Ciência & Saúde Coletiva
cienciaesaudecoletiva.com.br
ISSN 1413-8123. v.30, n.5
DOI: 10.1590/1413-81232025305.10582023EN

Factors associated with the Dietary Total Antioxidant Capacity of the Brazilian population

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Abstract *The aim is to assess whether socioeconomic and demographic conditions are associated with the Dietary Total Antioxidant Capacity (DTAC) of the Brazilian population. Study conducted with 46,164 Brazilians, aged 10 or over, evaluated by the Household Budget Survey (Pesquisa de Orçamentos Familiares – POF 2017-2018). Food consumption was assessed through a 24-hour recall, with DTAC determined by calculating the sum of the antioxidant content of the intake of each food, taken from a database containing information on the DTAC value in mmol/100g of 3,100 foods. Multinomial logistic regression models were proposed to test the relationship between socioeconomic factors and DTAC. The median DTAC was 3.48 (0.62-24.55) mmol/1000 Kcal. Women, older individuals (adults and the elderly), and residents of rural areas and the Northeast, South, and Southeast regions of the country showed a higher intake of antioxidants. By contrast, individuals with higher educational and income levels presented lower DTAC values. The socioeconomic and demographic scenario was associated with the consumption of antioxidants, reinforcing the importance of identifying risk groups for inadequate nutrition in order to better guide the implementation of public policies and nutritional interventions.*

Key words *Diet, Food consumption, Antioxidants, Socioeconomic factors*

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Introduction

Dietary Total Antioxidant Capacity (DTAC) can be defined as a tool used to evaluate the intake of antioxidants. It consists of an index that is useful when evaluating the quality of one's diet, since it takes into consideration the several chemical forms of antioxidants in the food, as well as the different levels of antioxidant capacity and the cumulative or synergistic effects they may have upon the body. One study conducted with the American population identified that DTAC may be an important predictor of all-cause mortality[1], since its result is directly associated with the level of oxidative stress in the body[2]. Moreover, this tool may be used as a marker of dietary quality, with implications for research regarding the onset, the installation, and the development of chronic diseases[3].

Noncommunicable diseases (NCDs) are responsible for 74% of all deaths worldwide[4], and an inadequate diet is considered one of the main risk factors for both the decrease in quality of life and the increase in mortality[5]. Studies about DTAC have been conducted internationally[6,7] and in different age groups[8,9]. However, studies with Brazilian data are scarce[9], especially regarding factors associated with the intake of antioxidants. It is also important to highlight that the results are conflicting in terms of the association between the quality of one's eating habits and sociodemographic and economic conditions[10,11]. Therefore, understanding the factors associated with inadequate eating habits, in the perspective of a low consumption of antioxidants, allows for the identification of risk groups for this condition.

Considering that socioeconomic conditions influence one's diet, and that dietary antioxidant capacity is a modifiable risk factor for the occurrence of NCD, the present study aimed to evaluate how socioeconomic and demographic conditions are associated with DTAC in the Brazilian population.

Methodology

This is a cross-sectional study that analyzed secondary data from the National Diet and Nutrition Survey (*Inquérito Nacional de Alimentação* - INA), conducted by the Brazilian Institute for Geography and Statistics (IBGE), in a sub-sample of the latest edition of the Household Budget Survey (*Pesquisa de Orçamentos Familiares* - POF), 2017-2018[12].

This survey used a representative sample of the Brazilian population, generating estimates for the five major regions of the country, for rural and urban areas, and for different socioeconomic levels. For sample selection, a common sample – or master sample – was used, designed by the IBGE based on the Integrated System of Household Surveys (*Sistema Integrado de Pesquisas Domiciliares* - SIPD). A conglomerate sampling plan was used, divided into two stages. The primary sampling units (PSU) were derived from the master sample, which is comprised of a set of census sectors. The selection of PSUs was conducted by sampling, with the probability proportional to the number of households in each sector. In the second stage, households were selected by simple random sampling. The sectors were distributed into the four quarters of the year of the study. Methodology details were described elsewhere[13].

In POF 2017-2018, a total of 57,920 households was selected. For the INA, 20,112 households, with 46,164 individuals older than 10 years of age, were evaluated.

