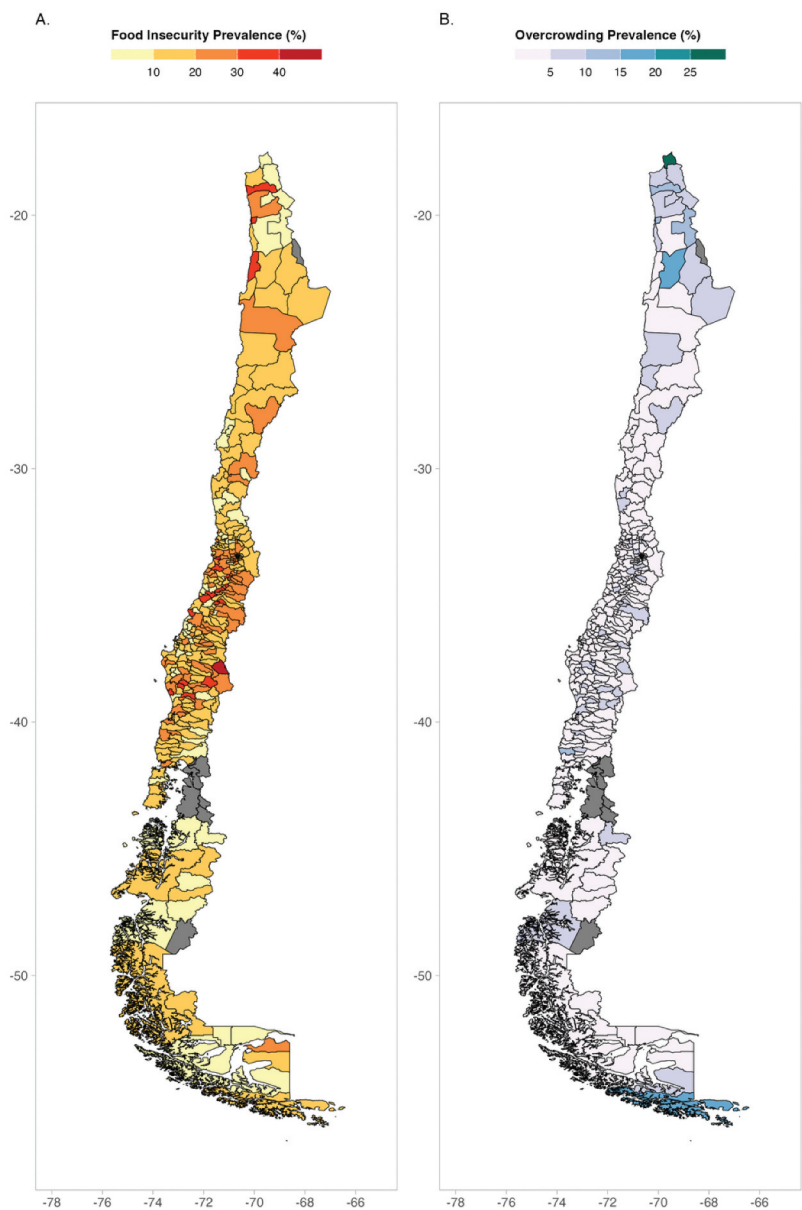


Figure 2. Spatial distribution of food insecurity and overcrowding prevalence by municipality.

insecurity remained substantial and statistically robust. In the standard survey-weighted logistic model, medium-level overcrowding (2.5–3.49 persons per bedroom) was linked to a 14% increase in the odds of food insecurity (OR 1.14; 95% CI 1.02–1.28; $p = .03$), while high overcrowding (3.5–4.99) conferred 31% higher odds (OR 1.31; 95% CI 1.04–1.65; $p = .02$) relative to non-overcrowded households. Although the point estimate for critical overcrowding (≥ 5 persons/bedroom) was of similar magnitude (OR 1.19), it did not

Table 4. Associations between overcrowding and food insecurity (OR [95% CI]).

