



Magnitude and spatial distribution of food and nutrition security during the COVID-19 pandemic in Tucumán (Argentina)

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Abstract

Objective: To describe the magnitude and spatial distribution of household food and nutrition security (FNS) during the COVID-19 pandemic in Tucumán (Argentina) and identify factors associated with food insecurity.

Methods: During April and May 2020 a cross-sectional quantitative study was performed. Data from 3915 households were analyzed. The study of FNS was performed with the Latin American and Caribbean Scale for Food Security. To identify associated factors, bivariate and multivariate logistic regression models were applied.

Results: Household food insecurity affected 55.9% of the sample (mild: 39.3%, moderate: 10.8%, severe: 5.8%). Analyzing the spatial distribution, the eastern area showed the highest food insecurity prevalence, followed by the south and west areas. Logistic regression analysis showed that household food insecurity varied according to household size, presence of children, socioeconomic status, and health area of residence.

Conclusions: Household size, presence of children, socioeconomic status and public health area of residence were associated to household food insecurity. The perception of hunger was higher in larger households, in those with low and medium socioeconomic status and in households located in the southern area of the province.

1 | INTRODUCTION

The food and nutrition security (FNS) concept refers to the right of all people to a regular and permanent physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO-FIDA-OMS-PMA-UNICEF, 2019). Although Argentina meets almost all the requirements for FNS (sufficiency, stability in production, sustainability, and autonomy in relation to external supply), access to sufficient, safe, and nutritious food is far from being real for many people countrywide (Ortale & Santos, 2020).

In addition, the implications of the current COVID-19 pandemic on FNS should be considered. According to Ribeiro-Silva et al. (2020), two dimensions should be examined when addressing the food- and nutrition-related challenges of the pandemic. One refers to the processes of availability (production, sale and access to food) and the other is more directly concerned with the choice, preparation, and consumption of food and its relationship with health. In Argentina, both dimensions were affected by the global virus pandemic, whose control remains the greatest challenge in a context of social disparities and historical deficiencies (Comisión de Ciencias Sociales de la Unidad Coronavirus COVID-19, 2020).

During March 2020, a policy of social, preventive, and mandatory isolation (SPMI) was implemented in order to avoid transmission of COVID-19. This measure affected the social dynamics and economies of several Argentinian households (HHs), since many activities were disrupted and lots of people lost their jobs, with consequent impact on the access to essential goods and services. In combination, the SPMI, employment instability, and reduced family income had a negative impact on

food access, worsening the quality of eating patterns and increasing perceived hunger.

In other words, the COVID-19 pandemic contributed to the existing FNS and health problems of many Argentinians, particularly the most socially and economically vulnerable populations (Comisión de Ciencias Sociales de la Unidad Coronavirus COVID-19, 2020).

This study of food and nutrition insecurity (FNI) at HH level analyzes perceptions of everyday life, such as

