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Household food insecurity before and during COVID-19 pandemic and its association with perceived stress: population-based studies

Insegurança alimentar domiciliar antes e durante a pandemia da COVID-19 e sua associação com o estresse percebido: estudos de base populacional

Inseguridad alimentaria de los hogares antes y durante la pandemia de COVID-19 y su asociación con el estrés percibido: estudios basados en la población

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Abstract

The growing prevalence of food insecurity observed in the last years, has been favored by the COVID-19 pandemic, leading to mental health issues, such as stress. We aim to analyze the prevalence of household food insecurity before and during the COVID-19 pandemic and its association with perceived stress. We analyzed data from two population-based studies conducted in 2019 and 2020-2021 in the municipality of Criciúma, State of Santa Catarina, Southern Brazil. Food insecurity and perceived stress were assessed with the Brazilian Food Insecurity Scale *and the* Perceived Stress Scale*. The covariables were sex, age, skin color, schooling level, income, job status, marital status, household crowding, overweight, and diet quality. Crude and adjusted associations between food insecurity and perceived stress were assessed using Poisson regression. A total of 1,683 adult individuals were assessed. Prevalence of food insecurity was 25.8% in 2019, decreasing to 21.6% in 2020. Prevalence of perceived stress was about 38% for both years. Before the pandemic, food insecurity increased the prevalence of perceived stress by 29% (PR = 1.29; 95%CI: 1.02; 1.63), but no association was found during COVID-19. We found a worrying prevalence of food insecurity before and after de pandemic, nonetheless food insecurity and perceived stress were associated only in 2019. An assessment of these aspects after COVID-19 is needed to ensure basic life rights for all.*

Food Insecurity; Physiological Stress; Mental Health; COVID-19

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Introduction

Despite being a longstanding problem for humanity, food insecurity persists worldwide. The concept is not just limited to hunger but also refers to the presence of nutritional deficiencies, uncertainty about access to food on a regular, permanent, and unrestricted basis, and fear of food running out [1,2]. The Food and Agriculture Organization of the United Nations (FAO) has estimated that 2.37 billion people did not have access to adequate food in 2020, 320 million people more than in 2019. It accounts for a 15% increase in the prevalence of food insecurity worldwide in just one year [3].

Brazil has faced a growing prevalence of food insecurity since 2013, after a decade of reducing this situation. In 2018, almost 40% of Brazilian households presented food insecurity [4], with important regional disparities (ranging from 57% in the North Region to 20.7% in the South Region). In December 2020, the *National Survey of Food Insecurity, within the Context of the COVID-19 Pandemic in Brazil*, estimated a sharp increase in the prevalence of household food insecurity, reaching over 50% of Brazilian households [5]. This increase was attributed to the economic consequences of the COVID-19 pandemic. Once again, the South Region had the lowest rate, with a total of 46.9% of households experiencing food insecurity. In this sense, a subsequent survey carried out in the city of Bagé, in the State of Rio Grande do Sul, Southern Brazil [6], from May to June 2020, found a prevalence of 29.4% of food insecurity. Although significantly lower than the food insecurity prevalence observed in the whole country, it is higher than the prevalence observed in the Southern Region before the pandemic.

The economic crisis caused by the COVID-19 pandemic has sparked many discussions about its immediate and future implications with a tendency towards negative repercussions on social and health issues [7]. The expansion of household food insecurity and its associated factors represents one of the points of interest. Different studies have shown an increase in food insecurity rates, especially in developing countries such as Brazil [5,8,9,10,11,12]. In parallel, during and after conditions that generate feelings of insecurity and fear, there is an increase in mental health disorders, e.g., stress, anxiety, and depression [13], a fact that has been found to occur as another consequence of the pandemic [14].

In this sense, considering the current global crisis generated by COVID-19, it is important to further investigate the consequences of the sum of risk factors for physical and mental health, like episodes of stress, anxiety, and depression. Recent studies have reported an association between food insecurity, depression, and stress [15,16]. A study that analyzed data from 160 countries showed that the presence of food insecurity, even if mildly, is related to a higher occurrence of mental health disorders, lower positive wellbeing, and lower life satisfaction, regardless of the income level of individuals and the country's development conditions [17].

In view of the consequences caused by the crisis arising from the COVID-19 pandemic and the advancement of health risk factors related to household food insecurity and mental health problems, we aim to assess the prevalence of household food insecurity before and during the COVID-19 pandemic and its association with perceived stress in adults from a city located in Southern Brazil.

Methods

Setting, study sample, and data collection

The data used in this study was collected from two population-based studies conducted in a city located in Southern Brazil. Criciúma, in the State of Santa Catarina, has around 215,000 inhabitants, with a Human Development Index (HDI) of 0.788, and a per capita Gross Domestic Product (GDP) of BRL 36,073.31 (both sociodemographic characteristics are better than those of the country as a whole, which are, BRL 33,593.82 and 0.699, respectively) [18].

