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Food Intake According to Food Insecurity among Older People in Brazil: National Food Survey 2017-2018

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Abstract

This study aimed to assess the dietary intake of Brazilian older adults based on their level of food insecurity (FI). A cross-sectional analysis was conducted using secondary data from the 2017-2018 Household Budget Survey (POF). FI was assessed with the Brazilian Food Insecurity Scale (EBIA), while dietary intake was measured using two nonconsecutive 24-hour dietary recalls. The data represent a nationwide sample of 26,220 individuals aged 60 or older. Overall, 32% of participants experienced some level of FI. Older adults with moderate or severe FI reported lower average consumption of fruits, natural juices, vegetables, beef, pork, and alcoholic beverages, and higher consumption of fish and seafood compared to those with food security (FS). We identified regional differences: in the North, those with moderate/severe FI consumed twice as much fruit; lower consumption of beef and pork was noted in the Southeast, Midwest, and South; and lower consumption of vegetables and oils was found among food-insecure older adults in the South. Overall, older Brazilians with moderate or severe FI consumed fewer markers of a healthy diet, particularly fruits and vegetables. They also had lower intake of protein sources such as beef and pork. These findings underscore the nutritional vulnerability of this population and highlight the need for public policies to promote access to healthy foods for food-insecure Brazilian older adults.

Keywords

Dietary Intake, Food Insecurity, Elderly, Food Survey

1. Introduction

Understanding eating habits across different age groups is essential for promoting

population health and well-being [1]. Research has shown that the diet of Brazilian older adults is marked by micronutrient deficiencies, with more than 85% having inadequate intake of calcium and vitamins D and E [2].

The most recent Household Budget Survey (POF), in 2017-2018, showed that although Brazilian older adults have healthier eating habits than other age groups, with higher consumption of fruits and vegetables, they still face dietary challenges. A study showed a reduction in the consumption of traditional Brazilian foods such as rice, beans, and beef and an increase in the consumption of snacks, sandwiches, and pizza [3].

The quality of the food consumed is crucial in people's health, meeting nutritional needs and promoting well-being. Healthy eating practices promote a decent life and foster the individual's full development [4].

Adequate diet is one of the social rights guaranteed by the 1988 Brazilian Federal Constitution, defined as regular and sufficient access to quality foods that are environmentally, economically, and socially sustainable, and respectful cultural diversity, forming the basis of the Brazilian concept of food and nutrition security (FNS) [5]. Meanwhile, food insecurity (FI) occurs when such access is restricted, compromising both the quantity and quality, adversely affecting health and well-being [6].

Studies with Brazilian older adults reported that the prevalence of some level of FI ranged from approximately 28% to 52% and also showed that Black and brown older adults, as well as the less educated and those with lower income, were more vulnerable to severe FI [7]-[9]. Older adults experiencing FI often have lower energy, protein, and carbohydrate intake, leading to poorer dietary and nutritional status [10].

Brazil's current demographic and epidemiological context shows the need to assess the population's dietary intake and FI. However, most studies that have analyzed aspects of diet and FI have concentrated on women and children. Given the country's new demographic reality, the limited understanding of the food situation among a representative sample of Brazilian older adults highlights the need for further research. This gap in the scientific literature can be attributed to the limited availability of joint nationwide data on diet and FI, the most recent of which are from the POF of 2017-2018 [11]. Understanding which foods are lacking in the diets of food-insecure Brazilian older adults is crucial, given their heightened vulnerability to diet-related diseases [12]. The present study addresses this gap by examining dietary intake among older Brazilians according to household FI status.

2. Materials and Methods

This cross-sectional, population-based study adopted publicly available secondary data from the Household Budget Survey (POF) conducted in 2017 and 2018 by the Brazilian Institute of Geography and Statistics (IBGE). The survey's main objective was to collect information on the Brazilian population's financial situation

and living conditions, covering urban and rural areas across Brazil's five major geographic regions.

2.1. Study Population

The sampling method was based on a two-stage cluster design: census tracts and private households. The first stage consisted of stratification of the census tracts by the mean income of the heads-of-households, with selection by proportional probability per the number of households in each tract. In the second stage, households were selected by simple random sampling, thereby ensuring geographic and temporal representativeness. Calculation of the sampling weights considered the sampling plan, lending representativeness to the collected data. Data were collected from July 11, 2017, to July 9, 2018, yielding a total of 57,920 households and 178,431 individuals participating nationwide.

A subsample of the POF survey, known as the National Dietary Survey (INA), focused on the assessment of individual dietary intake and covered 34.7% of the households in the overall sample, totaling 20,112 households and 46,164 individual participants. Further details on the sampling process can be found in official IBGE publications [13].

For this specific study, the elderly population was defined as individuals of both sexes 60 years and older, included in the total POF sample, or 26,220 older adults, and in the INA subsample, 6653 older adults. This subdivision was essential to guarantee adequate weighting according to the requirements of each respective dataset.

2.2. Data Collection

2.2.1. Food Insecurity

FI was assessed using the Brazilian Food Insecurity Scale (EBIA), which captures households' perceptions of their access to food. The scale was applied to the total POF sample and includes 14 items, eight of which are for adults and the last six are applied only to households with at least one resident under 18 [14]. For each question, respondents reported whether they had experienced concerns or uncertainties related to access to foods, as well as reductions in the quality and amount of foods consumed by adults and children in the household. The classification of households according to the situation of food security (FS) or FI was based on the scores generated by affirmative answers: mild FI: 1 to 5 points; moderate FI: 6 to 10 points; severe FI: 11 to 14 points (for households with members under 18); and mild FI: 1 to 3 points; moderate FI: 4 to 5 points; severe FI: 6 to 8 points (households without members under 18); and FS: households that did not score points on the scale [15].

2.2.2. Dietary Intake

In the individual dietary intake module, the assessment covered individuals ten years and older living in households from the INA subsample. Two nonconsecutive 24-hour recalls (24HR) were applied, in which participants reported all foods

and beverages consumed on the previous day. Interviewers used the automated multiple-pass method (AMPM) to minimize recall bias. Information on dietary intake included time, preparation of the foods, amounts in household measurements, additional items, place of consumption, and types of meals. The food and beverage database contained 1832 items [13].

2.2.3. Sociodemographic Characteristics

The study employed information from the POF survey related to the residents' demographic and socioeconomic data and the household's characteristics. This included the variables sex, age group, self-reported skin color, schooling years, and per capita household income. Additional aspects included retirement and pension benefits received and participation in government income transfer programs. The variable "state" was adopted to identify the participant's state of residence, later categorized into the country's five major geographic regions (North, Northeast, Midwest, South, and Southeast). The household's location was also classified as urban versus rural.