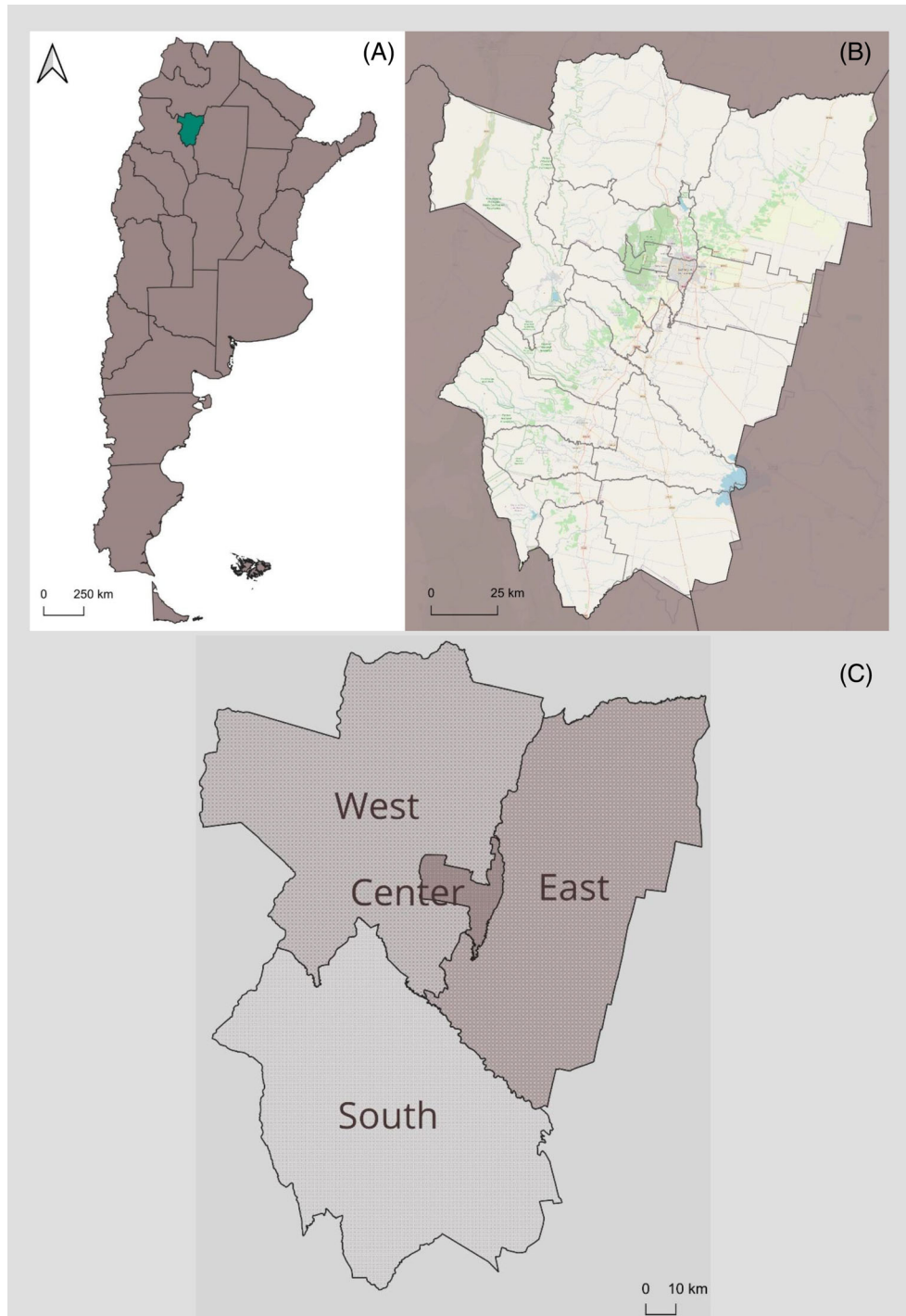


FIGURE 1 Study area. (A) Province of Tucumán in the national context. (B) Political-administrative division of Tucumán: departments and natural context. (C) Health areas in Tucumán.

Source: Own elaboration on the basis of cartography provided by <https://www.openstreetmap.org>, INDEC (2010) and Ministry of Health of the province of Tucumán (2009)

the lack of resources for food access and the implementation of domestic strategies such as monotonous diets, smaller portion sizes, and reduced number of rations consumed daily by HH members. Severe FNI has been recognized as perceived hunger, and it occurs when the food intake of HHs with children and adolescents is reduced and their normal eating patterns are disrupted because of the lack of resources for food access (Food and Agriculture Organization of the United Nations [FAO], 2011).

A recent study conducted in the metropolitan area of Buenos Aires (the largest province in Argentina) reporting the socioeconomic impact of the COVID-19 pandemic indicated that the prevalence of food insecure HH with children increased from 26% to 30% between 2019 and 2020, while perceived hunger rose almost nine percentage points, from 6.5% in 2019 to 15.2% in 2020 (Tuñón & Sánchez, 2020). These results show not only that many food secure HHs became food insecure during the pandemic, but also that deprivation was even more severe in previously food insecure HHs. Since that study was limited only to only one urban region in Argentina, the situation in other populations of the country is still unknown.