Socioeconomic and demographic variables were obtained by means of interviews conducted in the households. The present study used data referent to: sex (female and male), categorized age range (10 to 19, 20 to 59, and 60 years or over), self-reported race/color (white, brown, black, yellow, and indigenous), categorized education (up to 4, 4 to 8, 9 to 11, and 12 or more years of education) , family income in reais (R$) categorized by quartiles (<1,927.00; 1,927.00 to 3,183.73; 3,183.74 to 5,454.99; >5,454.99), household location (urban and rural), and geographic region of the country (North, Northeast, Southeast, South, and Midwest).

Easting was evaluated by means of two recording processes of 24 hours on non-consecutive days, following the multiple steps method[14], with detailed information about the quantity consumed, times and places of consumption, times of meals, and ways of cooking specific foods. In the present study, data from the first day of consumption was used. For the estimation of quantity consumed by individuals, the study used the measurement tables of foods consumed in Brazil, according to the the INA 2017-2018, with respective quantities in grams or milliliters. To estimate the amount of calories consumed, the study used the Brazilian Table of Food Composition (*Tabela Brasileira de Composição de Alimentos* - TBCA), from Universidade de São Paulo (USP), Food Research Center (FoRC), version 7.0 (Available at http://www.fcf.usp.br/tbca).

To determine the DTAC, a database was used with information on the value of the CAT of 3,100 foods in mmol/100 g[15]. This database was produced through a compilation of laboratorial analyses (FRAP trial) of foods from different countries; therefore, it is possible to verify details about the foods, such as the country of origin and product brand.

Whenever the value of CAT for a food was not available in the database, the values of botanically similar foods were considered. Moreover, when there was no established CAT value for a cooked food, the *in natura* CAT levels were considered. In terms of culinary preparation, the recipe for preparing the foods was standardized, the ingredients were separated, and the CAT was calculated for each item.

The CAT value for each food, established by the database and relevant articles, was multiplied by the quantity consumed in grams, resulting in the antioxidant content consumed in each food. The DTAC was calculated by determining the sum of the antioxidant capacity of all of the foods consumed[16], and the final value is expressed in 1,000 Kcal, with the purpose of adjusting the consumption by the total energy in the diet. Other studies have conducted energetic adjustment as well[8,9], aimed at analyzing the effect of the nutrient with no energetic influence[17].

The results were described in averages when they were continuous variables, or in frequency percentages when categoric, with their respective 95% confidence intervals, given the complexity of the design and the sample weights. The normality of the data was evaluated by the Shapiro-Wilk test. To compare the DTAC averages among the evaluated groups, the Student t test and ANOVA with Bonferroni *post hoc* were used.

The total antioxidant capacity of the diet in each quartile was considered to be a dependent variable, and the socioeconomic and demographic conditions of individuals, to be the explanatory variables. Models of multinomial logistic regression were proposed in order to establish the relationship between dependent and independent variables. As such, a bivariate analysis was conducted with the variables, and the predicting variables which presented a p-value below 20%, were inserted into the multivariate regression model by means of the backward method. Those with less significance were removed from the model one by one. The procedure was repeated until all of the variables present in the model had statistical significance. The level of statistical significance adopted in this study was 5%.

The analyses were conducted in the Strata program, version 14.0 (SPSS Inc., Chicago, IL, USA).

Results

Among the evaluated individuals, the majority were female, adult, of black or brown race, and residing in urban areas. Almost half of the individuals had 12 or more years of education and resided in the Southeast region of the country (Table 1).

The DTAC value ranged from 0.62 to 24.55 mmol/1,000 Kcal, with a 3.48 mmol/1,000 Kcal median. Women showed a significantly higher intake of antioxidants than men. Likewise, teenagers showed a lower intake of antioxidants in comparison to adults and the elderly. Differences were also observed in the intake of antioxidants according to geographic region. The lowest and the highest consumption of antioxidants were observed in the North and South regions of the country, respectively (Table 1).

After the bivariate analysis, it was observed that women had a 1.7-fold higher prevalence in the consumption of antioxidants (last quartile) when compared to men. Moreover, adults and elderly residing in rural areas and living in the Northeast, Southeast, and South regions of the country also presented a higher consumption of antioxidants. Furthermore, individuals with higher educational and income levels showed a lower prevalence in terms of belonging to the last quartile of the DTAC scores, in other words, less prevalence in having a diet with more antioxidant potential (Table 2).

In the final model, a higher prevalence of a better antioxidant diet (last quartile) was observed in female individuals, adult and elderly, and residing in rural areas. Moreover, residents from the Northeast, South, and Southeast regions presented a diet with more antioxidant potential. In contrast, higher educational and income levels were inversely associated with higher antioxidant consumption (Table 3).