	Weighted model					Complex design model				
	95% CI					95% CI				
	OR	SE	Low	High	p-value	OR	SE	Low	High	p-value
Overcrowding Categories										
(Ref. No overcrowding <2.5 PPB)										
Medium overcrowding (2.5 to 3.49 PPB)	1.14	0.06	1.02	1.28	0.03	1.14	0.09	0.96	1.35	0.13
High overcrowding (3.5 to 4.99 PPB)	1.31	0.12	1.04	1.65	0.02	1.36	0.18	0.95	1.96	0.09
Critical overcrowding (≥5 PPB)	1.19	0.24	0.74	1.90	0.47	1.14	0.35	0.57	2.28	0.71
Gender (Ref. Man)										
Woman	1.30	0.03	1.24	1.37	0.00	1.28	0.03	1.19	1.36	0.00
Age Group (Ref. 18–24)										
25–44	0.96	0.08	0.82	1.13	0.61	0.93	0.12	0.73	1.18	0.56
45–64	0.96	0.08	0.83	1.13	0.65	0.91	0.12	0.72	1.15	0.43
65+	0.48	0.08	0.41	0.57	0.00	0.44	0.13	0.34	0.56	0.00
Ethnic Identity (Ref. No)										
Yes	0.80	0.03	0.75	0.86	0.00	0.81	0.05	0.73	0.88	0.00
Nationality (Ref. Native)										
Foreign	1.65	0.05	1.50	1.82	0.00	1.63	0.07	1.42	1.87	0.00
Employment Status (Ref. Employed)										
Unemployed	1.51	0.05	1.37	1.68	0.00	1.43	0.07	1.24	1.65	0.00
Not in the labor force	0.93	0.03	0.88	0.99	0.03	0.94	0.04	0.87	1.02	0.13
Quintile Income (Ref. Q1 Lowest)										
Q2	0.67	0.03	0.63	0.71	0.00	0.65	0.04	0.60	0.70	0.00
Q3	0.43	0.04	0.40	0.46	0.00	0.43	0.05	0.39	0.47	0.00
Q4	0.31	0.04	0.29	0.34	0.00	0.30	0.05	0.27	0.33	0.00
Q5 Highest	0.12	0.06	0.11	0.14	0.00	0.11	0.09	0.09	0.13	0.00
Zone (Ref. Rural)										
Urban	1.32	0.03	1.24	1.40	0.00	1.24	0.04	1.15	1.34	0.00
Multidimensional Poverty (Ref. No poverty)										
Poverty	1.91	0.03	1.81	2.03	0.00	1.82	0.04	1.68	1.97	0.00
Region (Ref. 1 Region de Tarapacá)										
2 Region de Antofagasta	1.11	0.08	0.95	1.29	0.19	1.12	0.10	0.93	1.36	0.23
3 Region de Atacama	0.67	0.08	0.57	0.79	0.00	0.64	0.10	0.53	0.77	0.00
4 Region de Coquimbo	0.77	0.08	0.65	0.90	0.00	0.75	0.10	0.62	0.91	0.00
5 Region de Valparaíso	0.95	0.07	0.84	1.09	0.50	0.95	0.08	0.82	1.11	0.51
6 Region del Libertador Gral. Bernardo O'Higgins	1.52	0.07	1.33	1.74	0.00	1.39	0.08	1.19	1.63	0.00
7 Region del Maule	1.03	0.07	0.90	1.19	0.66	0.94	0.08	0.80	1.10	0.45
8 Region del Biobío	0.78	0.07	0.68	0.89	0.00	0.74	0.08	0.64	0.86	0.00
9 Region de La Araucanía	0.98	0.07	0.85	1.13	0.76	0.94	0.08	0.80	1.10	0.44
10 Region de Los Lagos	0.80	0.08	0.68	0.93	0.00	0.78	0.09	0.65	0.93	0.00
11 Region de Aysén del Gral. Carlos Ibáñez del Campo	0.72	0.11	0.58	0.89	0.00	0.73	0.15	0.54	0.99	0.04
12 Region de Magallanes y de la Antártica Chilena	0.63	0.11	0.51	0.78	0.00	0.60	0.12	0.47	0.76	0.00
13 Region Metropolitana de Santiago	1.21	0.06	1.07	1.36	0.00	1.17	0.07	1.02	1.35	0.03
14 Region de Los Ríos	0.87	0.07	0.75	1.01	0.07	0.83	0.09	0.70	0.98	0.03
15 Region de Arica y Parinacota	0.74	0.08	0.63	0.87	0.00	0.76	0.10	0.62	0.92	0.00
16 Region de Ñuble	0.82	0.08	0.70	0.96	0.01	0.82	0.09	0.69	0.97	0.02