The purpose of this study was to analyze FNS in Tucumán, a province located in the northwest of Argentina (Figure 1). In a previous research, Cordero and Cesani (2020) reported that during the first months of SPMI, FNS compromised half of the HHs in Gran San Miguel de Tucumán, the largest urban agglomeration in the province. Considering that Tucumán shows an accentuated territorial fragmentation manifested by social, demographic, economic and health inequalities (Bolsi & Paolasso, 2009; Ortale & Santos, 2020; Velázquez, 2016), in this study we focused on (a) describing the magnitude and analyzing the spatial distribution of FNS in the whole province of Tucumán during the COVID-19 pandemic, and (b) identifying FNI-associated factors in HHs, giving special attention to severe FNI (perceived hunger).

2 | MATERIALS AND METHODS

2.1 | Study area

Tucumán (27°00'S 65°30'O) is the smallest (22 524 km²) and most densely populated (64 inhabitants/km²) province of Argentina (Instituto Nacional de Estadísticas y Censos -INDEC-, 2010) (Figure 1A). It is located in the *Norte Grande Argentino*, a region which concentrates the worst quality-of-life conditions, the lowest literacy rates, the highest infant mortality rates, and the highest poverty rates in the country (Bolsi & Paolasso, 2009; Cordero & Cesani, 2019; INDEC, 2010; Velázquez, 2016).

A diversity of ecoregions promotes agro-industrial activities (Figure 1B). These include the production of industrial derivatives of lemon and other fruits (avocado, strawberries and blueberries), sugar, ethanol, and grains (maize, sorghum, soybeans and wheat), which position the province as one of the most important agro-industrial jurisdictions of the region (Calzada et al., 2018).

Despite the diversity of its economic activities, the province is unable to improve the structural conditions of deprivation that affect an important sector of the population (Osatinsky, 2016). This could be associated with the productive profile, which historically has a low participation of industry and commerce, while activities related to the state represent more than 25% of the provincial productive profile. Likewise, Osatinsky (2016) explains that the absence of structural transformations that allow economic development and the insufficiency of jobs lead to a large part of the population being excluded from the productive structure and, therefore, affected by poverty.

The province is divided into 17 departments (Figure 1B) with administrative functions, and four health areas (HAs): central, west, east and south (Figure 1C). These HAs represent a health care model based on the primary health care strategy that pursues equity in the access to public health (Honorable Legislatura de Tucumán, 2004). The four HAs manage health resources in their areas of influence. In this study, FNS was analyzed in terms of HA.

2.2 | Study design, population and sample

A cross-sectional quantitative study was performed. The units of analysis were HHs, defined as the group of people living together and sharing food expenses. According to the number of HHs in the province (310837) and considering a maximum variance assumption ($p \times q = .25$) for a binomial distribution with 3% resolution and 99% confidence level, the required sample was 1833 HHs. A stratified sampling was also carried out considering the number of HHs in each HA.

2.3 | Instruments and procedure

Data were collected during April and May 2020 using an *ad hoc* questionnaire designed with digital resources (Google Forms). The instrument included an introduction section with the objectives of the study and requesting informed consent from participants (>18 years).

The administration of the electronic survey was based on qualitative methodologies. Key community informants (i.e., educational and health leaders, local media, non-governmental organizations, community leaders) were identified using snowball sampling. These *gatekeepers* promoted the spread of the survey and the participation of the population, thus validating the presence of researchers in the territory.

To describe FNS during the pandemic, participants were asked to answer the questionnaire since the beginning of the SPMI. The questionnaire included aspects related to the representative HH, such as age, gender, educational level and current employment status. The following variables were also collected: HH size (number of members), children (presence and number of persons under 18 years) and HH location. This last information was used to *bottom up* the HH in each HA (central, west, south or east).