Discussion

In the present study, the socioeconomic and demographic situation was significantly associated with the consumption of antioxidants. Individuals who were female, either adult or elderly, residing in rural areas and in the Northeast, South, and Southeast regions of the country had

Table 1. Dietary total antioxidant capacity (DTAC) adjusted for energy. according to socioeconomic and demographic characteristics. Brazil. 2017-2018.

Variable	%	DTAC adjusted by energy (mmol/1.000 Kcal)
		Average (95%CI)
Sex		
Male	48.1	4.7 (4.5-4.9)
Female	51.9	5.7 (5.4-5.9)
Age		
Adolescent	17.7	3.8 (3.6-4.1) [a]
Adult	64.7	5.4 (5.2-5.6) [b]
Elderly	17.6	5.7 (5.4-6.1) [b]
Race		
White	43.1	5.4 (5.1-5.6)
Black and brown	55.8	5.1 (4.9-5.2)
Yellow and indigenous	1.1	6.7 (4.3-9.1)
Education		
Up to four years	12.3	5.4 (5.1-5.8)
4 to 8 years	29.5	5.0 (4.8-5.3)
9 to 11 years	16.8	5.3 (4.9-5.7)
12 years or more	41.4	5.2 (5.0-5.5)
Income		
1st quartile	21.4	5.4 (5.1-5.7)
2nd quartile	22.8	5.0 (4.7-5.2)
3rd quartile	25.2	5.1 (4.9-5.4)
4th quartile	30.6	5.3 (5.0-5.6)
Household location		
Urban	85.6	5.2 (5.0-5.3)
Rural	14.4	5.3 (5.0-5.6)
Region		
North	8.3	4.6 (4.3-5.0) [a]
Northeast	27.0	4.9 (4.6-5.1) [a]
Southeast	42.6	5.6 (5.3-5.9) [bc]
South	14.5	6.1 (5.6-6.6) [c]
Midwest	7.6	5.1 (4.7-5.6) [abc]

Notes: Student's t test and variance analysis (Anova) with Bonferrone post hoc. a,b,cAverage values on the same line with different overlapping letters are significantly different.

Source: Authors.

a diet with more antioxidant potential. On the other hand, lower educational and income levels were associated with lower DTAC.

The daily consumption of antioxidants was 5.2±6.1 mmol/1,000 Kcal. To the best of our knowledge, this is the first study to evaluate DTAC in the Brazilian population, based on a significant sample and taking into consideration all of the foods ingested in one day. Koehnlein *et al.*[18] used data from POF 2008-2009 to evaluate the level of antioxidants in the 36 foods most eaten by Brazilians and found an average of 10.3 mmol/d. Still, the DTAC found in this study is lower than that observed among Iranian adults (7.8 mmol/d)[19]. However, such differences may be attributed, in part, to the energetic adjustment used in our work, which is not present in other studies. Such an adjustment has the purpose of preventing that the effect of one specific nutrient being confounded or distorted by the total energetic consumption of the individual[17].

Women presented a higher intake of antioxidants, which corroborates with other studies that proved that the female population has a better quality of diet, takes better care of health and the body[20], has better nutritional knowledge, and includes healthier foods in her diet[21]. Evidence indicates that women consume more fruits, vegetables, and legumes than do men[11], and these food categories are among those that contribute the most in terms of antioxidants[22]. It is important to remember that the tea category provides a great contribution for the antioxidant potential of the diet[9], and it is more commonly consumed by the female segment, with the purpose of losing weight, among other reasons[23].

Age was among the factors associated with dietary antioxidant potential in the Brazilian population. Adults and elderly individuals showed a higher intake of antioxidants when compared to teenagers. It is assumed that older individuals are more prone to the adoption of a healthy lifestyle due to the understanding of the importance of an adequate diet for health, or because it is required to treat an NCD, given that the segment has a higher prevalence of such diseases[24]. Moreover, generational differences in food consumption may explain the fact that adults and elderly individuals have a higher quality diet. Hence, their eating habits were acquired at a time when there was less availability of ultra-processed foods[25].

This finding is worrisome, since an increase has already been noticed in terms of NCDs among young individuals[26]. Moreover, worse quality diets during adolescence may favor the adoption of habits that will last into adult life and favor the event of diseases associated with inadequate eating habits[5,26]. One study, which evaluated the evolution of the foods most consumed in Brazil between 2008-2009 and 2017-2018, identified a reduction in the consumption of fruits by the population, which was more evident among teenagers[27].