Models estimate odds ratios (OR) and 95% confidence intervals (CI) for the association between overcrowding and food insecurity (binary outcome: FIES ≥ 4). Adjusted for sex, age group, ethnic identity, nationality, employment status, income quintile, urban/rural zone, multidimensional poverty, and region. The first six columns present results from a standard (weighted) logistic regression; the last six columns use a survey-sampling design in a weighted GLS estimator. Reference categories are indicated in parentheses. Significant associations at $p < .05$ are highlighted in bold. CI = confidence interval. Estimates from survey-weighted logistic regression models.

reach statistical significance. Results were nearly identical under the complex-design survey model, underscoring the robustness of this relationship. Among individual characteristics, being female (OR 1.30; 95% CI 1.24–1.37), unemployed (OR 1.51; 95% CI 1.37–1.68), foreign-born (OR 1.65; 95% CI 1.50–1.82), and residing in an urban area (OR 1.32; 95% CI 1.24–1.40) each independently elevated the risk of food insecurity, whereas older adults (65+) and higher income quintiles demonstrated strong protective effects. Finally, multidimensional poverty nearly doubled the likelihood of experiencing food insecurity (OR 1.91; 95% CI 1.81–2.03). These findings highlight that overcrowding at home alongside broader socioeconomic vulnerabilities is a key determinant of food insecurity in Chile.

Figure 3 illustrates the relationship between food insecurity (FI) and housing overcrowding across Chilean regions. Regions shaded in darker red represent a stronger correlation between FI and overcrowding, while lighter shades indicate weaker relationships. The map aligns with previous findings, highlighting significant regional disparities. In the northern regions, such as Tarapacá. The relationship between FI and overcrowding is most pronounced