The *Family Affluence Scale* was applied to estimate the HH socioeconomic status (SES). Using four closed questions, this instrument allows us to examine aspects concerned with purchasing power, classifying SES into low, medium, and high (Currie et al., 2008).

The analysis of FNS was performed with the *Latin American and Caribbean Scale for Food Security* (FAO, 2012). This instrument has been validated in different Latin American countries, including Argentina (Cordero & Cesani, 2020; Couceiro et al., 2015; Melgar-Quiñonez et al., 2010; Rosso et al., 2015). It contains 15 questions; the first eight are related to FNI situations of adults (over the age of 18) and the remaining questions involve situations that children or adolescents (under 18 years) may have experienced. The questions identify secure HH and mild, moderate or severe FNI.

These categories refer to the dimensions of food insecurity and its measurement based on the experience of households (FAO, 2012). According to the conceptual framework proposed by FAO, initially households perceive uncertainty and concern regarding access to food (mild FNI). Subsequently, the restrictions promote adjustments in the quality of the food and the diet is no longer varied (moderate FNI). When food insecurity becomes even more severe, the amount of food consumed decreases, food rations become smaller and some meals are even skipped. Initially, adults are the household members affected by food insecurity. In general, children are protected until amounts to food insecurity severity levels it is impossible to guarantee its supply (severe FNI). The latter category is also referred to as “perceived hunger” (FAO, 2012).

2.4 | Statistical analyses

A descriptive analysis of the variables was carried out to characterize HHs and the HH representatives. The

prevalence of FNI and confidence intervals (95% CI) were calculated. Binary logistic regression test (odds ratio) was used to identify associations between FNI and HH size, presence of children, SES and HA ($p < .01$). Finally, to identify severe FNI-associated factors (perceived hunger), a multivariate logistic regression model (adjusted odds ratio) was applied ($p < .01$) in covariates with p value $\leq .10$. The statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS) 25.0.

2.5 | Ethics

The research protocol was approved by the Ethics Committee of Research of CCT CONICET NOA Sur (Res. No 03/2020). The investigation was in accordance with the ethical standards instituted by the 1948 Universal Declaration of Human Rights, the 1947 Nuremberg Code, and the 1964 Helsinki Declaration and subsequent modifications, with particular attention to National Law 26 343 about protection of personal data.

3 | RESULTS

From 3945 surveys collected, 30 containing incomplete information were excluded; thus, 3915 surveys were included in the study. Of the total number of respondents, 74.9% were women, with a higher representation of the 30–39-year-old group (mean, 40.7 years, SD, 13.5). In addition, 39% of them had a university education and 45.1% were employed (Table 1).

The characteristics of HHs are presented in Table 2. As can be seen, they were composed of two to four persons (62.4%), five or more (29.5%), and 8.4% were single person HH. On average, four people (SD: 1.75) lived in half of the HH surveyed. The presence of children was observed in 52.5% of HH, with a mean of two children per HH. In addition, medium SES (42.9%) predominated, followed by HH with low (29.5%) and high (27.6%) SES.

The prevalence of FNI was 55.9%, distributed as follows: mild FNI was the most prevalent form (39.3%, CI: 37.75–40.82), followed by moderate (10.8%, CI: 9.86–11.80) and severe (5.8%, CI: 5.04–6.50) FNI.

Figure 2 shows the spatial distribution of food secure and food insecure HHs according to HAs. Except for the central area, the prevalence of FNI was higher than that of FNS in all HAs. The eastern area showed the highest FNI prevalence, followed by the south and west areas.

On the other hand, when the different levels of FNI were analyzed, it was observed that mild FNI was above 40% in all HAs, and that the south and east HA presented the highest prevalence of severe FNI (Figure 3).