2.3. Data Analysis

We used data on FI in households with at least one older adult. When there were two or more older adults in the household, information on FI was applied equally to all the individuals. FI was analyzed two ways: according to the original scale in four levels (FS; mild FI; moderate FI; severe FI) and recategorized in three levels, combining the two most severe levels in a single category (FS; mild FI; moderate FI/severe FI), due to the relatively small sample size in the severe FI group. Information on the financial income of all residents in the household was divided by the total number of residents in the household, resulting in per capita household income, later categorized in four brackets of multiples of the prevailing monthly minimum wage (BRL 954.00 or US $300.00 on January 15, 2018).

Assessment of dietary intake was based on the first 24HR of older adults from the INA subsample. A single 24HR per participant is sufficient to estimate the usual mean intake at the group level or to compare mean intakes across groups [16] [17]. The present study collected 24HR throughout the week, including weekend days, and across seasons. Although two 24HRs were collected in the survey, not all participants completed the second day. Therefore, to ensure comparability and preserve sample representativeness, analyses were restricted to the first 24HR, which was available for all participants. Foods were categorized in 19 food groups used as markers of diet quality, previously identified in other studies that analyzed aspects of diet associated with FI: rice and other grains; beans and legumes; fruits; natural juices; greens, vegetables, and vegetable-based preparations; dairy products; beef and pork; chicken, other poultry, and eggs; fish and seafood; roots and tubers; sodas and sweetened beverages; cold cuts, processed meats and canned meats; cakes, pastries, and cookies; oil and fats; snacks, pizzas, and crackers; coffee; alcoholic beverages; flours and pasta; bread. The amounts of each food item were recorded in household measurements, and the corresponding quantities in

grams were estimated with the "Reference table for foods consumed in Brazil" [13].

2.4. Statistical Analyses

Prevalence of FS and FI levels was estimated for the elderly population analyzed in the 2017-2018 POF survey according to the individuals' demographic and socioeconomic characteristics. The means and respective 95% confidence intervals (95% CI) were used for grams of consumption of the food groups according to the situation of FI in the households where these older adults lived.

Generalized linear regression models were adopted to estimate mean consumption of the foods, adjusted for potential confounders: sex, schooling, area of residence and region. A distinct regression model was produced for each food group, with grams of food groups as the dependent variable and FS or levels of household FI as the principal independent variable, besides the other independent variables used to adjust the model. Statistical significance was assessed by comparing 95% confidence intervals (CIs), with non-overlapping intervals indicating a significant difference [18] [19].

We tested for collinearity between FS status and the variables household income per capita and skin color using variance inflation factors (VIFs) and correlation analyses. Both variables showed high collinearity with food security and, therefore, were excluded from the regression models to avoid redundancy and instability of the estimates. Total energy intake was also tested as an adjustment variable in the models, but graphical analysis showed a poor model fit; therefore, this variable was excluded from the final models. All statistical analyses were performed with Statistical Analysis System—SAS® OnDemand for Academics [20], considering the sample's complexity, and the weighting factors were applied and graphs were generated with the R software version 4.2.3 [21], and IDE RStudio version 2023.6.1.524 [22]. The present study used a secondary database from POF conducted in 2017 and 2018, which is publicly and freely available, in which the microdata is on the institution's website (https://www.ibge.gov.br/statistics/social/saude/24786-research-de-orcamentos-families-2.html?=&t=microdados). Therefore, the work does not require consideration by the Research Ethics Committee of the educational institution.

3. Results

Most of the 26,220 Brazilian older adults surveyed were women (56%), lived in urban areas (86%), had self-identified as white (50.6%), and had completed primary school (42%). Most of the older adults relied on retirement benefits and pensions as their primary source of income (62.5%), with only 3.1% enrolled in government cash transfer programs. Prevalence of FI among older adults was 32.1%, with 21.8% in mild FI, 6.8% in moderate FI, and 3.5% in severe FI. Severe FI was more prevalent among older adults who self-identified as brown (4.5%) or Black (4%) and those living in rural areas (5.3%). Prevalence of FI decreased with the

older adults' increasing schooling and per capita income. Illiterate older adults had nearly five times the prevalence of severe FI compared to those with university education. In comparison, those with income below one monthly minimum wage had three times higher prevalence of FI compared to those receiving more than three times the minimum wage (Table 1).

Table 1. Sociodemographic characteristics of elderly Brazilians (≥60 years) according to food security and insecurity. Household Budget Survey (POF), 2017-2018.