Table 2. Analysis of the bivariate multinomial logistic regression of the factors associated with the Dietary Total Antioxidant Capacity (DTAC) of the Brazilian population. Brazil, 2017-2018.

Variável	DTAC adjusted by energy (mmol/1.000 Kcal)		
	2nd quartile (2.36-3.48)	3rd quartile (3.49-5.17)	4th quartile (>5.17)
	RP (95%CI)	RP (95%CI)	RP (95%CI)
Sex			
Male	1.0	1.0	1.0
Female	1.2 (1.1-1.2)	1.4 (1.3-1.5)	1.7 (1.5-1.8)
Age			
Adolescent	1.0	1.0	1.0
Adult	1.7 (1.6-1.9)	2.0 (1.8-2.2)	2.6 (2.4-3.0)
Elderly	2.0 (1.8-2.4)	2.8 (2.4-3.3)	4.8 (4.1-5.5)
Race			
White	1.0	1.0	1.0
Black and brown	1.0 (0.9-1.1)	1.0 (0.9-1.1)	1.0 (0.9-1.1)
Yellow and indigenous	1.4 (0.9-2.3)	1.1 (0.7-1.6)	1.1 (0.7-1.7)
Education			
Up to four years	1.0	1.0	1.0
4 to 8 years	0.8 (0.7-0.9)	0.7 (0.6-0.8)	0.6 (0.6-0.7)
9 to 11 years	0.8 (0.7-0.9)	0.7 (0.6-0.8)	0.5 (0.5-0.6)
12 years or more	0.9 (0.8-1.1)	0.8 (0.7-0.9)	0.6 (0.5-0.7)
Income			
1st quartile	1.0	1.0	1.0
2nd quartile	1.1 (1.0-1.3)	1.1 (0.9-1.2)	1.0 (0.9-1.2)
3rd quartile	1.1 (1.0-1.2)	1.0 (0.8-1.1)	0.9 (0.8-1.0)
4th quartile	1.1 (0.9-1.2)	1.0 (0.9-1.1)	0.8 (0.7-0.9)
Household location			
Urban	1.0	1.0	1.0
Rural	1.1 (1.0-1.3)	1.2 (1.1-1.4)	1.4 (1.2-1.6)
Region			
North	1.0	1.0	1.0
Northeast	1.1 (1.0-1.3)	1.2 (1.0-1.4)	1.3 (1.1-1.6)
Southeast	1.2 (1.0-1.4)	1.6 (1.3-1.9)	2.1 (1.7-2.5)
South	1.0 (0.9-1.3)	1.3 (1.1-1.5)	1.9 (1.6-2.3)
Midwest	0.9 (0.8-1.1)	1.1 (0.9-1.3)	1.1 (0.9-1.4)

Note: Multinomial logistic regression analysis.

Source: Authors.

In terms of household location, residents of rural areas showed diets with more antioxidant potential in comparison to individuals from urban areas. The analysis of the data on the availability of foods in Brazilian households already demonstrates important distinctions in the acquisition of foods for household consumption, when comparing the rural and urban areas of the country. Households in rural areas, as compared to urban areas, showed more *in natura* or minimally processed foods than processed culinary ingredients in one's diet (58.2% vs. 47.1% and 24.5% vs. 21.1% of the total calories, respectively). By contrast, the participation of both processed ultra-processed foods was larger in urban areas (11.1% and 20.6%, respectively) when compared to rural areas (5.8% and 11.5%)[28]. *In natura* and minimally processed foods include legumes, vegetables, beans, tubers, among others, which are items that contain a higher amount of antioxidants[8,22]. Corroborating with this data, an analysis by the National Health Survey (NHS) demonstrated that Brazilians residing in rural areas had a higher frequency of the consumption of *in natura* and minimally processed foods, highlighting the consumption of beans, which was more common in rural than in urban areas (OR=1.20;

Table 3. Analysis of the multivariate multinomial logistic regression of the factors associated with Dietary Total Antioxidant Capacity (DTAC) of the Brazilian population. Brazil, 2017-2018.

