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Influence of Unhealthy Food Environment on Premature Cardiovascular Disease Mortality in Brazil: An Ecologic Approach

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Introduction: Cardiovascular disease is the main cause of general and premature death of adults aged 30−69 years in Brazil and around the world. Unhealthy food environments have been implicated as one of the factors associated with cardiovascular disease morbimortality because they affect people's health conditions and nutrition. This study aims to explore the association between unhealthy food environments (deserts/swamps) and premature cardiovascular disease mortality in the Brazilian population.

Methods: This is an ecologic study using data from 5,558 Brazilian municipalities in 2016. The cardiovascular disease mortality data were obtained from the Mortality Information System of the Ministry of Health. The study on mapping food deserts in Brazil, developed by the Interministerial Chamber of Food and Nutrition Security, was used to evaluate the physical dimension of food access. The authors calculated the standardized rates of premature general and specific cardiovascular disease (stroke and ischemic heart disease) causes of death in the same period. To characterize food environments, the density of unprocessed and ultraprocessed foods per 10,000 population in tertiles was used. Crude and adjusted negative binomial regression models were used to study the associations of interest.

Results: After the necessary adjustments (human development index, gross domestic product per capita, unemployment rate, Gini index and Family Health Strategy coverage), it was found that municipalities with low unprocessed food supply were at the highest risk of increased mortality among women with ischemic heart disease (rate ratio first tertile: 1.08 [95% CI=1.01, 1.15]). Conversely, the municipalities where there was a greater offer of ultraprocessed foods showed a higher risk of death from cardiovascular diseases (rate ratio second tertile: 1.17 [95% CI=1.12, 1.22]; rate ratio third tertile: 1.20 [95% CI=1.14, 1.26]), from strokes (rate ratio second tertile: 1.19 [95% CI=1.13, 1.25]; rate ratio third tertile: 1.22 [95% CI=1.15, 1.30]), and ischemic heart disease (rate ratio second tertile: 1.19 [95% CI=1.12, 1.25]; rate ratio third tertile: 1.22 [95% CI=1.13, 1.29]).

Conclusions: This study's findings show an increase in the risk of cardiovascular disease, stroke, and ischemic heart disease mortality, especially in the municipalities where there was a greater offer

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of ultraprocessed foods. Initiatives aiming to minimize the effects of these food environments are urgently needed in the Brazilian context.

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INTRODUCTION

Cardiovascular disease (CVD) is the main cause of general and premature death worldwide. In 2019, data from the Global Burden of Disease indicated that CVD was responsible for the deaths of 18.6 million people, of which 85.1% were attributed to ischemic heart disease and cerebrovascular diseases.[1,2] Of those deaths, a third occurred in individuals aged between 30 and 69 years, representing premature CVD mortality.[2] Brazil has a mortality pattern similar to the global one, with CVD being the main cause of general death and ischemic heart disease and cerebrovascular diseases being the first and second causes of premature death in the country, respectively.[3] Therefore, the associated economic costs have been high. Estimates show that in 2015, Brazil spent around BRL 56.2 billion (USD17.3 billion) on treating CVDs.[4]

Recently, the debate on the relationship between unhealthy food environments and chronic diseases has gained prominence. Studies have shown a close relationship between such environments (swamp areas/desert areas) and CVD.[5−8] Food deserts are places where access to unprocessed or minimally processed foods is scarce or completely unavailable.[9] Swamps, in turn, are places where the sale of foods high in calories and low in micronutrients predominate, as is the case with fast food chains and convenience stores.[10] These environments are commonly found in middle- and high-income countries, whose nutritional transition process is at an advanced or intermediate stage.[11] In this transitional context, the urbanization process, the increased production of industrialized foods, and changes in people's lifestyles have contributed to the increased consumption of foods with a high-energy density and high fat, added sugar, and sodium content, which are deficient in vitamins and minerals. These foods are associated with the increased prevalence of overweight/obesity and diet-related diseases, such as CVD, in different population subgroups.[12]