Variables	Total	FS		Mild FI		Moderate FI		Severe FI	
	%	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
Total	100.0	67.9	(67.0 - 68.9)	21.8	(20.7 - 22.3)	6.8	(6.4 - 7.3)	3.5	(3.2 - 3.8)
Sex									
Male	44.1	66.6	**(65.2 - 67.8)**	22.6	(21.6 - 23.7)	6.9	(6.2 - 7.5)	3.8	(3.4 - 4.3)
Female	55.9	69.1	**(67.9 - 70.3)**	20.7	(19.6 - 21.7)	6.9	(6.3 - 7.5)	3.2	(2.9 - 3.6)
Age group (in years)									
60 - 69	56.0	67.7	(66.4 - 68.9)	21.7	(20.7 - 22.6)	6.8	(6.3 - 7.5)	3.7	(3.3 - 4.1)
70 - 79	29.5	68.3	(66.8 - 69.8)	21.5	(20.1 - 23.0)	6.8	(6.0 - 7.6)	3.2	(2.8 - 3.7)
>80	14.5	68.5	(66.2 - 70.6)	21.1	(19.3 - 23.0)	7.0	(5.9 - 8.2)	3.4	(2.7 - 4.1)
Skin color									
White	50.6	72.0	**(70.0 - 73.0)**	19.5	**(18.0 - 20.0)**	5.5	**(4.8 - 5.9)**	3.0	**(2.4 - 3.2)**
Black	9.7	64.5	**(61.0 - 66.0)**	23.0	(20.0 - 25.0)	8.5	**(7.0 - 10.0)**	4.0	**(3.2 - 5.1)**
Brown	38.0	63.0	**(61.0 - 64.0)**	24.0	**(22.0 - 25.0)**	8.5	**(7.7 - 9.0)**	4.5	**(4.0 - 4.9)**
Other	1.7	70.0	(62.0 - 76.0)	21.0	(15.0 - 27.0)	8.5	(5.0 - 13.7)	0.5	**(0.2 - 1.2)**
Education									
None	18.0	56.6	**(54.7 - 58.5)**	26.7	**(25.1 - 28.3)**	11.2	**(10.0 - 12.6)**	5.3	**(4.6 - 6.1)**
Elementary	14.6	60.0	**(57.7 - 62.0)**	26.7	**(24.8 - 28.8)**	8.7	**(7.7 - 9.8)**	4.6	**(3.9 - 5.4)**
Junior high	42.0	69.6	**(68.1 - 71.1)**	20.6	**(19.4 - 22.0)**	6.2	**(5.5 - 7.0)**	3.4	**(2.9 - 3.9)**
High school	15.1	73.3	**(71.1 - 75.3)**	19.1	**(17.4 - 21.0)**	5.0	**(4.1 - 6.1)**	2.4	**(1.9 - 3.1)**
University	10.0	83.4	**(81.0 - 85.6)**	12.5	**(10.4 - 14.9)**	2.9	**(2.2 - 3.7)**	1.1	**(0.7 - 1.8)**
Geographic region									
North	5.5	45.6	**(42.2 - 49.1)**	31.8	**(28.7 - 35.1)**	13.1	**(11.3 - 15.1)**	9.3	**(7.6 - 11.4)**
Northeast	25.0	54.4	**(52.8 - 56.0)**	27.4	**(26.2 - 28.6)**	12.2	**(11.1 - 13.4)**	6.0	**(5.2 - 6.6)**
Central-West	6.5	67.3	**(64.2 - 70.2)**	21.7	**(19.0 - 24.6)**	7.0	**(5.2 - 9.2)**	3.8	**(2.9 - 4.9)**
Southeast	47.3	73.1	**(71.4 - 74.7)**	20.0	**(18.6 - 21.5)**	4.7	**(4.1 - 5.4)**	2.1	**(1.7 - 2.5)**
South	15.7	82.4	**(80.8 - 84.0)**	13.0	**(11.7 - 14.5)**	2.5	**(2.0 - 3.1)**	2.0	**(1.5 - 2.5)**
Area of residence									
Urban	85.6	69.4	**(68.3 - 70.5)**	21.1	**(20.1 - 22.1)**	6.2	**(5.7 - 6.6)**	3.2	**(2.9 - 3.5)**
Rural	14.4	59.4	**(57.3 - 61.5)**	24.2	**(22.8 - 25.8)**	11.0	**(9.3 - 12.7)**	5.3	**(4.4 - 6.3)**
Income[a]									
<1 monthly minimum wage	34.5	51.7	**(50.1 - 53.3)**	30.8	**(29.4 - 32.2)**	11.6	**(10.7 - 12.6)**	5.8	**(5.2 - 6.5)**
1 - 2 monthly minimum wages	33.6	70.0	**(68.2 - 71.6)**	21.1	**(19.7 - 22.6)**	6.1	**(5.3 - 7.0)**	2.7	**(2.3 - 3.2)**

Continued

2 - 3 monthly minimum wages	13.5	78.8	**(76.5 - 81.0)**	15.8	**(14.0 - 18.0)**	3.3	**(2.6 - 4.2)**	1.9	**(1.4 - 2.5)**
> 3 minimum wages	20.4	85.5	**(83.6 - 87.1)**	10.1	**(8.7 - 11.7)**	2.3	**(1.8 - 3.0)**	1.9	**(1.5 - 2.5)**
Retirement benefits and pensions									
Yes	62.5	76.8	**(75.3 - 78.2)**	15.6	**(14.5 - 17.0)**	5.3	(4.6 - 6.0)	2.1	**(1.8 - 2.6)**
No	37.5	69.0	**(67.0 - 71.0)**	20.0	**(18.3 - 21.6)**	6.8	(5.8 - 7.9)	4.1	**(3.6 - 4.8)**
Income transfer program									
Yes	3.1	42.6	**(37.0 - 48.4)**	26.1	**(21.6 - 31.1)**	19.6	**(15.0 - 25.3)**	11.5	**(8.9 - 14.8)**
No	96.8	75.0	(73.6 - 76.1)	17.0	**(16.0 - 18.0)**	5.4	**(4.8 - 6.0)**	2.6	**(2.3 - 3.0)**

FS: Food security. FI: Food insecurity. [a]Based on the prevailing monthly minimum wage in 2018: BRL 954.00 (≈US $300.00). Bold indicates statistically significant differences based on non-overlapping 95% CIs. Results are weighted and account for the complex survey design.

Table 2. Means and 95% confidence intervals for diet markers among elderly Brazilians (≥60 years) according to food security and insecurity. Household Budget Survey (POF), 2017-2018.

Food groups (g/ml)	Total		FS		Mild FI		Moderate/severe FI	
	Mean	(95% CI)	Mean	(95% CI)	Mean	(95% CI)	Mean	(95% CI)
Rice and other grains	147	(141 - 152)	142	(136 - 148)	161	(148 - 173)	151	(137 - 167)
Beans and legumes	170	(164 - 176)	165	(158 - 172)	184	(171 - 196)	179	(164 - 196)
Fruits	86	(79 - 92)	97	**(89 - 106)**	60	**(50 - 70)**	55	**(45 - 66)**
Natural juices	105	(99 - 112)	108	**(99 - 116)**	110	(93 - 127)	80	**(65 - 94)**
Greens and vegetables	53	(50 - 56)	58	**(54 - 62)**	47	**(41 - 53)**	34	(26 - 42)
Dairy products	48	(43 - 52)	52	**(47 - 57)**	33	**(26 - 40)**	49	(29 - 69)
Lean meat (beef and pork)	69	(65 - 736)	71	**(67 - 76)**	69	(60 - 78)	49	(41 - 58)
Poultry and eggs	59	(56 - 63)	57	(52 - 61)	63.1	(55 - 71)	70	(59 - 81)
Fish and seafood	17	(12 - 21)	17	(11 - 23)	13	**(9 - 17)**	26	**(18 - 33)**
Roots and tubers	32	(29 - 35)	35	(31 - 38)	26	(20 - 31)	26	(17 - 34)
Bread	50	(48 - 53)	51	(48 - 54)	48	(43 - 52)	46	(40 - 52)
Sodas and sweetened beverages	98	(90 - 106)	101	(91 - 111)	95	(77 - 112)	83	(59 - 108)
Processed meats	8	(7 - 9)	8	(6 - 9)	9	(6 - 11)	11	(7 - 15)
Sweets, candy, cake, cookies	62	(58 - 66)	62	(58 - 65)	67	(56 - 79)	55	(47 - 63)
Oil and fats	11	(10 - 11)	11	(10 - 12)	11	(9 - 12)	9	(6 - 11)
Pizzas, sandwiches, snacks, crackers	41	(38 - 44)	44	(40 - 48)	36	(31 - 41)	35	(22 - 48)
Coffee	172	(165 - 179)	173	(164 - 181)	168	(153 - 183)	175	(145 - 205)
Alcoholic beverages*	38	(28 - 49)	44	**(31 - 58)**	29	(9 - 48)	17	**(4 - 30)**
Flours and pasta	49	(45 - 53)	51	(46 - 58)	40	(33 - 48)	52	(42 - 62)

FS: Food security. FI: Food insecurity. Values are means (grams/day) with 95% confidence intervals. Bold indicates statistically significant differences based on non-overlapping 95% CIs. Results are weighted and account for the complex survey design. *Alcohol intake may be underestimated due to zero-inflated 24HR data.