Variável	DTAC adjusted by energy (mmol/1.000 Kcal)		
	2nd quartile (2.36-3.48)	3rd quartile (3.49-5.17)	4th quartile (>5.17)
	RP (95%CI)	RP (95%CI)	RP (95%CI)
Sex			
Male	1.0	1.0	1.0
Female	1.1 (1.1-1.2)	1.4 (1.3-1.5)	1.7 (1.5-1.8)
Age			
Adolescent	1.0	1.0	1.0
Adult	1.8 (1.6-2.0)	2.0 (1.8-2.3)	2.9 (2.5-3.2)
Elderly	2.0 (1.7-2.3)	2.7 (2.3-3.2)	4.5 (3.8-5.2)
Education			
Up to four years	1.0	1.0	1.0
4 to 8 years	1.0 (0.8-1.1)	0.9 (0.8-1.1)	0.9 (0.8-1.0)
9 to 11 years	0.9 (0.8-1.1)	0.9 (0.8-1.1)	0.8 (0.7-0.9)
12 years or more	0.9 (0.8-1.0)	0.8 (0.7-1.0)	0.7 (0.6-0.8)
Income			
1st quartile	1.0	1.0	1.0
2nd quartile	1.1 (1.0-1.3)	1.0 (0.9-1.1)	0.9 (0.8-1.0)
3rd quartile	1.1 (1.0-1.3)	0.9 (0.8-1.1)	0.8 (0.7-0.9)
4th quartile	1.1 (0.9-1.2)	0.9 (0.8-1.1)	0.7 (0.6-0.8)
Household location			
Urban	1.0	1.0	1.0
Rural	1.2 (1.1-1.3)	1.3 (1.2-1.5)	1.5 (1.3-1.8)
Region			
North	1.0	1.0	1.0
Northeast	1.1 (0.9-1.3)	1.1 (1.0-1.4)	1.2 (1.0-1.5)
Southeast	1.1 (1.0-1.4)	1.6 (1.3-1.9)	2.2 (1.9-2.7)
South	1.0 (0.8-1.2)	1.3 (1.1-1.6)	2.0 (1.6-2.5)
Midwest	0.9 (0.8-1.1)	1.1 (0.9-1.4)	1.2 (0.9-1.5)

Note: Multinomial logistic regression analysis.

Source: Authors.

95%CI: 1.14-1.26), regardless of sex, age, race, education, and region of the country; meanwhile the residents of urban areas presented a higher intake of ultra-processed foods[29].

In the present study, individuals with higher income and educational levels presented a lower intake of antioxidants. Our results are opposite to those in the study by Jun *et al.*[8], conducted with Korean adults, which identified that a low socioeconomic status was associated with a lower consumption of antioxidants. However, one study based on data from POF 2017-2018 identified that individuals with greater purchasing power adhere more to the "Western" standards[30], whereas the typically Brazilian foods, such as rice and beans, were consumed more often by individuals with a lower income[31]. The traditional combination of rice and beans is responsible for a high contribution in the intake of phenolics and flavonoids, as well as high DTAC[18].

The relationship between the quality of one's diet and socioeconomic status is still controversial. Some studies have found evidence of a direct relationship between income and education, and more access to healthy foods, given the higher purchasing power[32,33]. On the other hand, higher socioeconomic status is also associated with a higher consumption of ultra-processed foods[34], suggesting that socioeconomic status may increase access to foods in Brazil, impacting food consumption; however this does not necessarily result in a higher quality diet. The fact that individuals with less income and a lower educational level present a higher average intake of antioxidants may be related to matters

of access to foods, since the traditional foods in the Brazilian diet, such as beans and some regional fruits, still have a lower cost[35].

The Northeast, South, and Southeast regions presented a diet with more antioxidant potential when compared to the northern part of the country. A higher prevalence of healthier eating standards, which include fresh or cooked vegetables and legumes, chicken, fruits, natural fruit juice, and milk, was verified in the South and Southeast regions of the country[36]. According to Malta *et al.*[37], the Midwest and Southeast are the Brazilian regions with the highest daily consumption of fruits and vegetables, followed, in decreasing order, by the North, South, and Northeast region. The fact that the Northeast has presented a high consumption of antioxidants may also be explained by the access to cheaper foods in the region, which, however, have high levels of these nutrients.

This study has, as a limitation, the fact that it used a theoretical data bank for DTAC evaluation. However, although such limitation is inherent to the tool, DTAC has been widely recommended as a good marker for dietary quality[3] and a good predictor of all-cause mortality[1]. As one of the strengths of this study, we highlight that it is the first study of its kind conducted with a representative sample of the Brazilian population, which evaluated the antioxidant content of the diet, taking into consideration all of the foods consumed. Moreover, it is important to mention that the POF 2017-2018 is considered to be the most complete, as well as the most up-to-date, databank in the country for studies of this nature.