The study *Health of the Criciúma Population* [19,20] was conducted in 2019 (before the COVID-19 pandemic). All individuals aged 18 years or older who were living in the urban area of the city were eligible to take part in this study. The survey was conducted using a two-stage sampling process. To ensure random and representative population sampling, 77 census tracts were randomly selected out of 306 existing in the city [21]. The number of households was sampled proportionally to sector size and visits were made to 618 households selected systematically within the census sectors. All eligible

individuals living in the selected households were invited to take part in the study. Data was collected in home interviews conducted by trained study personnel.

The *Mental COVID* study [22,23,24], carried out from October 2020 to January 2021 (during COVID-19 pandemic), included the same target population, that is, individuals aged 18 years or older, living in the urban area of Criciúma. The sampling process of *Mental COVID* was also conducted in two stages: the first stage, which focused on the random selection of the primary units (the census tracts), and the second stage, when the secondary units (households) were randomly selected. A total of 60 census tracts were randomly selected, resulting in 15,765 households. The number of households was sampled proportionally to sector size, in a total of 607 households systematically selected within the census sectors. All eligible individuals living in the selected households were invited to take part in the study.

Data was collected in home interviews, and all interviewers wore personal protective equipment during fieldwork to avoid SARS-CoV-2 infection. The questionnaires used in both studies were applied to those who had consented to participate in the study and had signed the Informed Consent Form.

In both studies, the sample size calculation was carried out considering the following parameters: 80% power, 95% confidence interval (95%CI), 50% for the outcome prevalence, sampling error of five percentage points, design effect of 1.5, and increment of 15% for eventual losses and refusals. Considering all these parameters, the sample needed for each study was 662 individuals.

Household food insecurity status

In the study *Health of the Criciúma Population* [19,20] the complete version of *Brazilian Food Insecurity Scale* (EBIA) was used to define food insecurity [25]. The EBIA consists of 14 closed questions (yes, no) considering a 3-month recall period, and a score of 1 is given to each positive answer. In households with individuals younger than 18 years of age, the respondents answered 14 questions while in other households, they answered 8. Households were classified into four levels: food security (score of 0), mild food insecurity (score of 1-5 points for households with children/adolescents and 1-3 for the other households), moderate food insecurity (score of 6-9 points for households with children/adolescents and 4-5 for the other households), and severe food insecurity (score of 10-14 points for households with children/adolescents and 6-8 for the other households).

For the *Mental COVID* study [22,23,24], the short-form version was applied instead of the complete EBIA since we needed a quick questionnaire application in each household due to the pandemic scenario. This scale is composed of five questions considering a 3-month recall period. Although it does not allow to classify the different intensity levels of food insecurity (mild, moderate, and severe food insecurity status), it allows screening of households experiencing this situation, and it presents high sensitivity and specificity when compared to the complete questionnaire [26]. Households in which at least one positive answer was reported were classified as having food insecurity.

Perceived stress

The *Perceived Stress Scale*, previously validated for the Brazilian population [27], was used to evaluate stress. It is a self-reported measure designed to assess the degree to which situations in an individual's life are appraised as stressful. It was originally developed as a 14-item scale that assessed the perception of stressful experiences over the previous month using a Likert-type scale from 0-4 corresponding to the answer options "never", "almost never", "sometimes", "fairly often", and "very often". The total score consisted of the sum of points, ranging from 0 (lower stress) to 56 points (higher stress). We categorized the total score into quintiles, and those individuals in the highest quintile were classified as having perceived stress.

Sociodemographic and behavioral characteristics: potential confounders

The following variables were included in our analysis as covariables: sex (male, female), age group (collected in completed years and categorized as: 18-29, 30-39, 40-49, 50-59, ≥ 60 years), skin color (white, black, mixed race), schooling level (collected in completed years and categorized as: 0-4, 5-8, 9-11, ≥ 12 years), income (< 1,000.00; 1,001.00-2,000.00; > 2,000.00 BRL per month), job status (currently employed: no, yes), marital status (unmarried, married), household crowding (1-2, 3-4, ≥ 5 persons living in the household), overweight (no, yes – considering body mass index – BMI – as ≥ 25kg/m^2 for adults [28] and ≥ 27kg/m^2 for older adults [29]), and diet quality (in tertiles). BMI was calculated based on participants' self-reported weight and height.

Diet quality was evaluated using the diet indicator based on a set of foods considered to be healthy and foods considered as unhealthy. Considering intake frequency of each food, the following questions were asked: "How many days a week do you usually eat fruit?", "How many days a week do you usually eat at least one type of vegetable such as lettuce, tomato, cabbage, carrot, chayote, eggplant, zucchini (not including potatoes or cassava)?", "How many days a week do you usually drink milk (not including vegetable milk such as soy, almonds, chestnuts, rice)?", "How many days a week do you usually eat legumes such as beans, lentils, peas?", "How many days a week do you usually eat sweet foods, such as: ice cream, chocolates, cakes, cookies or sweets?", "How many days a week do you usually drink soda or processed juice?", "How many days a week do you usually eat red meat (beef, pork)?", and "How many days a week do you usually eat chicken?". Those questions had the following response options: "never", "almost never", "one or two days a week", "three or four days a week", "five or six days a week" and "every day (including weekends)". According to the diet indicator, depending on the food and the frequency of consumption, the answers could be scored from zero to four points. Individuals that consumed healthy foods every day were assigned zero points while those that never or hardly ever consumed them were assigned four points. For unhealthy foods, an inverse score was calculated, i.e., zero points were assigned to individuals that never or hardly ever consumed them. Thus, the maximum score (four points) was assigned to healthy foods consumed almost never or hardly ever and to unhealthy foods eaten daily. The total score consisted of the sum of food items, ranging from 0 (best food quality) to 28 points (worst food quality) [19,30].