Older adults with moderate or severe FI showed significantly lower mean intake of fruits, natural juices, vegetables, beef, pork, and alcoholic beverages compared to older adults in FS. Regarding fish and seafood, mean consumption was statistically higher among older adults with moderate or severe FI. Importantly, mean consumption of fruits, vegetables, and alcoholic beverages was two to three times higher in older adults with FS compared to those with moderate or severe FI. Older adults with mild FI showed lower consumption of fish and seafood and dairy products than those with moderate or severe FI and FS, respectively. Meanwhile, mean consumption of the food groups such as rice, beans, bread, coffee, and flour was similar in older adults with FS and both levels of FI (Table 2).

When the means were adjusted for demographic and socioeconomic characteristics, the results were consistent with the crude analysis, except for foods in the alcoholic beverages and fish and seafood groups, which were no longer significantly different (Table 3).

Table 3. Means and 95% confidence intervals for diet markers among elderly Brazilians, adjusted by sex, schooling, area of residence, and geographic regions according to situation of food security and insecurity. Brazilian National Dietary Survey, 2017-2018.

Food groups (g/ml)	FS		Mild FI		Moderate/severe FI	
	Mean	(95% CI)	Mean	(95% CI)	Mean	(95% CI)
Rice and other grains	160	(152 - 167)	172	(159 - 184)	158	(144 - 173)
Beans and legumes	170	(161 - 179)	183	(169 - 197)	177	(158 - 195)
Fruits	103	**(95 - 11)**	70	**(58 - 81)**	66	**(53 - 79)**
Natural juices	112	**(102 - 122)**	113	(95 - 131)	80	**(64 - 96)**
Greens and vegetables	51	**(47 - 55)**	47	(40 - 53)	37	**(29 - 45)**
Dairy products	48	**(42 - 54)**	30	**(22 - 38)**	46	(28 - 63)
Lean meat (beef and pork)	83	**(77 - 88)**	81	(72 - 90)	61	**(52 - 71)**
Poultry and eggs	59	(54 - 64)	64	(56 - 72)	69	(57 - 81)
Fish and seafood	26	(19 - 33)	20	(14 - 26)	32	(22 - 42)
Roots and tubers	33	(28 - 37)	27	(19 - 34)	26	(17 - 35)
Bread	40	(37 - 43)	38	(33 - 42)	37	(31 - 43)
Sodas and sweetened beverages	90	(79 - 102)	94	(76 - 112)	87	(63 - 111)
Processed meats	7	(6 - 8)	8	(6 - 10)	10	(6 - 14)
Sweets, candy, cake, cookies	67	(61 - 72)	70	(60 - 80)	55	(45 - 64)
Oil and fats	9	(8 - 10)	9	(7 - 10)	7,7	(5 - 10)
Pizzas, sandwiches, snacks, crackers	39	(35 - 44)	34	(27 - 40)	34	(21 - 46)
Coffee	169	(159 - 180)	170	(154 - 186)	182	(152 - 212)
Alcoholic beverages*	41	(28 - 54)	32	(11 - 54)	23	(5 - 42)
Flours and pasta	52	(47 - 57)	40	(32 - 48)	51	(41 - 61)

FS: Food security. FI: Food insecurity. Means (grams/day) and 95% confidence intervals estimated by generalized linear regression, with food group intake (grams) as the dependent variable and FS/FI levels, sex, schooling, area of residence, and geographic region as independent variables. Bold indicates statistically significant differences based on non-overlapping 95% CIs. Results are weighted and account for the complex survey design. *Alcohol intake may be underestimated due to zero-inflated 24HR data.

Figure 1 highlights dietary markers that showed significant differences in mean consumption in two or more regions of Brazil. Figure 1(a) shows that unlike nationwide assessments and those in other major geographic regions, older adults living in the North of Brazil with moderate or severe FI consumed twice as much fruit (159 g) as older adults from the same region with FS (79 g).