TABLE 1 Characteristics of the participants in the present study, Tucumán, Argentina (2020)

	Frequency	Percentage
<i>Age (years)</i>		
20–29	917	23.4
30–39	1121	28.6
40–49	847	21.6
50–59	600	15.3
>60	430	11.0
<i>Gender</i>		
Male	977	25.0
Female	2932	74.9
Other	6	0.2
<i>Educational level</i>		
Without formal education	50	1.3
Primary complete	288	7.4
Secondary complete	1405	35.9
Tertiary complete	646	16.5
University	1526	39.0
<i>Employment status</i>		
Student	517	13.2
Formal worker	1765	45.1
Self-employed worker	694	17.7
Retired	304	7.8
Unemployed	386	9.9
Informal worker	249	6.4

Note: Own elaboration based on data from this study (2020).

Table 3 shows the results of binary logistic regression. It can be seen that FNI varied according to HH size, children, SES and HA (Table 3).

Finally, the Hosmer and Lemeshow Test for multivariate logistic regression model indicated an adequate goodness-of-fit ($p = .70$) and properly classified 94.2% of cases. The results indicated that the odds of severe FNI were significantly higher in HHs with the highest number of members, in HHs with low and medium SES, and among HHs located in the southern HA of the province (Table 4).

4 | DISCUSSION

The COVID-19 pandemic has not only produced a global health crisis, but also constitutes a challenge for developing countries. According to the Economic Commission for Latin America and the Caribbean (CEPAL), the negative crisis effects of the COVID-19 pandemic on food

TABLE 2 Characteristics of households, Tucumán, Argentina (2020)

	Frequency	Percentage
<i>Household size</i>		
Single person	329	8.4
2–4 persons	2439	62.4
5 or more persons	1147	29.2
<i>Presence of children</i>		
Presence	2054	52.5
Absence	1861	47.5
<i>Number of children</i>		
1	914	23.3
2	764	19.5
3 or more	376	8.2
<i>Socioeconomic status</i>		
Low	1155	29.5
Medium	1680	42.9
High	1080	27.6
<i>Health area</i>		
Central	2164	55.3
East	224	5.7
West	623	15.9
South	904	23.1

Note: Own elaboration based on data from this study (2020).

insecurity would be uneven and more intense in vulnerable countries, regions and population groups (CEPAL-FAO, 2020b).

In Argentina, the already documented chronic problem of FNI increased during the COVID-19 pandemic (Comisión de Ciencias Sociales de la Unidad Coronavirus COVID-19, 2020; Tuñón & Sánchez, 2020). Our results showed that 56% of HHs in Tucumán perceived FNI during the SPMI, largely exceeding the 20% reported at the beginning of the pandemic by Bonfiglio et al. (2020) in populations from Buenos Aires.

The magnitude of FNI in other countries of America during the pandemic is variable. For instance, food insecurity was perceived in 35% of HHs from Lima (Perú) (Saldaña Arévalo, 2020), while in the United States FNI prevalence ranged from 15% to 38% (Ahn & Norwood, 2020; Fitzpatrick et al., 2020). Beyond these differences, many authors agree that food insecurity has increased in relation to the pre-pandemic context (Adams et al., 2020; Bonfiglio et al., 2020; Niles et al., 2020; Saldaña Arévalo, 2020).

In this sense, and although the information available in Argentina is limited, previous reports indicate that