In conclusion, the present study identified that socioeconomic and demographic conditions were significantly associated with the consumption of antioxidants. Individuals who are female, both adult and elderly and residing in rural areas of the Northeast, South, and Southeast regions of the country, presented a diet with more antioxidant potential. By contrast, higher educational and income levels were associated with a lower DTAC. Such results reinforce the importance of the identification of risk groups in terms of inadequate diet, aiding in the design and implementation of public policies and nutritional interventions, which may promote healthy eating, together with a higher level of antioxidants.

Collaborations

MA Silva conceived the study, participated in data analysis and interpretation, as well as the drafting and final revision of the article. LG Suhett contributed to the drafting of the article. IN Bezerra and SP Machado contributed to data interpretation, drafting, and final revision of the article.

References

1. Ha K, Kim K, Sakaki JR, Chun OK. Relative Validity of Dietary Total Antioxidant Capacity for Predicting All-Cause Mortality in Comparison to Diet Quality Indexes in US Adults. *Nutrients* 2020; 12(5):1210.
2. Wang Y, Yang M, Lee SG, Davis CG, Koo SI, Chun OK. Dietary total antioxidant capacity is associated with diet and plasma antioxidant status in healthy young adults. *J Acad Nutr Diet* 2012; 112:1626-1635.
3. Zujko ME, Wáskiewicz A, Witkowska AM, Cicha-Mikołajczyk A, Zujko K, Drygas W. Dietary Total Antioxidant Capacity - A New Indicator of Healthy Diet Quality in Cardiovascular Diseases: A Polish Cross-Sectional Study. *Nutrients* 2022; 14:3219.
4. World Health Organization (WHO). *Noncommunicable Diseases Progress Monitor 2022*.Geneva: WHO; 2022.
5. Collaborators TUBOD, Mokdad AH, Ballestros K, Echko M, Glenn S, Olsen HE, Mullany E, Lee A, Khan AR, Ahmadi AR, Ferrari AJ, Kasaeian A, Werdecker A, Carter A, Zipkin B, Sartorius B, Serdar B, Sykes BL, Troeger C, Fitzmaurice C, Rehm CD, Santomauro D, Kim D, Colombara D, Schwebel DC, Tsoi D, Kolte D, Nsoesie E, Nichols E, Oren E, Charlson FJ, Patton GC, Roth GA, Hosgood HD, Whiteford HA, Kyu H, Erskine HE, Huang H, Martopullo I, Singh JA, Nachega JB, Sanabria JR, Abbas K, Ong K, Tabb K, Krohn KJ, Cornaby L, Degenhardt L, Moses M, Farvid M, Griswold M, Criqui M, Bell M, Nguyen M, Wallin M, Mirarefin M, Qorbani M, Younis M, Fullman N, Liu P, Briant P, Gona P, Havmoller R, Leung R, Kimokoti R, Bazargan-Hejazi S, Hay SI, Yadgir S, Biryukov S, Vollset SE, Alam T, Frank T, Farid T, Miller T, Vos T, Bärnighausen T, Gebrehiwot TT, Yano Y, Al-Aly Z, Mehari A, Handal A, Kandel A, Anderson B, Biroscak B, Mozaffarian D, Dorsey ER, Ding EL, Park EK, Wagner G, Hu G, Chen H, Sunshine JE, Khubchandani J, Leasher J, Leung J, Salomon J, Unutzer J, Cahill L, Cooper L, Horino M, Brauer M, Breitborde N, Hotez P, Topor-Madry R, Soneji S, Stranges S, James S, Amrock S, Jayaraman S, Patel T, Akinyemiju T, Skirbekk V, Kinfu Y, Bhutta Z, Jonas JB, Murray CJL. The State of US Health, 1990-2016: Burden of Diseases, Injuries, and Risk Factors among US States. *JAMA* 2018; 319(14):1444-1472.