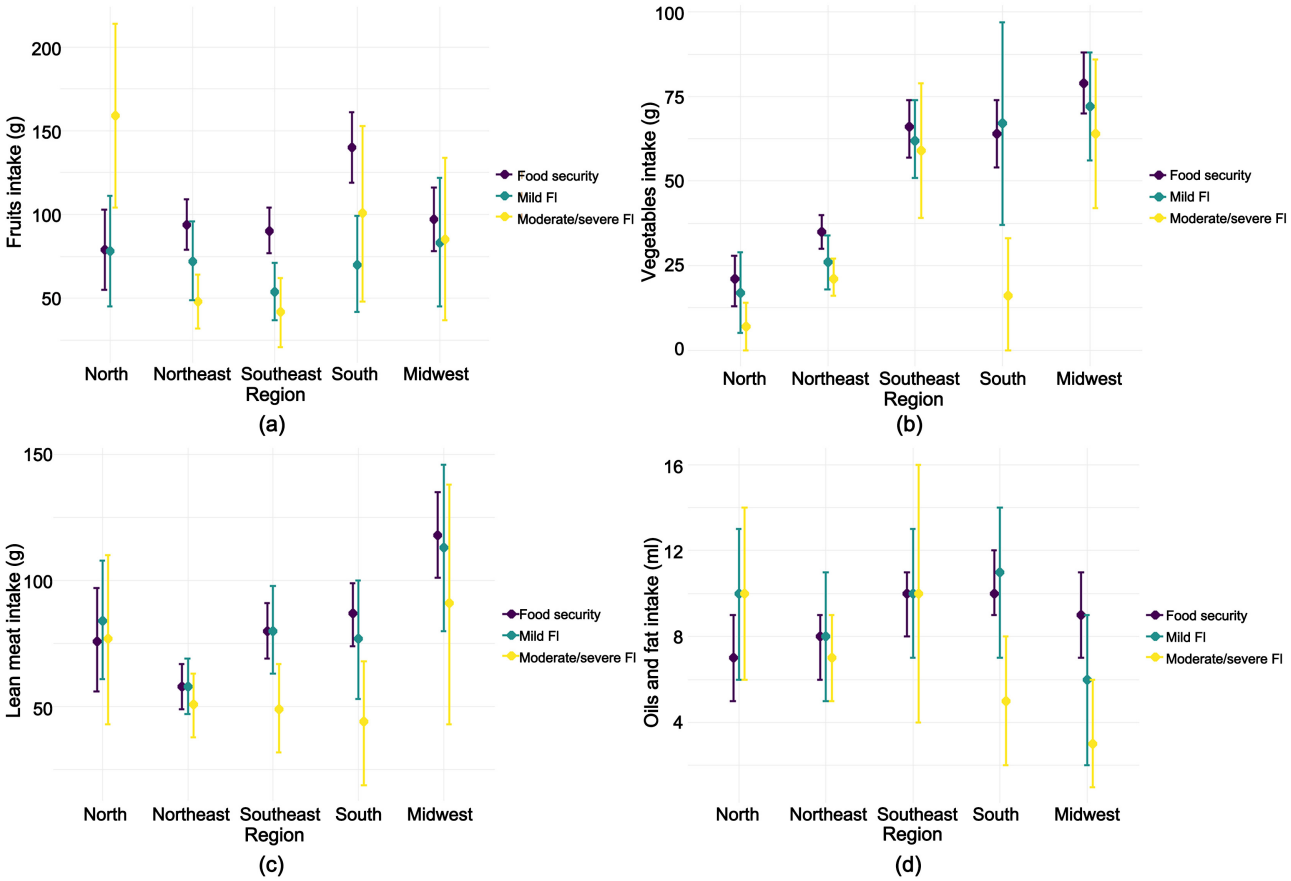

Figure 1. Adjusted means (grams/day) and 95% confidence intervals for selected dietary markers—fruits (a), vegetables (b), beef and pork (c), and oils and fats (d)—according to food security (FS) and food insecurity (FI) status across Brazil's major geographic regions. Data from the Brazilian National Dietary Survey (INA), 2017-2018. Estimates derived from generalized linear regression models, with intake of each food group (grams/day) as the dependent variable and FS/FI levels, sex, schooling, and area of residence as independent variables. Adjusted means were calculated for each FI category within each geographic region.

Analysis of the food group of vegetables (Figure 1(b)) showed that the mean intake decreased as the level of FI deteriorated in all Brazilian regions, especially for older adults living in the South, where mean consumption among those with moderate or severe FI was only one-third the intake of older adults with FS or mild FI in the same region. As for the group of beef and pork (Figure 1(c)), older adults with the most severe level of FI in the Southeast and South showed lower mean consumption than those with FS. Meanwhile, the mean consumption in the group of oil and fats (Figure 1(d)) showed a statistically significant difference in the Midwest and South, where older adults with moderate or severe FI consumed three times less and two times less than those with FS in their respective

regions.

The results in the **Supplementary Material** (Table S1) show the mean intake of all the food groups analyzed according to major geographic region and adjusted by demographic and socioeconomic variables.

4. Discussion

The prevalence of FI was high, with significant differences related to schooling, per capita household income, and place of residence. Older Brazilians with FI exhibited distinct dietary patterns, characterized by significantly lower consumption of essential foods such as fruits, vegetables, and meats. Regional disparities were also identified, with some regions experiencing unique challenges in access to healthy foods.

The prevalence of FI among older Brazilians was 32.1% and is slightly lower than the Brazilian national prevalence of 36.7% for all age groups in the same POF survey in 2017-2018. Studies focusing on specific groups of older people reported higher prevalence rates than in our study, ranging from 21% to 52% some level of FI [7] [10] [20], and specifically ranging from 6% to 10% of severe FI. Meanwhile, a study that assessed FI in households headed by elders with data from the 2017-2018 POF survey found a lower prevalence rate, 29.1% [9]. These differences in FI prevalence among Brazilian older adults may be explained by the characteristics of the elderly groups analyzed, which in some studies concentrated on more economically vulnerable older adults, as well as the period analyzed, since the evolution of FI in Brazil has been marked by important changes over time.

Brazil has experienced significant changes in FI rates in recent years. From 2004 to 2013, FS prevalence increased substantially, from 64.8% to 77.1%, while FI, exceptionally moderate and severe FI, decreased substantially, from 17% to 7.9% in the same period [21]-[24]. In 2014, the country reached an important international target, reducing by half the prevalence of undernutrition, resulting in Brazil's removal from the Food and Agriculture Organization (FAO) "Hunger Map". This success was attributed to factors like inclusive economic growth, improved conditions for family farmers, and strengthened social protection policies [25].

However, key public policies were weakened as of 2016, leading to increasing poverty and worse living conditions. Results from 2018 indicated an increase in the prevalence of FI to 36.1%, with 3.1 million households experiencing hunger. The COVID-19 pandemic was accompanied by a significant increase in FI (58.7% of households), with 33.1 million Brazilians living with hunger [26]. It is therefore likely that the current prevalence of FI among Brazilian older adults is higher than observed in this analysis, signaling the ongoing need for monitoring to ensure better interventions in this age group [27].

The current study's results clearly reveal that FI among Brazilian older adults is strongly associated with multiple socioeconomic and demographic factors, showing that severe FI—commonly referred to as hunger—is associated with the place of residence, skin color, and schooling/income levels. The prevalence of severe FI

was higher in households with older Brazilians who self-identified as brown or Black, living in rural areas, and with lower income. The results corroborate previous studies in the literature, frequently showing a profile of racial and income disparities in relation to FI [28]-[30]. More recent data from the Second Brazilian National Food Insecurity Survey (VIGISAN 2018) found a 70% increase in hunger in the Black population, even with per capita income greater than one minimum wage, while 67% of households with income greater than one minimum wage were in FS [26].

The inverse association between education and FI was also observed by Cabral *et al.* (2013) [31] and Poblacion *et al.* (2016) [32], reporting higher prevalence of severe FI in Brazilian households with school-aged children and lower maternal education (or that of another reference person), thus emphasizing the importance of education for access to foods with sufficient quantity and quality [30].

Another notable finding was that retirement benefits and pensions were the primary sources of income for 62.5% of Brazilian older adults, among whom only 2.1% were in severe FI. This reflects the age group's strong reliance on social security benefits. More recent results from the VIGISAN survey corroborate this observation, indicating that Brazilian households with at least one retired member had a lower prevalence of severe FI, which is more common in households without retirees [26].

Bagni *et al.* (2021) [33] assessed the living conditions and diet of Brazilian households with elderly members who were receiving the Noncontributory Regular Pension (BPC) and found that although the households spent more on food for consumption at home, they experienced worse sociodemographic conditions than nonbeneficiary households and lower acquisition of natural and minimally processed foods.

Although the BPC helps mitigate FI in low-income Brazilian older adults, it is not sufficient on its own to ensure FS. The results showed that 23% of Brazilian older adults who receive the benefit still suffer some level of FI, indicating that even after contributing to society throughout their lives, they still face challenges to maintain an adequate diet. Rosales *et al.* (2022) [34] assessed the impact of the BPC on nutritional status and FI in Brazilian older adults. They highlighted that although the benefit aims to increase older adults' income, there are broader structural issues with FI that the program alone cannot address. This underscores the need for complementary policies and programs that address not only income but also food and nutritional security in these more vulnerable individuals [35].