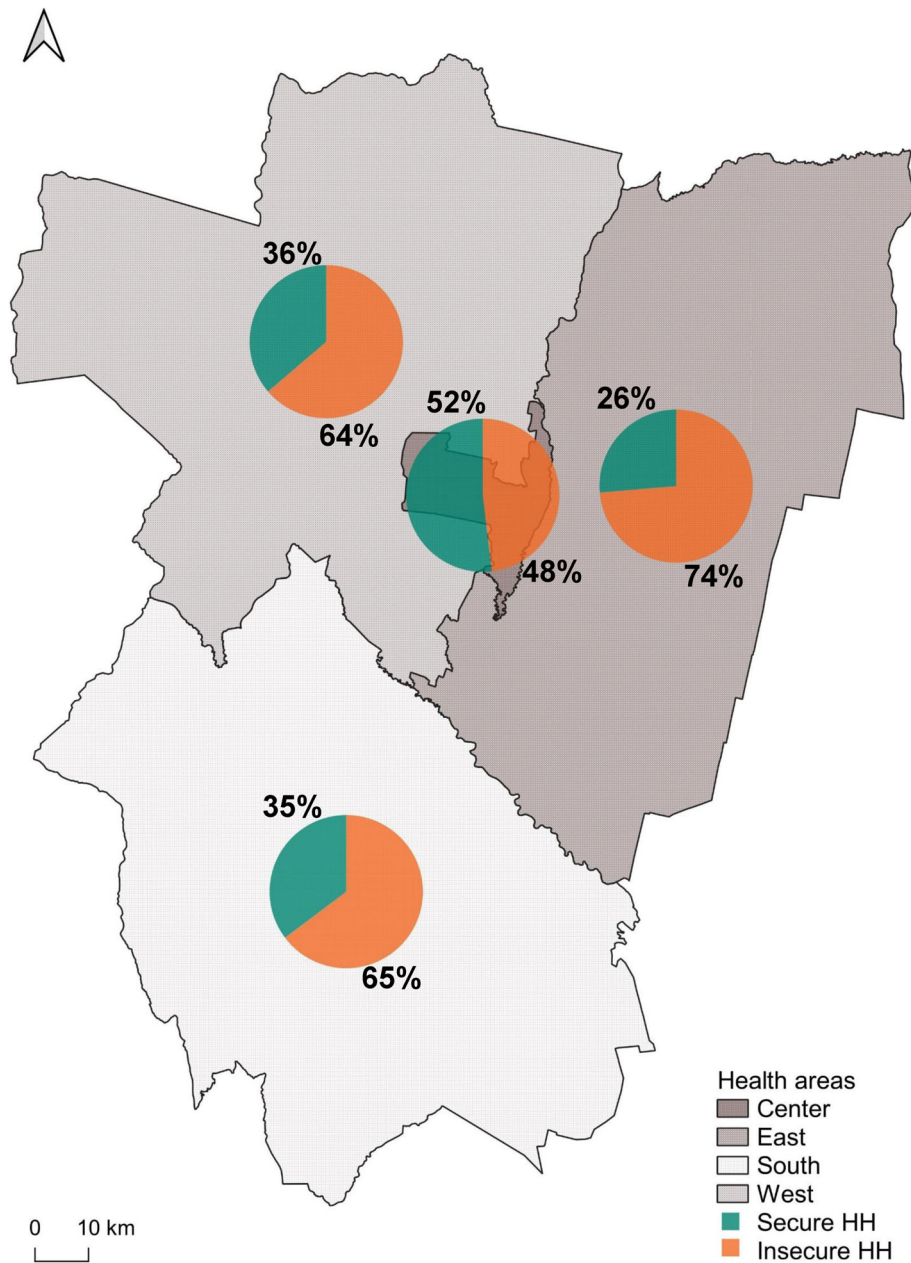


FIGURE 2 Food secure and food insecure households (HHs) distribution by health areas. Tucumán, Argentina (2020).

Source: own elaboration based on data from this study (2020) and cartography provided by the Ministry of Health of Tucumán Province (2009)