Statistical analysis

For the analysis, the final EBIA score was categorized as food security or insecurity, which included situations of mild, moderate, or severe food insecurity.

Relative and absolute frequencies and 95%CI were used to describe the characteristics of the sample. Statistically significant differences in household food insecurity and perceived stress according to sociodemographic and behavioral characteristics were assessed using chi-squared test.

Crude and adjusted analyses of the association between household food insecurity and perceived stress were performed using Poisson regression with robust variance, presenting the p-values corresponding to the Wald test for heterogeneity. We have chosen Poisson over logistic regression because it fits better in cross-sectional studies with binary outcomes [31]. Regression results were reported as prevalence ratio and its corresponding 95%CI.

Adjusted models were used to check whether significant associations were independent of sociodemographic and behavioral characteristics. To control for possible confounders, we used a three-level hierarchical model of analysis [32]. In level 1 we included the following variables: sex, age, and skin color. In level 2 we included schooling level, income, job status, marital status, and household crowding. Finally, in level 3 we included overweight and diet quality. Variables were selected using a backward method considering each hierarchical level, and those associated with exposure and outcome at a 20% significance level (p-value < 0.20) remained in the final model.

All analyses were performed using Stata version 16.1 (https://www.stata.com) with the *svy* prefix, which is used in complex datasets for weighting the data, making the analyses more conservative and, therefore, reducing the probability of errors in the results.

Ethical aspects

All participants provided a written informed consent to participate in the study, and both projects were approved by the Ethics Research Committee of the University of South Santa Catarina in December 2018 (protocol n. 04033118.4.0000.0119), and by the Brazilian National Ethics Research Committee in July 2020 (protocol n. 30955120.0.0000.5324).

Results

A total of 1,683 individuals were interviewed: 820 from the *Health of the Criciúma Population* [19,20] study and 863 from the *Mental COVID* [22,23,24] study (response rate of 86.1% in 2019 and 75% in 2020). In the first study, most of the participants were female (63.8%), older adults (45%), and reported having white skin color (82.5%). About one-third of them were employed (36%) and had from 9-11 years of education (32.5%). In the study performed during the COVID-19 pandemic, there was a decrease in the proportion of older adults (29.7%). Additionally, more than 80% reported white as skin color and most of them were employed (52.8%). The prevalence of overweight was more than 50% in both studies (Table 1).

There was no significant difference in the prevalence of food insecurity before and during the COVID-19 pandemic. The prevalence of household food insecurity status was 25.8% (95%CI: 22.3; 29.6) before the COVID-19 pandemic and 21.6% (95%CI: 18.9; 24.4) during the pandemic. In both studies, there was higher prevalence of food insecurity among poorly educated, unmarried, and non-white individuals, with a larger decrease among mixed race individuals between 2019 and 2020. Younger individuals and those with the worst diet quality had a higher food insecurity prevalence in 2019 but not in 2020. There was no difference in the prevalence of food insecurity between sexes in both studies (Table 2).

Perceived stress prevalence was about 38% in the two surveys. It was higher among females and those individuals with poor diet quality. Younger people were more stressed before the COVID-19 pandemic, with no difference in the second survey according to age. Moreover, perceived stress prevalence was higher in overcrowded houses, with a decrease of the prevalence among this group in the second study. There was no difference in the prevalence of perceived stress according to skin color and marital status in both studies (Table 3).

The association between household food insecurity and perceived stress is shown in Table 4. Before the COVID-19 pandemic, food insecurity status increased the prevalence of perceived stress by 40% (prevalence ratio – PR = 1.41; 95%CI: 1.12; 1.76). After adjustment for potential confounders included in the analyses, household food insecurity status remained positively associated with perceived stress: individuals residing in households with food insecurity were more likely to be stressed than their counterparts (PR = 1.29; 95%CI: 1.02; 1.63). During the COVID-19 pandemic, household food insecurity status was not associated with perceived stress in both crude and adjusted models.

Discussion

Our study, which evaluates the association between household food insecurity and perceived stress before and during the COVID-19 pandemic, highlights three important results from the public health perspective. First, we found that household food insecurity status has been present in about a quarter of Criciúma population in 2019, with a slight increase during the COVID-19 pandemic. Second, almost 40% of the interviewed population before and during COVID-19 outbreak reported perceived stress. Finally, individuals who lived in households with food insecurity had higher prevalence of perceived stress before COVID-19 pandemic, although no association has been found during the pandemic.