The current results also showed that 11.5% of elderly beneficiaries of income transfer programs lived in households affected by severe FI. This emphasizes that these benefits are being directed toward households experiencing the most significant social vulnerability [23] [36], corroborating Silva and Bento (2019) [37], who assessed FI in households supported economically by elderly beneficiaries of the Bolsa Família program in Goiás state and found 28% prevalence of severe FI in the households followed by the study.

Regarding differences in food consumption among older adults by level of FI, the study found reduced consumption of healthy diet markers such as fruits, natural juices, vegetables, legumes, and protein sources such as beef and pork among older adults in households affected by moderate or severe FI. The same was observed by Coletro *et al.* (2023) [38], associating FI with less healthy eating, with low intake of natural and minimally processed foods and less dietary diversity.

Previous studies by Cavalcante Martins *et al.* (2015) [39], da Silva Guerra *et al.* (2018) [40], and Cardozo *et al.* (2020) [41] in residents of Ceará state, Amazonia, and São Paulo state, respectively, found that households with FI often experience difficulties in accessing healthy foods at affordable prices, making them more likely to reduce consumption of these food groups. In addition, retail outlets offering healthy foods are less common in socioeconomically disadvantaged neighborhoods, making them less available in low-income areas [41], which concentrate most of the individuals with some level of FI.

Some markers of unhealthy diet, such as alcoholic beverages, sodas, sweetened beverages, sweets and candy, oil and fats, and snacks, were also consumed in smaller amounts by older adults with moderate or severe FI. Rodrigues *et al.* (2021) [3], who evaluated food consumption data from the latest POF, reported that lower-income individuals consumed more items classified as part of a healthy diet, such as rice and beans; meanwhile, some negative markers of diet quality, such as sodas and sandwiches, were consumed more by higher-income individuals.

Another factor that may explain the lower consumption of unhealthy beverages and foods such as sodas, sweets, candy, and snacks among older adults with moderate or severe FI is the prioritization of food choices. This may reflect greater emphasis on the purchase of staple foods rather than processed food products [42] [43]. In addition, considering the high prevalence of comorbidities in this population, especially health conditions that require specific diets, these older adults may be making food choices that are more consistent with their nutritional needs [26].

An unexpected finding of the current analysis was the lower consumption of alcoholic beverages among Brazilian older adults in households with moderate or severe FI (three times lower than among older adults with FS). However, it is important to highlight that 24HR underestimates the consumption of episodic foods, zero-inflated foods, and alcoholic beverage consumption. Therefore, the observed differences should be interpreted with caution, as they may partly reflect methodological limitations rather than actual differences in alcohol consumption among older Brazilians.

The food groups with higher consumption among Brazilian older adults living in households with moderate or severe FI included chicken, other poultry, eggs, fish, seafood, cold cuts, and processed meats. Rodrigues *et al.* (2021) [3] reported that lower-income Brazilians tended to consume more processed meats. These variations reflect potential dietary adaptations among individuals with FI to se-

cure sufficient calorie intake, since these foods are a cheaper source of protein [44] [45].

The groups of rice, beans, dairy products, coffee, and flour showed similar consumption levels among older Brazilians, regardless of the level of FI. This stability likely reflects their role as staple foods with a national consumption pattern, supported by their broad availability and affordability in the Brazilian market. They are often cheaper and more widely available in Brazilian supermarkets, making them more accessible to the population, even in situations of FI [44]. These foods are commonly found in supermarkets across the country and are often included in government food baskets distributed to low-income households, ensuring access even in situations of FI [41] [44]. As a result, they tend to occupy a larger share of low-income diets, often replacing more expensive foods such as meat and vegetables. In contrast, other food groups such as fruits, vegetables, fish, and meats display more substantial regional variation, as their consumption depends more heavily on the financial availability of households, local availability, cultural practices, and food environments [46]. Another key aspect is the predominant dietary pattern among Brazilian older adults described by Araujo *et al.* (2021) [47] and Hough and Sosa (2015) [45] as "coffee with milk and bread with butter", characterized by low variety and limited nutritional values.

The indicators on the consumption of alcoholic beverages and fish and seafood were no longer statistically significant after adjustment, which may be partly explained by the influence of adjustment variables such as sex, schooling, area of residence, and geographic region on the estimates. In particular, stratified analyses showed that the higher consumption of fish and seafood among older adults with moderate or severe FI was concentrated in the North and was not observed consistently across the country. This regional pattern is likely related to the greater availability and cultural importance of fish in coastal and riverine areas, where small-scale fishing plays a vital role in promoting food security. Small-scale family fishers provide an essential source of nutritionally important animal protein, diversify local diets, and generate income for their households [48] [49]. Therefore, this finding should not be interpreted as a nationwide trend, but rather as a reflection of region-specific food environments.

As for alcohol consumption, older adults in Southeast Brazil with moderate or severe FI showed tenfold lower intake than those in households with FS, lower than the national mean and other regions of the country. Regional differences in the consumption of foods among older adults living in households with moderate or severe FI are an important aspect for analysis. Eating habits varied across geographic regions, demonstrating that cultural and regional factors influence food choices in this population [49]-[51].

Ygnatios *et al.* (2023) [52] assessed the diet of Brazilian older adults in the ELSI-Brasil study. They found that households living outside of the country's large metropolises showed higher levels of self-production of food and greater access to local food items. This discovery helps explain why certain foods were more fre-

quently consumed by older adults with moderate or severe FI in specific Brazilian regions. A wide diversity of eating habits is observed across the Brazilian population [50] due to Brazil's large territory and the climatic, cultural, and economic variations between its geographic regions. dos Anjos Campos Coelho and Gubert (2015) [53] studied adolescents in the country's 26 capital cities and also found a positive association between FI and higher consumption of regional fruits and vegetables. Thus, the promotion of the production and consumption of these regional foods may be an effective strategy to foster a healthy diet in this population. The support for family farming and affordable prices is a measure that can increase consumption of these foods and improve the health of older adults, particularly in rural areas and in the North and Northeast [50] [53].

The results indicate that Brazilian older adults with moderate or severe FI face restricted access to foods such as fruits, vegetables, beef, and pork, placing them at increased risk of nutrient deficiencies. Low fruit intake may result in deficiencies of vitamin C, potassium, magnesium, and dietary fiber. Inadequate consumption of vegetables and legumes can compromise intake of vitamins A, C, and K. In contrast, reduced intake of beef and pork limits the supply of high-quality proteins, B-complex vitamins, and minerals such as zinc. Deficiencies in these nutrients are associated with anemia, cardiovascular disease, impaired immune function, and neurological disorders, all of which may accelerate frailty and functional decline [54] [55]. From a public health perspective, these findings underscore the urgent need for strategies to prevent nutrient deficiencies in vulnerable elderly populations, such as nutrition education, targeted supplementation programs, and improved access to affordable fresh produce and protein sources.