6. Jayed A, Rashidy-Pour A, Parohan M, Zargan MS, Shab-Bidar S. Dietary Antioxidants, Circulating Antioxidant Concentrations, Total Antioxidant Capacity, and Risk of All-CauseMortality: A Systematic Review and Dose ResponseMeta-Analysis of Prospective Observational Studies. *Adv Nutr* 2018; 9(6):701-716.
7. Mozaffari H, Daneshzad E, Larijani B, Surkan PJ, Azadbakht L. Association of dietary total antioxidant capacity to anthropometry in healthy women: A cross-sectional study. *Nutr* 2020; 69:110577.
8. Jun S, Chun OK, Joung H. Estimation of dietary total antioxidant capacity of Korean adults. *Eur J Nutr* 2017; 57(4):1615-1625.
9. Nascimento-Souza MA, Paiva PG, Silva A, Duarte MSL, Ribeiro AQ. Coffee and tea group contribute the most to the dietary total antioxidant capacity of older adults: a population study in a medium-sized Brazilian city. *J Am Coll Nutr* 2020; 40(8):713-723.
10. Silva MA, Milagres LC, Castro APC, Filgueiras MS, Rocha NP, Hermsdorff HHM, Longo GZ, Novaes JF. The consumption of ultra-processed products is associated with the best socioeconomic level of the children's families. *Cien Saude Colet* 2019; 24 (11): 4053-4060.
11. Stea TH, Nordheim O, Bere E, Stornes P, Eikem TA. Fruit and vegetable consumption in Europe according to gender, educational attainment and regional affiliation—A cross-sectional study in 21 European countries. *Plos One* 2020; 15(5):e0232521.
12. Instituto Brasileiro de Geografia e Estatísticas (IBGE). *Pesquisa de orçamentos familiares 2017-2018: primeiros resultados*. Rio de Janeiro: IBGE 2019.
13. Instituto Brasileiro de Geografia e Estatísticas (IBGE). *Pesquisa de Orçamentos Familiares (POF 2017-2018)* [Internet]. [acessado 2022 ago 30]. Disponível em: https://www.ibge.gov.br/estatisticas/sociais/populacao/24786-pesquisa-de-orcamentos-familiares-2.html?=&t=o-que-e.
14. Conway JM, Ingwersen LA, Vinyard BT, Moshfegh AJ. Effectiveness of the US Department of Agriculture 5-step multiple-pass method in assessing food intake in obese and nonobese women. *Am J Clin Nutr* 2003; 77(5):1171-1178.
15. Carlsen MH, Halvorsen BL, Holte K, Bøhn SK, Dragland S, Sampson L, Willey C, Senoo H, Umezono Y, Sanada C, Barikmo I, Berhe N, Willett WC, Phillips KM, Jacobs DR Jr, Blomhoff R. The total antioxidant content of more than 3100 foods, beverages, spices, herbs and supplements used worldwide. *Nutr J* 2010; 9:3.
16. Puchau B, Zulet MA, Echávarri AG, Hermsdorff HH, Martínez JA. Dietary total antioxidant capacity: a novel indicator of diet quality in healthy young adults. *J Am Coll Nutr* 2009; 28(6):648-656.
17. Willett W, Stampfer M. *Implications of total energy intake for epidemiologic analyses. In: Willett W. Nutritional epidemiology*. 2ª ed. New York: Oxford University Press, 1998.
18. Koehnlein EA, Bracht A, Nishida VS, Peralta RM. Total antioxidant capacity and phenolic content of the Brazilian diet: a real scenario. *Int J Food Sci Nutr* 2014; 65(3):293-298.
19. Saneie S, Aminianfar A, Shidfar F, Keshteli AH, Esmailzadeh A, Adibi P. The association between dietary total antioxidant capacity and odds and severity of irritable bowel syndrome among Iranian adults: a cross-sectional study. *BMC Gastroenterol* 2022; 22:472.