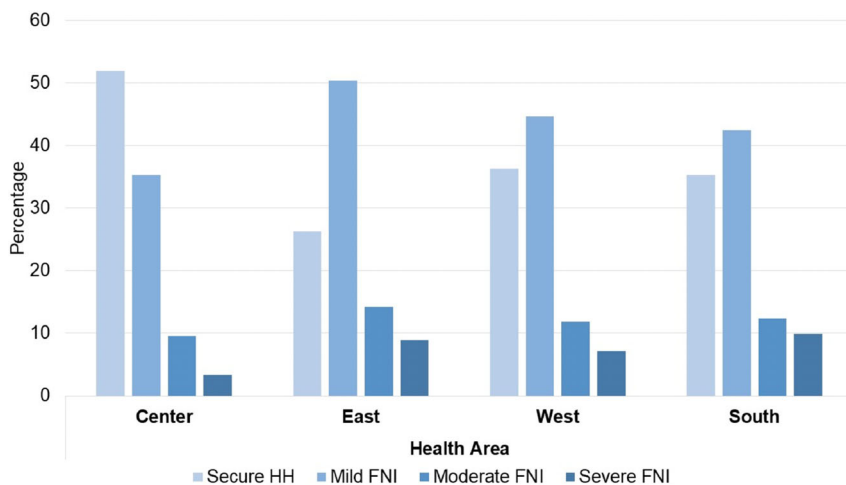


FIGURE 3 Food secure households (HHs) and food and nutrition insecurity (FNI) levels by health areas. Tucumán, Argentina (2020).

Source: own elaboration based on data from this study (2020)

food insecurity has experienced a constant increase since 2010, affecting 16.4% of HH in 2018 (Bonfiglio et al., 2019). That same year, another 6% of HHs suffered severe FNI, which means that they were unable to sustain child and adolescent feeding. Our results showed

that ~6% of HH perceived hunger, similar to the national figures reported in 2018 (Bonfiglio et al., 2019) but lower than those from Buenos Aires HHs during the pandemic (8.6%) (Bonfiglio et al., 2020).

TABLE 3 Factors associated with food and nutrition insecurity in the province of Tucumán, Argentina (2020)

Food and nutrition insecurity (n = 2188)			
	n	Odds ratio (95% CI)	p value
<i>Household size</i>	2188	1.14 (1.09–1.18)	.01
<i>Children</i>			
Absence ^a	934	-	
Presence	1254	1.56 (1.37–1.77)	.01
<i>Socioeconomic status</i>			
High ^a	407	-	
Medium	922	2.01 (1.72–5.75)	.01
Low	859	4.80 (4.01–5.75)	.01
<i>Health area</i>			
Central ^a	1041	-	
East	165	3.02 (2.22–4.11)	.01
West	397	1.89 (1.58–2.28)	.01
South	585	1.98 (1.69–2.32)	.01

Abbreviation: CI, confidence interval.

^aReference category. Source: own elaboration based on data from this study (2020).

The analysis of the spatial distribution of FNI in Tucumán revealed differences according to HA. Thus, while the Central HA (which includes the main urban agglomeration in the *Norte Grande Argentino* region) showed the lowest prevalence of food insecurity, the East and South HAs had the highest. The population that perceived hunger in these areas amounted to 10%. In this sense, geographic information systems are strategic resources that have shown their relevance during the COVID-19 pandemic (Rosenkrantz et al., 2020). In the current context, priority areas of action on FNI can also be identified and delimited.

The analysis of FNI-associated factors revealed that the odds of perceiving hunger were significantly higher in HH with the highest number of members, in HH with low and medium SES, and in those located in the southern HA of the province. It has been reported that the risk of FNI is positively associated with the number of HH members (Niles et al., 2020; Schwarts et al., 2019). The number of occupants and HH composition affect the methods of administration and expenditure of economic and food resources. In this study, the odds of severe FNI increased 1.1 times for each HH member, probably because the size of HH, increased during the SPMI as a byproduct of changing care strategies among family groups.