The current study is particularly relevant in light of the recent "Brazil Without Hunger" Plan [56], since it is vital in monitoring FI among older adults. By focusing attention on a group that is frequently underrepresented in studies on FI, the study helps expand understanding of the nutritional needs and health conditions of this population group. The study also allows an approach that considers the household context, strengthening efforts to promote equality and well-being for all Brazilians.

The study has some limitations, such as the fact that the data were collected in permanent private households, excluding Brazilian older adults living in long-term care institutions and homeless older adults, who experience greater vulnerability and worse health and living conditions. Another limitation is the use of consumption data from single 24-hour recalls, which does not allow the assessment of this population's usual dietary patterns, only reflecting their single-day dietary intake. In addition, FI was assessed at the household level, whereas dietary intake was measured at the individual level. This mismatch may have introduced misclassification, as individuals living in the same household may have different dietary behaviors, potentially affecting the associations observed between food insecurity and food consumption. Finally, as this was a cross-sectional study, the temporal relationship between food insecurity and dietary intake cannot be established, which pre-

cludes any inference of causality.

However, the study's results revealed, for the first time, that older Brazilians with moderate or severe FI tend to have lower consumption of food group markers of a healthy diet, such as fruits, vegetables, legumes, and vegetable-based preparations, as well as protein-rich foods such as beef and pork. In contrast, older adults with FI consumed more foods from groups associated with lower-cost products, including cold cuts, processed and canned meats, poultry and eggs, and fish and seafood. Notably, no significant differences were found in the consumption of traditional Brazilian staples such as rice, beans, and legumes among Brazilian older adults living in households with FS compared to those with FI. These variations in dietary intake among Brazilian older adults emphasize the need for targeted public policies, including region-specific strategies that account for cultural and socioeconomic differences. Examples include programs to improve access to fruits, vegetables, and lean meats, food subsidy initiatives, and actions that respect and preserve traditional dietary practices. Such measures are essential to reduce nutritional disparities and ensure equitable access to a healthy diet for Brazilian older adults.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Supplementary Material

Table S1. Means and 95% confidence intervals for diet markers among elderly Brazilians adjusted by sex, schooling, and area of residence according to a situation of food security and insecurity and major geographic regions. Brazilian National Dietary Survey, 2017-2018.

Food groups (g/ml)	North					
	FS		Mild FI		Moderate/severe FI	
	Mean	(95% CI)	Mean	(95% CI)	Mean	(95% CI)
Rice and other grains	161	(136 - 185)	136	(110 - 162)	131	(103 - 160)
Beans and legumes	173	(132 - 214)	160	(122 - 199)	139	(90 - 188)
Fruits	**79**	**(55 - 103)**	78	(45 - 111)	**159**	**(104 - 214)**
Natural juices	105	(73 - 137)	105	(66 - 143)	97	(52 - 142)
Greens, vegetables, and vegetable-based preparations	21	(13 - 28)	17	(5 - 29)	7	(0 - 14)
Dairy products	18	(6 - 30)	23	(5 - 41)	13	(0 - 26)
Beef and pork	76	(56 - 97)	84	(61 - 108)	77	(43 - 110)
Poultry and eggs	61	(45 - 78)	56	(36 - 75)	94	(57 - 130)
Fish and seafood	48	(31 - 64)	32	(14 - 50)	67	(37 - 98)
Roots and tubers	18	(1 - 35)	14	(1 - 30)	16	(0 - 32)
Bread	33	(23 - 42)	44	(31 - 57)	40	(26 - 54)
Sodas and sweetened beverages	69	(37 - 102)	67	(32 - 103)	77	(39 - 114)
Cold cuts, processed meats, canned meats	14	(1 - 27)	13	(1 - 24)	14	(3 - 24)
Sweets and candy	62	(43 - 82)	71	(46 - 96)	74	(49 - 100)
Oil and fats	7	(5 - 9)	10	(6 - 13)	10	(6 - 14)
Pizzas, sandwiches, snacks	41	(28 - 55)	26	(15 - 38)	37	(19 - 55)
Coffee	135	(112 - 158)	147	(114 - 181)	124	(84 - 163)
Alcoholic beverages	32	(0 - 67)	2	(0 - 14)	24	(0 - 59)
Flours and pasta	**76**	**(58 - 95)**	**69**	**(50 - 89)**	**133**	**(98 - 168)**
Food groups (g/ml)	**Northeast**					
	FS		Mild FI		Moderate/severe FI	
	Mean	(95% CI)	Mean	(95% CI)	Mean	(95% CI)
Rice and other grains	165	(151 - 179)	180	(156 - 204)	187	(164 - 211)
Beans and legumes	168	(150 - 185)	167	(145 - 189)	191	(166 - 216)
Fruits	**94**	**(79 - 109)**	72	(49 - 96)	**48**	**(32 - 64)**
Natural juices	148	(129 - 167)	132	(110 - 155)	110	(86 - 134)
Greens, vegetables, and vegetable-based preparations	**35**	**(30 - 40)**	26	(18 - 34)	**21**	**(16 - 27)**
Dairy products	59	(46 - 72)	44	(31 - 57)	45	(17 - 72)
Beef and pork	58	(49 - 67)	58	(47 - 69)	51	(38 - 63)
Poultry and eggs	73	(64 - 83)	82	(69 - 95)	83	(65 - 101)
Fish and seafood	21	(15 - 27)	26	(14 - 38)	37	(22 - 53)

Continued

Roots and tubers	42	(32 - 52)	43	(22 - 64)	27	(14 - 41)
Bread	36	(31 - 41)	35	(28 - 42)	41	(32 - 50)
Sodas and sweetened beverages	55	(42 - 68)	72	(53 - 92)	49	(28 - 71)
Cold cuts, processed meats, canned meats	10	(7 - 13)	11	(6 - 15)	15	(8 - 22)
Sweets and candy	**85**	**(74 - 96)**	**89**	**(75 - 103)**	**60**	**(49 - 72)**
Oil and fats	8	(6 - 9)	8	(5 - 11)	7	(5 - 9)
Pizzas, sandwiches, snacks	41	(35 - 48)	36	(28 - 44)	38	(25 - 50)
Coffee	144	(126 - 162)	160	(126 - 193)	158	(130 - 186)
Alcoholic beverages	33	(15 - 51)	27	(9 - 45)	47	(11 - 83)
Flours and pasta	56	(48 - 63)	58	(47 - 69)	53	(42 - 64)