Table 1

Sociodemographic and behavioral characteristics of adults aged 18 years or older. Criciúma, Santa Catarina State, Brazil, 2019-2021.

Characteristics	Before COVID-19 pandemic (n = 820)		During COVID-19 pandemic (n = 863)	
	n	% (95%CI)	n	% (95%CI)
Sex				
Male	297	36.2 (32.9; 39.5)	359	41.6 (38.3; 44.9)
Female	523	63.8 (60.5; 67.1)	504	58.4 (55.1; 61.6)
Age group (years)				
18-29	101	12.3 (10.1; 14.6)	146	16.9 (14.6; 19.6)
30-39	93	11.3 (9.2; 13.5)	138	15.9 (13.7; 18.6)
40-49	85	10.4 (8.3; 12.5)	162	18.8 (16.3; 21.5)
50-59	172	21.0 (18.2; 23.8)	161	18.7 (16.2; 21.4)
≥ 60	369	45.0 (41.6; 48.4)	256	29.7 (26.7; 32.8)
Skin color *				
White	660	82.5 (79.7; 85.0)	716	83.2 (80.5; 85.6)
Black	49	6.1 (4.7; 8.0)	83	9.6 (7.8; 11.8)
Mixed race	91	11.4 (9.4; 13.8)	62	7.2 (5.6; 9.1)
Schooling level (years)				
0-4	219	26.7 (23.7; 29.8)	186	21.6 (18.9; 24.4)
5-8	220	26.9 (23.8; 29.9)	214	24.8 (22.0; 33.9)
9-11	266	32.5 (29.3; 35.7)	265	30.7 (27.8; 33.9)
≥ 12	114	13.9 (11.5; 16.3)	198	22.9 (20.3; 25.9)
Income (BRL per month)				
< 1,000.00	317	39.9 (36.5; 43.3)	172	27.7 (24.3; 31.3)
1,001.00-2,000.00	248	31.2 (28.1; 34.5)	241	38.7 (35.0; 42.6)
> 2,000.00	230	28.9 (25.9; 32.2)	209	33.6 (30.0; 37.4)
Currently employed				
No	523	64.0 (60.7; 67.2)	382	47.2 (43.8; 50.7)
Yes	294	36.0 (32.8; 39.3)	427	52.8 (49.3; 56.2)
Marital status				
Not married	325	39.6 (36.3; 43.0)	381	44.1 (40.9; 47.5)
Married	495	60.4 (57.0; 63.7)	482	55.9 (52.5; 59.1)
Household crowding **				
1-2	364	44.6 (41.2; 48.0)	247	30.8 (27.7; 34.0)
3-4	331	40.6 (37.2; 43.9)	442	55.0 (51.6; 58;5)
≥ 5	121	14.8 (12.4; 17.3)	114	14.2 (11.9; 16.8)
Overweight ***				
No	333	42.7 (39.3; 46.2)	339	42.4 (39.0; 45.9)
Yes	446	57.3 (53.8; 60.7)	460	57.6 (54.1; 61.0)
Diet quality				
Tertile 1 (best)	287	35.3 (32.0; 38.5)	315	36.5 (33.4; 39.8)
Tertile 2	259	31.8 (28.6; 35.0)	297	34.5 (31.4; 37.7)
Tertile 3 (worst)	268	32.9 (29.7; 36.2)	250	29.0 (26.1; 32.1)

95%CI: 95% confidence interval.

* Indigenous and yellow skin color were excluded from the analysis (n = 18);

** Variable with highest number of missing data points in the second study;

*** Variable with highest number of missing data points in the first study.

Table 2

Prevalence of household food insecurity according to sociodemographic characteristics of adults aged 18 years or older. Criciúma, Santa Catarina State, Brazil, 2019-2021.