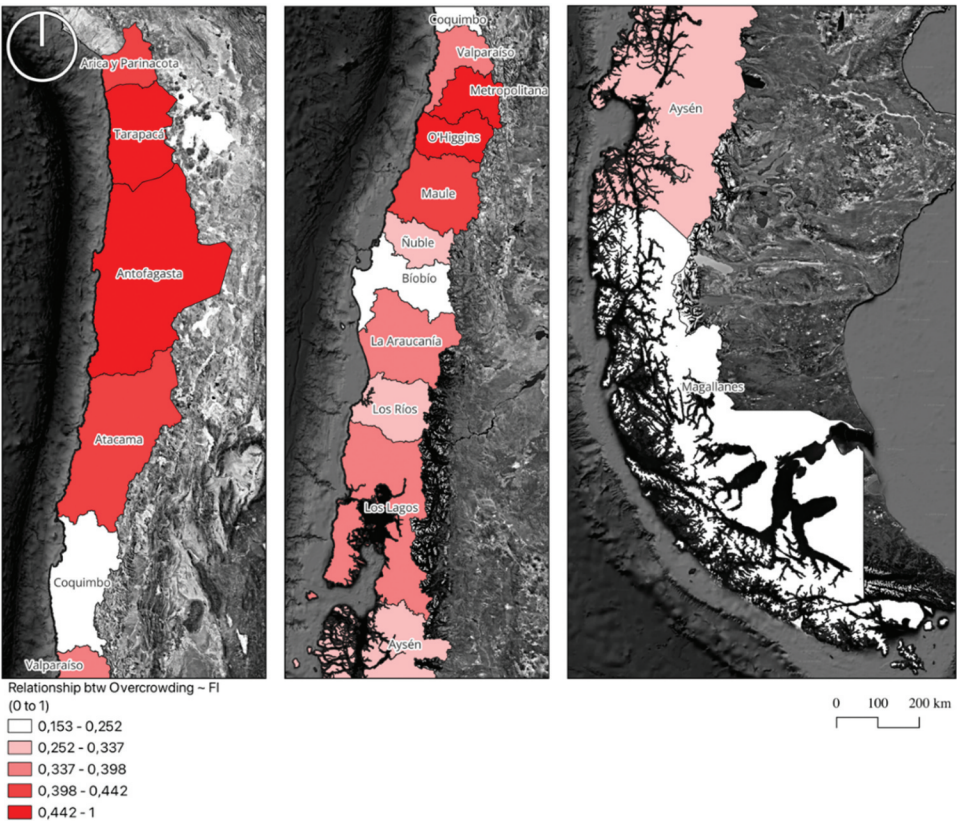


Figure 3. Relationship between food insecurity (FI) and housing overcrowding across Chilean regions.

in Antofagasta and Atacama, represented by the darkest red shading. These regions exhibit high overcrowding prevalence and elevated levels of FI consistent with their socioeconomic challenges and limited access to affordable housing and nutritious food.

In contrast, the southern regions, including Magallanes and Aysén, show the weakest correlations, with lighter shades of red or white. These regions have lower overcrowding and less severe FI, reflecting better housing conditions and food accessibility. The map supports the broader trend observed in scatter plots and regression models, where regions with greater overcrowding tend to experience higher FI prevalence.

Discussion

Food insecurity is a persistent public health issue linked to overcrowding, household income, and regional differences across the country. Numerous studies demonstrate that socioeconomic status and demographic factors are key predictors of food insecurity.^{5,32,33} For instance, a cross-sectional study in Tehran found a significant association between food insecurity and household income (OR = 2.744, 95% CI = 1.100–6.846), echoing trends observed in this study (OR = 0.75, 95% CI = 0.69–0.82 for low income).⁵ Similarly, in Puerto Rico, 40% of low-income households were classified as food insecure,³² while in Alagoas, Brazil, 58.3% of households experienced food insecurity, with 7.3% classified as severe.³⁴ However, while low income consistently predicts food insecurity, higher income does not guarantee food security, as income may inadequately capture the complexity of household economic circumstances, including debt burden, housing costs, and irregular income patterns.³⁵ In this sense, we found that household overcrowding is associated with food insecurity independently of household income, which suggests additional mechanisms are involved in the relationship between economic status and food insecurity.

Recent research during the COVID-19 pandemic has underscored the public health implications of overcrowded housing, which was linked to increased transmission and mortality rates.³⁶ Overcrowding reflects broader socioeconomic challenges and often intensifies health inequities. Low-income households and ethnic minority groups are particularly vulnerable to overcrowding, perpetuating cycles of disadvantage.³⁷ Overcrowding is deeply connected to social and health disparities, its relationship with societal concerns is complex and multifaceted, requiring nuanced and context-specific interventions. Indeed, the current study highlighted that food insecurity and household overcrowding are highly heterogeneous across the country, and the correlation between both variables depends on the region.

Regions such as Tarapacá, Antofagasta and Atacama exhibit the strongest correlations, reflecting the compounded vulnerabilities of areas marked by

economic inequality and inadequate housing infrastructure. These findings resonate with prior discussions emphasizing the role of socioeconomic disparities and structural inequities in shaping food insecurity.³⁸ Overcrowding in these regions not only exacerbates the physical and mental health challenges associated with food insecurity but also reflects broader systemic issues, such as economic marginalization and limited access to affordable housing.³⁹ Conversely, Southern regions like Aysén and Magallanes show weaker correlations, likely due to lower population density and better housing access.⁴⁰ This spatial differentiation highlights the nuanced nature of food insecurity, where geographical and social contexts intersect to create uneven vulnerabilities. The observed patterns reinforce the need for targeted, region-specific policies that address the structural drivers of both food insecurity and overcrowding, moving beyond reactive measures to rights-based, systemic interventions. Moreover, the findings suggest that addressing overcrowding as a determinant of food insecurity could yield broader public health benefits, particularly in urbanized and economically disadvantaged regions. This approach would integrate housing policy with food justice frameworks, fostering more equitable outcomes.