20. Dias-da-Costa JS, Olinto MTA, Gigante DP, Menezes AMB, Macedo S, Daltoé T, Ida SS, Fuchs SC. Use of outpatient services in Pelotas, Rio Grande do Sul State, Brazil: factors related to above-average number of physician visits. *Cad Saude Publica* 2008; 24(2):353-363.
21. Hiza HAB, Casavale KO, Guenther PM, Davis CA. Diet quality of Americans differs by age, sex, race/ethnicity, income, and education level. *J Acad Nutr Diet* 2013; 113(2):297-306.
22. Hantikainen E, Lof M, Grotta A, Lagerros YT, Serafini M, Bellocco R, Weiderpass E. Dietary non enzymatic antioxidant capacity and the risk of myocardial infarction in the Swedish women's lifestyle and health cohort. *Eur J Epidemiol* 2018; 33(2):213-221.
23. Huang LH, Liu CY, Wang LY, Huang CJ, Hsu CH. Effects of green tea extract on overweight and obese women with high levels of low density-lipoprotein--cholesterol (LDL-C): a randomised, double-blind, and cross-over placebo-controlled clinical trial. *BMC Complement Altern Med* 2018; 18:294.
24. Ciumărnean L, Milaciu MV, Negrean V, Orăsan OH, Vesa SC, Sălăgean O, Iluț S, Vlaicu SI. Cardiovascular Risk Factors and Physical Activity for the Prevention of Cardiovascular Diseases in the Elderly. *Int J Environ Res Public Health* 2022; 19(1):207.
25. Bezerra IN, Bahamonde NMSG, Marchioni DML, Chor D, Cardoso LO, Aquino EM, Almeida MCC, Molina MCB, Fonseca MJM, Matos SMA. Generational differences in dietary pattern among Brazilian adults born between 1934 and 1975: a latent class analysis. *Public Health Nutr* 2018; 21(16):2929-2940.
26. Lane MM, Davis JA, Beatti S, Gómez-Donoso C, Loughman A, O'Neil A, Jacka F, Berk M, Page R, Marx W, Rocks T. Ultraprocessed food and chronic noncommunicable diseases: A systematic review and meta-analysis of 43 observational studies. *Obes Rev* 2020; 22(3):e13146.
27. Rodrigues RM, Souza AM, Bezerra IN, Pereira RA, Yokoo EM, Sichieri R. Most consumed foods in Brazil: evolution between 2008–2009 and 2017–2018. *Rev Saude Publica* 2021; 55(Supl. 1):4s.
28. Levy RB, Andrade GC, Cruz GLD, Rauber F, Louzada MLC, Claro RM, Monteiro CA. Three decades of household food availability according to NOVA - Brazil, 1987-2018. *Rev Saude Publica* 2022; 56:75.
29. Costa DVP, Lopes MS, Mendonça RD, Malta DC, Freitas PPL, Lopes ACS. Food consumption differences in Brazilian urban and rural areas: the National Health Survey. *Cien Saude Colet* 2021; 26(Supl. 2):3805-3813.
30. Antunes ABS, Cunha DB, Baltar VT, Steluti J, Pereira RA, Yokoo EM, Sichieri R, Marchioni DM. Dietary patterns of Brazilian adults in 2008–2009 and 2017-2018. *Rev Saude Publica* 2021; 55(Supl. 1):8s.
31. Cunha CML, Canuto R, Rosa PBZ, Longarai LS, Schuch I. Association between dietary patterns and socioeconomic factors and food environment in a city in the South of Brazil. *Cien Saude Colet* 2022; 27(2):687-700.
32. Canuto R, Fanton M, Lira PICD. Social inequities in food consumption in Brazil: a critical review of the national surveys. *Cien Saude Colet* 2019; 24(9):3193-3212.
33. Bielemann RM, Motta JVS, Minten GC, Horta BL, Gigante DP. Consumption of ultraprocessed foods and their impact on the diet of young adults. *Rev Saude Publica* 2015; 49:28.
34. Moratoya EE, Carvalhaes GC, Wander AE, Almeida LMDMC. Changes in food consumption pattern in Brazil and around the world. *Rev Política Agrícola* 2013; 22(1):72-84.
35. Claro RM, Maia EG, Costa BVL, Diniz DP. Preço dos alimentos no Brasil: prefira preparações culinárias a alimentos ultraprocessados. *Cad Saude Publica* 2016; 32(Supl. 8):e00104715.
36. Pereira IFS, Vale D, Bezerra MS, Lima KC, Roncalli AG, Lyra CO. Dietary patterns of the elderly in Brazil: National Heath Survey, 2013. *Cien Saude Colet* 2020; 25(3):1091-1102.
37. Malta DC, Andrade SSCA, Stopa SR, Pereira CA, Szwarcwald CL, Silva Júnior JB, Reis AAC. Brazilian lifestyles: National Health Survey results, 2013, Brasil 2013. *Epidemiol Serv Saude* 2015; 24(2):217-226.

Article submitted 20/07/2023
Approved 07/11/2023
Final version submitted 09/11/2023

Chief editors: Maria Cecília de Souza Minayo, Romeu Gomes, Antônio Augusto Moura da Silva