Characteristics	Before COVID-19 pandemic		During COVID-19 pandemic	
	% (95%CI)	p-value *	% (95%CI)	p-value *
Sex		0.134		0.081
Male	22.6 (17.8; 28.4)		18.7 (15.0; 23.0)	
Female	28.2 (23.5; 33.4)		23.6 (20.1; 27.5)	
Age group (years)		0.010		0.167
18-29	34.9 (21.9; 50.5)		26.7 (20.1; 34.5)	
30-39	42.0 (28.9; 56.3)		20.3 (14.3; 27.9)	
40-49	30.9 (20.0; 44.5)		16.1 (11.1; 22.6)	
50-59	25.8 (18.7; 34.5)		24.8 (18.7; 32.2)	
≥ 60	20.8 (16.5; 25.8)		20.7 (16.2; 26.1)	
Skin color		0.040		0.017
White	23.4 (19.7; 27.6)		20.3 (17.5; 23.4)	
Black	38.5 (24.2; 54.9)		33.7 (24.3; 44.7)	
Mixed race	33.3 (22.7; 46.0)		19.4 (11.2; 31.3)	
Schooling level (years)		0.013		< 0.001
0-4	24.4 (18.2; 31.8)		25.8 (20.0; 32.6)	
5-8	34.0 (27.0; 41.6)		29.9 (24.1; 36.4)	
9-11	24.3 (18.4; 31.3)		20.0 (15.6; 25.3)	
≥ 12	14.3 (7.8; 24.8)		10.6 (7.0; 15.8)	
Income (BRL per month)		< 0.001		< 0.001
< 1,000.00	36.6 (29.7; 44.1)		29.7 (23.3; 36.9)	
1,001.00-2,000.00	27.8 (21.8; 34.7)		24.9 (19.8; 30.8)	
> 2,000.00	14.1 (9.7; 19.9)		8.6 (5.4; 13.3)	
Currently employed		0.448		0.018
No	26.9 (22.6; 31.7)		25.4 (21.3; 30.0)	
Yes	24.0 (18.5; 30.5)		18.5 (15.1; 22.5)	
Marital status		0.001		0.048
Not married	32.8 (27.1; 39.0)		24.7 (20.6; 29.3)	
Married	20.7 (16.6; 25.5)		19.1 (15.8; 22.9)	
Household crowding		0.003		< 0.001
1-2	20.4 (16.2; 25.4)		18.6 (14.2; 24.0)	
3-4	29.9 (24.0; 36.6)		18.3 (15.0; 22.2)	
≥ 5	38.7 (27.3; 51.5)		36.8 (28.4; 46.1)	
Overweight		0.137		0.312
No	22.0 (17.1; 27.9)		18.0 (14.2; 22.5)	
Yes	27.7 (23.0; 33.0)		20.9 (17.4; 24.8)	
Diet quality		0.007		0.109
Tertile 1 (best)	19.0 (14.0; 25.1)		23.8 (19.4; 28.8)	
Tertile 2	25.4 (19.5; 32.4)		17.5 (13.6; 22.3)	
Tertile 3 (worst)	33.2 (26.7; 40.3)		23.6 (18.7; 29.3)	
Total	25.8 (22.3; 29.6)		21.6 (18.9; 24.4)	

95%CI: 95% confidence interval.

* Chi-square test, *svy* prefix was used by considering the complexity of the sampling process.

Table 3

Prevalence of perceived stress according to sociodemographic characteristics of individuals in both studies. Criciúma, Santa Catarina State, Brazil, 2019-2021.

Characteristics	Before COVID-19 pandemic		During COVID-19 pandemic	
	% (95%CI)	p-value *	% (95%CI)	p-value *
Sex		0.004		0.003
Male	32.2 (27.1; 37.8)		31.7 (27.1; 36.8)	
Female	42.6 (38.4; 47.0)		41.6 (37.3; 46.0)	
Age group (years)		< 0.001		0.120
18-29	54.6 (44.6; 64.2)		43.8 (36.0; 52.0)	
30-39	51.6 (41.4; 61.7)		37.7 (29.9; 46.1)	
40-49	48.8 (38.0; 59.6)		40.7 (33.4; 48.5)	
50-59	39.3 (32.1; 46.9)		38.0 (30.7; 45.8)	
≥ 60	28.4 (23.9; 33.4)		31.4 (25.9; 37.4)	
Skin color		0.920		0.070
White	39.0 (35.3; 42.8)		37.1 (33.6; 40.8)	
Black	41.7 (28.4; 56.3)		30.5 (21.4; 41.4)	
Mixed race	38.2 (28.6; 48.8)		49.2 (36.7; 61.8)	
Schooling level (years)		0.762		0.005
0-4	38.2 (31.9; 45.0)		40.3 (33.4; 47.7)	
5-8	41.8 (35.3; 48.7)		27.2 (21.6; 33.6)	
9-11	37.1 (31.4; 43.1)		41.1 (35.3; 47.2)	
≥ 12	38.6 (30.0; 47.9)		41.1 (34.4; 48.2)	
Income (BRL per month)		< 0.001		0.019
< 1,000.00	46.9 (41.3; 52;5)		50.9 (43.4; 58.3)	
1,001.00-2,000.00	38.8 (32.8; 45.1)		44.0 (37.8; 50.3)	
> 2,000.00	27.4 (22.0; 33.6)		35.6 (29.3; 42.4)	
Currently employed		0.720		0.557
No	38.2 (34.1; 42.5)		39.4 (34.6; 44.4)	
Yes	39.5 (34.0; 45.3)		37.4 (32.9; 42.1)	
Marital status		0.762		0.631
Not married	39.4 (34.2; 44.9)		38.4 (33.6; 43.4)	
Married	38.4 (34.1; 42.8)		36.8 (32.6; 41.2)	
Household crowding		0.002		0.054
1-2	32.1 (27.4; 37.2)		32.7 (27.0; 38.8)	
3-4	42.5 (37.1; 48.0)		42.0 (37.4; 46.6)	
≥ 5	47.5 (38.6; 56.5)		37.2 (28.7; 46.5)	
Overweight		0.095		0.341
No	35.0 (30.0; 40.3)		35.9 (30.9; 41.2)	
Yes	40.9 (36.4; 45.7)		39.2 (34.8; 43.8)	
Diet quality		< 0.001		< 0.001
Tertile 1 (best)	28.6 (23.6; 34.2)		30.9 (26.0; 36.2)	
Tertile 2	41.1 (35.0; 47.3)		36.4 (31.1; 42.0)	
Tertile 3 (worst)	47.5 (41.5; 53.6)		47.0 (40.8; 53.2)	
Total	38.8 (35.5; 42.2)		37.5 (34.3; 40.8)	

95%CI: 95% confidence interval.