TABLE 4 Factors associated with severe food and nutrition insecurity in the province of Tucumán, Argentina (2020)

Severe food and nutrition insecurity (n = 226)					
	n	Odds ratio (95% CI)	p value	Adjusted odds ratio (95% CI)	p value
<i>Household size</i>	226	1.23 (1.15–1.33)	.01	1.11 (1.02–1.21)	.01
<i>Presence of children (under 18 years)</i>					
Absence ^a	77	-		-	
Presence	149	1.8 (1.36–2.39)	.01	1.06 (0.76–1.49)	.73
<i>Socioeconomic status</i>					
High ^a	7	-		-	
Medium	46	4.32 (1.94–9.60)	.01	3.93 (1.76–8.74)	.01
Low	173	27.01 (12.62–57.77)	.01	21.66 (10.04–45.58)	.01
<i>Health area</i>					
Central ^a	72	-		-	
East	20	2.85 (1.70–4.77)	.01	1.39 (0.82–2.39)	.22
West	45	2.26 (1.54–3.32)	.01	1.24(0.81–2.39)	.31
South	89	3.17 (2.30–4.37)	.01	1.79(1.27–2.51)	.01

Abbreviation: CI, confidence interval.

^aReference category. Source: own elaboration based on data from this study (2020).

On the other hand, the current results indicated that the odds of experiencing severe FNI were four times higher in HHs with medium SES than in those with high SES. The most disadvantaged situation was evidenced in low SES HHs, where the possibility of severe FNI increased 21 times. In these circumstances, the purchase of food represents a higher percentage in the family budget, and most nutritious and expensive foods (dairy, meat, fruits and vegetables, among others) are often replaced by cheaper food higher in saturated fats, sugar, sodium, and calories. In low SES HHs, this scenario further reduces the chances of achieving a balanced diet that includes fresh foods with antioxidant and immunomodulatory properties, necessary conditions to avoid possible COVID-19 complications (CEPAL-FAO, 2020a). Furthermore, economic difficulties, food insecurity, changes in consumption patterns and reduced physical activity can lead to higher levels of malnutrition, overweight, and obesity. These three conditions, which constitute the recognized global food syndemic, may increase the risk of adverse health outcomes. According to Huizar et al. (2020), the global food syndemic depends on an initial onset of food insecurity, its subsequent interplay with malnutrition and obesity, and the complex sequelae that increase vulnerabilities to modifiable adverse health outcomes.

From an ecological perspective, the southern region in Tucumán has the lowest SES and the worst environmental conditions of the province (Velázquez, 2016). Also, the latest national census data indicate that the percentage of HHs with unmet basic needs in the southern area doubles that reported in the central area (INDEC, 2010). In this scenario of environmental vulnerability and structural poverty, our results indicated that the chance of perceiving hunger in southern HH was almost twice as high as for HHs located in the central area. This may relate to certain aspects that historically affect the availability, access, and use of food, such as subsistence economies and small-scale agricultural activities, the high incidence of problems like flooding, proliferation of informal settlements, and pesticide contamination, which could explain the differential impact of food security on this specific territory.

Finally, we consider that this study has some limitations that should be addressed. First, because this research was cross-sectional, causal relations between FNI and HH size, SES, and HA could not be discerned. Second, our study population limited the generalizability of results to other populations of Argentina. Third, some population groups (dispersed rural population, older adults, people with very low income or those who do not read) could be underrepresented in the sample due to the methodology applied for data collection that required access to internet service and management of digital

technologies. Despite these limitations, we consider that the size of the sample and the representative nature of the data led to the reliability of the outcomes. Also, this is one of the first studies analyzing food insecurity in Argentinean HHs during the COVID-19 pandemic, providing new evidence that could be used as a source to implement public health policies. International organizations have declared that the economic effects of the health crisis due to COVID-19 will produce the highest poverty rates of the past two decades in Latin America and the Caribbean (CEPAL-FAO, 2020b). These projections highlight the need for state policies that address historical inequalities to mitigate the health and social effects of this pandemic.

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AUTHOR CONTRIBUTIONS

María Cordero: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; software; validation; visualization; writing-original draft; writing-review & editing. **María Cesani:** Conceptualization; funding acquisition; investigation; project administration; resources; supervision; validation; writing-original draft; writing-review & editing.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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