Food groups (g/ml)	**Central-West**					
	FS		**Mild FI**		**Moderate/severe FI**	
	Mean	**(95% CI)**	**Mean**	**(95% CI)**	**Mean**	**(95% CI)**
Rice and other grains	208	(189 - 227)	190	(161 - 219)	158	(92 - 224)
Beans and legumes	222	(199 - 245)	236	(196 - 276)	221	(167 - 275)
Fruits	97	(78 - 116)	83	(45 - 122)	85	(37 - 134)
Natural juices	105	(83 - 127)	81	(39 - 124)	90	(32 - 147)
Greens, vegetables, and vegetable-based preparations	79	(70 - 88)	72	(56 - 88)	64	(42 - 86)
Dairy products	47	(27 - 66)	29	(6 - 52)	91	(1 - 182)
Beef and pork	118	(101 - 135)	113	(80 - 146)	91	(43 - 138)
Poultry and eggs	62	(48 - 76)	59	(39 - 78)	76	(48 - 103)
Fish and seafood	9	(4 - 13)	4	(0 - 8)	10	(0 - 20)
Roots and tubers	34	(25 - 42)	21	(9 - 32)	19	(4 - 33)
Bread	**39**	**(32 - 45)**	**20**	**(10 - 31)**	20	(2 - 38)
Sodas and sweetened beverages	117	(89 - 144)	134	(66 - 201)	49	(0 - 99)
Cold cuts, processed meats, canned meats	6	(2 - 10)	6	(1 - 10)	6	(0 - 11)
Sweets and candy	57	(46 - 68)	52	(32 - 72)	63	(26 - 99)
Oil and fats	**9**	**(7 - 11)**	6	(2 - 9)	**3**	**(1 - 6)**
Pizzas, sandwiches, snacks	39	(30 - 48)	35	(19 - 52)	40	(11 - 69)
Coffee	166	(140 - 191)	143	(87 - 199)	154	(105 - 204)
Alcoholic beverages	32	(14 - 50)	54	(0 - 157)	16	(0 - 17)
Flours and pasta	29	(21 - 37)	14	(3 - 25)	19	(0 - 38)

Food groups (g/ml)	**South**					
	FS		**Mild FI**		**Moderate/severe FI**	
	Mean	**(95% CI)**	**Mean**	**(95% CI)**	**Mean**	**(95% CI)**
Rice and other grains	133	(119 - 147)	162	(128 - 196)	127	(85 - 169)
Beans and legumes	**129**	**(113 - 145)**	**188**	**(150 - 225)**	137	(91 - 183)

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Fruits	**140**	**(119 - 161)**	**70**	**(42 - 99)**	101	(48 - 153)
Natural juices	115	(92 - 139)	167	(110 - 224)	85	(28 - 143)
Greens, vegetables, and vegetable-based preparations	**62**	**(54 - 74)**	**67**	**(37 - 97)**	**16**	**(0 - 33)**
Dairy products	39	(29 - 49)	26	(5 - 48)	39	(8 - 70)
Beef and pork	**87**	**(74 - 99)**	77	(53 - 100)	**44**	**(19 - 68)**
Poultry and eggs	57	(45 - 70)	73	(48 - 99)	86	(30 - 143)
Fish and seafood	14	(7 - 21)	13	(3 - 23)	8	(0 - 17)
Roots and tubers	58	(45 - 71)	50	(32 - 67)	89	(40 - 138)
Bread	42	(37 - 48)	40	(32 - 48)	36	(23 - 48)
Sodas and sweetened beverages	120	(93 - 148)	100	(53 - 147)	104	(31 - 178)
Cold cuts, processed meats, canned meats	10	(7 - 13)	4	(1 - 7)	6	(1 - 12)
Sweets and candy	72	(62 - 81)	67	(51 - 84)	63	(18 - 109)
Oil and fats	**10**	**(9 - 12)**	11	(7 - 14)	**5**	**(2 - 8)**
Pizzas, sandwiches, snacks	40	(32 - 48)	48	(26 - 69)	36	(7 - 65)
Coffee	210	(182 - 237)	224	(171 - 277)	168	(108 - 227)
Alcoholic beverages	53	(26 - 80)	36	(0 - 74)	16	(0 - 77)
Flours and pasta	58	(43 - 74)	48	(22 - 75)	58	(8 - 107)

Food groups (g/ml)	Southeast					
	FS		Mild FI		Moderate/severe FI	
	Mean	(95% CI)	Mean	(95% CI)	Mean	(95% CI)
Rice and other grains	156	(142 - 171)	171	(147 - 196)	147	(120 - 174)
Beans and legumes	205	(187 - 222)	220	(195 - 245)	202	(162 - 241)
Fruits	**90**	**(77 - 104)**	**54**	**(37 - 71)**	**42**	**(21 - 62)**
Natural juices	83	(69 - 97)	87	(55 - 118)	41	(13 - 69)
Greens, vegetables, and vegetable-based preparations	66	(57 - 74)	62	(51 - 74)	59	(39 - 79)
Dairy products	56	(45 - 67)	34	(19 - 48)	57	(26 - 89)
Beef and pork	**80**	**(69 - 91)**	80	(63 - 98)	**49**	**(32 - 67)**
Poultry and eggs	53	(46 - 61)	56	(41 - 71)	53	(33 - 72)
Fish and seafood	19	(7 - 31)	8	(0 - 17)	17	(5 - 30)
Roots and tubers	28	(21 - 35)	18	(10 - 26)	27	(8 - 47)
Bread	50	(44 - 55)	46	(36 - 57)	35	(23 - 47)
Sodas and sweetened beverages	97	(76 - 118)	94	(61 - 128)	119	(60 - 179)
Cold cuts, processed meats, canned meats	4	(2 - 6)	7	(3 - 11)	8	(1 - 16)
Sweets and candy	58	(49 - 66)	64	(38 - 89)	49	(32 - 66)
Oil and fats	10	(8 - 11)	10	(7 - 13)	10	(4 - 16)
Pizzas, sandwiches, snacks	37	(30 - 44)	30	(19 - 41)	26	(2 - 57)

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Coffee	195	(177 - 213)	184	(157 - 2110	230	(150 - 310)
Alcoholic beverages	37	(18 - 56)	30	(0 - 65)	3	(0 - 23)
Flours and pasta	46	(37 - 56)	27	(12 - 41)	40	(18 - 61)

FS: Food security. FI: Food insecurity. Means and 95% confidence intervals by generalized linear regression with mean dietary intake of each food group as the dependent variable; and independent variables FS and FI levels, sex, schooling, and area of residence. Adjusted means were estimated for each degree of FI and major geographic regions of Brazil. Bold indicates statistically significant differences based on non-overlapping 95% CIs.