* Chi-square test, *svy* prefix was used by considering the complexity of the sampling process.

Table 4

Crude and adjusted analysis of the association between household food insecurity and perceived stress in adults aged 18 years or older. Criciúma, Santa Catarina State, Brazil, 2019-2021.

	Before COVID-19 pandemic			During COVID-19 pandemic		
	n (%)	Crude analyses PR (95%CI)	Adjusted analyses * PR (95%CI)	n (%)	Crude analyses PR (95%CI)	Adjusted analyses * PR (95%CI)
Food insecurity		p = 0.003 **	p = 0.036 **		p = 0.327 **	p = 0.391 **
No	134 (33.0)	Reference	Reference	246 (36.7)	Reference	Reference
Yes	66 (46.5)	1.41 (1.12; 1.76)	1.29 (1.02; 1.63)	75 (40.5)	1.11 (0.90; 1.35)	1.10 (0.89; 1.35)

95%CI: 95% confidence interval; PR: prevalence ratio.

* Adjusted for sex, age, skin color, income, currently employed, marital status, household crowding, and diet quality respecting hierarchical levels;

** Wald test, *svy* prefix was used by considering the complexity of the sampling process.

In our study, food insecurity did not appear to be associated with stress during the pandemic; nonetheless, the COVID-19 outbreak has disclosed many fragilities in people's mental health. Changes in daily life and infection-containment measures affected everyone but had a greater impact on those who were already in a vulnerable position before the pandemic. In this scenario, stress is one mental health indicator that has been most impacted by the outbreak [33]. Quarantine measures to mitigate or eliminate the virus, although important to contain SARS-CoV-2 transmission, increased feelings such as fear, boredom, frustration, and financial concerns, favoring increases in the prevalence of stress [34]. Especially in low and middle-income countries, uncertainties of transmission and containment of the coronavirus along with economic problems may favor increases in mental health disorders, such as stress [33].

Criciúma also implanted measures to avoid the spread of SARS-CoV-2. In the beginning of the outbreak several measures were adopted to cope with the pandemic, such as the closing of non-essential services, public transport, commerce, and education services and the centralization of screening and care procedures for COVID-19 in many health services. These conditions lasted until October 2020, when the application of a contingency plan, mainly, with the return of educational and public transport activities, started. It is important to cite that our study began during this period (October 2020), when COVID-19 cases were still very frequent in the city and, therefore, insecurity about the return of activities was predominant.

The prevalence of stress found in our study are in consonance with other investigations conducted during the COVID-19 pandemic. Another research carried out in Brazil with data from a web-based survey demonstrated an overall prevalence of post-traumatic stress disorder of 34.2%, assessed via a questionnaire that evaluated the stress resulting from a traumatic event, named the *Impact of Event Scale-Revised* (IES-R). In this instrument a score with more than 5.6 points indicates the presence of stress [35]. Similar to our results, Goularte et al. [35] also found a higher prevalence of stress symptoms among women and less affluent individuals. In Mexico – a Latin American country similar to Brazil in political and economic characteristics as well as in pandemic coping strategies – the prevalence of moderate stress was 40.4%, whereas very severe stress was observed in 31.6% of individuals [36]. In this research [36], stress was evaluated by the *Depression Anxiety Stress Scale* (DASS-21) and the answers were classified as normal, mild, moderate, severe, and very severe levels of stress, although details about this classification are not cited in the study. In India, however, a study that also applied DASS-21, but which classified a higher level of stress as a higher score from the questionnaire, found that only 11.6% of the participants reported stress during the COVID-19 outbreak [37].

Brazil has implemented insufficient measures, partially based on unscientific recommendations to contain the novel coronavirus. Along with the previously existing inequalities in the country, this contributed to a critical pandemic scenario in terms of mental health [38,39]. However, the high prevalence of stress found in Brazil cannot be only explained by the pandemic situation, since the Brazilian population has already been living in a troubled political and democratic scenario in the last few years [38],

affecting the country's economy and job market. This situation might help to explain why differences in perceived stress before and during the COVID-19 pandemic were not found in our study.

Our study also revealed a small reduction in food insecurity prevalence from 2019 to 2020. However, in both studies, more than 20% of the Criciúma population reported to be living in a food insecurity situation. This result is very similar to the one evidenced by a nationally representative survey. According to the 2017-2018 *Brazilian Household Budget Survey* (POF), the South, where Criciúma is located, is the region with the lowest prevalence of food insecurity (20.7%) [4]. During the pandemic, the South Region continued to be the Brazilian region with the lowest prevalence of food insecurity in Brazil, although this prevalence has sharply increased by more than 50%, according to recent estimates [40].