Concerning other social determinants, such as gender and age, we found that more women report food insecurity. However, these differences do not remain when adjusted by household income levels, suggesting that social inequalities in income explain it. Then, this study corroborates findings that women are at greater risk of experiencing food insecurity, aligning with prior research highlighting the adverse conditions women face, such as challenges in employment, social networks, and the burden of household responsibilities, which undermine gender equity and heighten their vulnerability to food insecurity.^{41,42} Concerning age, we found 65+ age group had a negative association, which is unexpected considering older people face unique challenges, including physical and functional limitations that affect their ability to prepare, consume, and absorb food.⁴³ However, we adjusted for household income and overcrowding related to living alone or lacking support.^{43,44}

Limitations and future research

This study has some limitations. First, the CASEN dataset restricts the analysis to self-reported measures and survey design constraints, which may introduce reporting biases. For example, people chronically exposed to food insecurity could find it more challenging to identify a lack of food quality. Secondly, the regional scope does not fully capture the localized dynamics of FI and overcrowding at finer territorial levels, such as neighborhoods or municipalities, which limits the scalability of findings to targeted policy interventions at smaller spatial levels. Thirdly, the cross-

sectional design impedes the ability to infer causality, underscoring the need for longitudinal data to understand these social determinants' temporal dimensions better.

Despite these constraints, this research provides valuable findings. The survey has national and regional representativeness, and analysis included survey weights to get more robust descriptive and inferential statistics. Multivariate regression model allows to test if gender and age differences are associated with food insecurity independently of the household income, aligning with global evidence on food insecurity's gendered and socioeconomic dimensions. The regional analysis provides actionable insights for policymakers, particularly in northern Chile, where high levels of FI and overcrowding co-occur, calling for targeted, integrated interventions that simultaneously address housing and food access.

The study presents a valuable contribution to understanding the relationship between food insecurity (FI) and overcrowding as social determinants of health in Chilean urban households, yet it opens several avenues for further research. Future studies could investigate the causal mechanisms underlying the relationship between overcrowding and FI, exploring how the spatial concentration of poverty exacerbates these conditions. Additionally, comparative research across rural and urban settings and longitudinal designs would allow for more comprehensive insights into how these determinants evolve. Including qualitative approaches could also enrich our understanding of the lived experiences of affected populations, providing contextual depth to the quantitative findings.

Conclusion

This study highlights the interconnection between food and housing as human rights and social determinants of health. People in overcrowded households face increased food insecurity risk regardless of income, yet home environments have received less attention than public spaces, neighborhoods, or cities in policy discourse. Food insecurity and overcrowding disproportionately affect populations across regions, emphasizing the need to understand geographical inequalities. This research advocates intersectoral, rights-based approaches rather than reactive food relief programs. By identifying overcrowding as a food insecurity determinant, we argue for housing policies that address interconnected vulnerabilities. Effective interventions require coordinated governance, recognizing households as focal points where improvements in housing, food security, and service access can benefit all members.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

Original data resources and codes are listed in the repository: https://github.com/JDConejeros/FOOD_INSECURITY_2025.

Author Contributions

GG-M: Writing – review & editing. Writing – original draft. Conceptualization. Methodology. Formal Analysis; LL-D: Writing – review & editing. Writing – original draft. Conceptualization. Project administration; FV-P: Writing – review & editing. Writing – original draft. Conceptualization. Methodology; Formal Analysis; JD-C: Writing. Methodology. Formal Analysis.

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