Regarding the association between food insecurity and perceived stress, we found that household food insecurity status increased the likelihood of stress in 2019, but this result did not persist during the outbreak. A study carried out in 2016 (prior to COVID-19) in another city from Southern Brazil found similar results. Food insecurity increased stress prevalence by 44% (95%CI: 1.19; 1.75) [41]. Similarly, the same association was also found in a systematic review and meta-analysis with pre-pandemic data from cross-sectional studies (odds ratio – OR = 1.34; 95%CI: 1.24; 1.44) [16]. On the other hand, during the COVID-19 pandemic, studies have been showing an increase in the risk of perceived stress in food insecure individuals [42,43].

The pathway in which food insecurity leads to stress may be individual and collective, even existing in a national level, affecting each person differently. Unstable situations, e.g., political instability, socioeconomic crisis, working conditions, and natural disasters, can increase food insecurity by affecting food availability, accessibility, utilization, and stability [44]. Moreover, people in a food insecure situation present lower diet quality, including lower intake of nutrients such as vitamin A and complex B, zinc, calcium, and magnesium [45]. Lower quality diet is associated with stress, an outcome that increases physiologic, nutritional, and energetic needs. Vitamins A and complex B, and magnesium are examples of important nutrients for coping with stress [46].

The increase in nutritional needs occurs due to the biological and systemic response generated by stress, with the activation of metabolic pathways that require the action of micronutrients as cofactors for their correct functioning. Therefore, an inadequate diet is not associated only with psychological stress, but also with biological distress [46]. According to that, it is demonstrated that an adequate nutritional intake is related to better levels of inflammation and stress biomarkers [46]. In this way, it is possible to observe the bidirectional relationships between food insecurity and stress. Food insecurity hinders the achievement of an adequate diet, generating stress response, and stress is responsible for increasing nutritional needs, including energy and micronutrients.

The lack of association between household food insecurity and perceived stress during the pandemic, as found in our study, can be explained by the government's measures implemented in 2020. During the emergency situation, governments felt the need to develop and implement actions to ensure basic living conditions, including food access, such as income transfer and social protection programs [47,48]. In Brazil, emergency aid and distribution of food for students and families assisted by the Brazilian National School Feeding Program (PNAE) are examples of actions that provided food and income for vulnerable families, which apparently helped to keep food insecurity situation stable in 2020 [6,49]. These measures could have provided a feeling of security and reduced stress in relation to access and availability of food, which can explain the lack of association between stress and food insecurity during the COVID-19 in our study. Moreover, the city of Criciúma has a strong economy, which may not have been as heavily impacted by the consequences of the economic crisis generated by the pandemic as in the whole country. Data from the Brazilian Institute of Geography and Statistics (IBGE) and from the State of Santa Catarina, where Criciúma is located, demonstrated that the region had the lowest rate of unemployment and informal jobs in the country in the last quarter of 2020 [50].

Regarding the association between stress, food insecurity, and sociodemographic characteristics, we found higher prevalence of perceived stress in women and in individuals with poor diet quality in 2019 and 2020. Higher prevalence of perceived stress was also found in younger and low-income individuals before the COVID-19 pandemic. On the other hand, those who lived in overcrowded houses, were unmarried, and reported black skin color presented a decrease in stress prevalence from 2019 to 2020. There was a decrease in the prevalence of food insecurity in unmarried younger

individuals with poor diet quality. Higher prevalence of food insecurity was found among the less educated, low-income, and non-white individuals. Similar results before and during the pandemic were found in other studies [5,6,41,51,52,53].

Notably, this study has some methodological limitations; for example, the fact that different versions of the EBIA scale were used for data collection. In the 2019 study, the full version of the scale was used, while in the 2020-2021 study, in which a greater number of questions were included in the instrument, the short-form version was used. Both scales are validated for the Brazilian population, allowing us to calculate the outcome prevalence. However, the full version assesses the intensity levels of food insecurity, classifying individuals into light, moderate, and severe fod insecurity levels. This is not possible when using the short-form version. Other limitations refer to characteristics of the study sample, in which women and older adults were overrepresented due to the interviews being conducted during business hours, possibly indicating sex inequality in the access to job market. Interestingly, in the 2020-2021 study, the proportion of women and older adults decreased (probably due to remote work), but it remained high.

As strengths, this is a study conducted with a population-based sample. These kinds of studies are an important tool for production of data and estimation of health condition indicators, contributing to the knowledge of the local epidemiological situation. Moreover, this study enabled a comparison of the situation of food insecurity and perceived stress at two different moments (before and during the COVID-19 pandemic). The data found here can contribute to the generation of knowledge about the effects of the pandemic on the living and health conditions of the Brazilian population, especially in the South Region.

Conclusion

Food insecurity status increased the likelihood of perceived stress before but not during the COVID-19 pandemic. It suggests that the COVID-19 pandemic does not seem to have negatively interfered in the prevalence of food insecurity and perceived stress in the Criciúma population. Nor did it interfere in the association between these two factors. Nonetheless, individuals who have a lower socioeconomic level and unfavorable socioeconomic conditions continue to be the most affected by both food insecurity and perceived stress. These facts emphasize the deleterious effects of Brazilian social inequalities. It is important to maintain and expand social and health policies already established in Brazil; for example, the Brazilian National Food and Nutrition Policy, which serves as an instrument to guarantee basic life rights of our society, protecting the human right to adequate food, which defends access and availability of food in sufficient quantity and quality for the entire population.

Contributors

F. O. Meller participated in the study conception, data analysis and interpretation, writing, and review, approved the final version to be published, and is responsible for all aspects of the work to ensure the accuracy and completeness of any part of the work. L. P. Santos participated in data analysis and interpretation, writing, and review, approved the final version to be published, and is responsible for all aspects of the work to ensure the accuracy and completeness of any part of the work. B. L. Vargas participated in data interpretation, writing, and review, approved the final version to be published, and is responsible for all aspects of the work to ensure the accuracy and completeness of any part of the work. M. R. Quadra participated in data interpretation, writing, and review, approved the final version to be published, and is responsible for all aspects of the work to ensure the accuracy and completeness of any part of the work. C. D. Martins participated in data interpretation, writing, and review, approved the final version to be published, and is responsible for all aspects of the work to ensure the accuracy and completeness of any part of the work. A. A. Schäfer participated in the study conception, data analysis and interpretation, writing, and review, approved the final version to be published, and is responsible for all aspects of the work to ensure the accuracy and completeness of any part of the work.

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Resumo

*A pandemia da COVID-19 favoreceu a tendência crescente de insegurança alimentar observada nos últimos anos, causando consequências na saúde mental, como o estresse. Nosso objetivo foi analisar a prevalência de insegurança alimentar domiciliar antes e durante a pandemia da COVID-19 e a sua associação com o estresse percebido. Analisamos dados de dois estudos de base populacional conduzidos em 2019 e 2020 a 2021 com adultos em Criciúma, Estado de Santa Catarina, Sul do Brasil. A insegurança alimentar e o estresse percebido foram avaliados usando a E*scala Brasileira de Insegurança Alimentar *e da* Escala de Estresse Percebido*. As covariáveis foram sexo, idade, raça, escolaridade, renda, situação profissional, estado civil, aglomeração domiciliar, excesso de peso e qualidade da dieta. Associações brutas e ajustadas entre insegurança alimentar e estresse percebido foram avaliadas usando a regressão de Poisson. Foram avaliados 1.683 indivíduos. A prevalência de insegurança alimentar foi de 25,8% em 2019, diminuindo para 21,6% em 2020. A prevalência de estresse percebido foi de aproximadamente 38% nos dois anos. Antes da pandemia, a insegurança alimentar aumentava a prevalência de estresse percebido em 29% (RP = 1,29; IC95%: 1,02; 1,63), mas nenhuma associação foi encontrada durante a pandemia da COVID-19. Identificamos uma prevalência preocupante de insegurança alimentar antes e depois da pandemia, no entanto, a insegurança alimentar e o estresse percebido foram associados apenas em 2019. Uma avaliação desses aspectos após a pandemia da COVID-19 é necessária para garantir direitos básicos de vida para todos.*

Insegurança Alimentar; Estresse Fisiológico; Saúde Mental; COVID-19

Resumen

La creciente tendencia a la inseguridad alimentaria observada en los últimos años se ha visto favorecida por la pandemia de COVID-19, provocando consecuencias en la salud mental, tales como el estrés. Nuestro objetivo fue analizar la prevalencia de inseguridad alimentaria en el hogar antes y durante la pandemia de COVID-19 y su asociación con el estrés percibido. Analizamos datos de dos estudios poblacionales realizados en 2019 y 2020-2021 con adultos en Criciúma, Santa Catarina, Sur de Brasil. La inseguridad alimentaria y el estrés percibido se evaluaron con la Escala Brasileña de Inseguridad Alimentaria *y la* Escala de Estrés Percibido*. Las covariables fueron sexo, edad, color de piel, escolaridad, ingresos, situación laboral, estado civil, hacinamiento en el hogar, sobrepeso y calidad de la dieta. Las asociaciones crudas y ajustadas entre la inseguridad alimentaria y el estrés percibido se evaluaron mediante regresión de Poisson. Se evaluó a un total de 1.683 personas. La prevalencia de la inseguridad alimentaria fue del 25,8% en 2019, disminuyendo al 21,6% en 2020. La prevalencia del estrés percibido fue de alrededor del 38% en ambos años. Antes de la pandemia, la inseguridad alimentaria aumentaba la prevalencia del estrés percibido en un 29% (RP = 1,29; IC95%: 1,02; 1,63), pero no se encontró ninguna asociación con COVID-19. Encontramos una prevalencia preocupante de inseguridad alimentaria antes y después de la pandemia, aunque la inseguridad alimentaria y el estrés percibido solo se asociaron en 2019. Es necesaria una evaluación de estos aspectos después del COVID-19 para garantizar los derechos básicos vitales para todos.*

Inseguridad Alimentaria; Estrés Fisiológico; Salud Mental; COVID-19

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