A study conducted by the Interministerial Chamber of Food and Nutrition Security (CAISAN) in 2016 managed to map food retailers with the aim of characterizing food environments in Brazil.[13] Food access and availability are part of the consumer's food environment, and its characteristics can be associated with people's health and well-being.[14−17] According to CAISAN estimates, approximately 22.5% of Brazilian establishments that provide food services sell ultraprocessed foods.[13] Thus, this study aimed to explore the association between food environments (deserts/swamps) and premature CVD mortality in the Brazilian population. The authors' intent is to produce information that can support the development of public policies that act to improve the cardiovascular health of the Brazilian population, particularly among the most vulnerable groups. According to the WHO, actions that promote health equality, such as those guaranteeing universal access to healthy foods, should be at the heart of and the top priority for urban planning and public policies.[18]

METHODS

Study Population

The authors conducted an ecologic study, in which the units of analysis were the Brazilian municipalities. Brazil is a continental-sized country with an area of 8,510,345.538 km^2 (32,858,627.949/16 mi^2) and the largest country in Latin America. It comprises 26 federative units plus the Federal District and 5,570 municipalities. According to the Brazilian Institute of Geography and Statistics (IBGE), in 2016, Brazil had an estimated population of 206.1 million inhabitants.[19]

This study included adult individuals aged between 30 and 69 years with information on deaths from CVDs (strokes and heart attacks) in 2016. Individuals with missing municipal information, sex, missing diagnosis, and other underlying causes of death other than CVD (stroke and heart attack) were excluded from the study, in addition to those aged <30 years and >60 years.

The data were obtained from the Mortality Information System, made available by the Ministry of Health's Department of Information and Informatics of the Unified Health System, derived from death certificates in 2016.[20] The deaths included were based on ICD-10, considering all CVDs causes (I00–I99), strokes (I60–I69), and ischemic heart disease (IHD) (I20–I25).[21]

The crude mortality rate by general and specific causes of CVD was calculated by dividing the number of deaths by the population and multiplying by 100,000 inhabitants; also, crude rates stratified by sex were performed. Age-standardized premature CVD mortality rates were calculated using the WHO standard population.[22] The age groups defined for the rates standardization were 30–39, 40–49, and 50–60 years.

Measures

The food environment information was obtained through a study conducted by CAISAN.[13] This study aimed to map the food deserts in Brazil. For this, it used information from the Annual Social Information Report (2016) database (only the database of establishments). In this database, the establishments are classified according to the National Classification of Economic Activities (this is an instrument for national standardization of economic activity codes and framing criteria used by the various branches of the country's tax administration). For this mapping, data were also incorporated on open markets from the Map of Organic Food Markets produced by the Brazilian Consumer Defense Institute, the markets from the SAN Map, and the food markets featuring on the local government websites of the Brazilian state capitals. For this purpose, the database chosen was the Family Budgets Survey (2008−2009). In this database, it is possible to identify foods acquired by the population and the respective locations of acquisition. Next, the foods acquired were classified according to the 4 categories proposed by the 2014 Food Guide for the Brazilian Population.[23] Next, the buying locations reported in the Family Budgets Survey were related to the establishments classified by the National Classification of Economic Activities. Having carried out the previous stages, it was possible to determine the acquisition percentage of each one of the food categories from national classification of economic activities (NOVA).[24,25] The analysis of the profile of establishments and their respective classification was conducted through the Annual Social Information Report. Thus, the establishments were classified into categories that predominantly (>50%) sell (1) unprocessed foods, (2) ultraprocessed foods, and (3) mixed establishments where there was no predominance of the offer of healthy foods or the offer of unhealthy foods.

To characterize the food environments, only the density of establishments that sell unprocessed and ultraprocessed foods (per 10,000 inhabitants) was used. The density of the food establishments was categorized as tertiles.[24,25]

Municipal-level socioeconomic and demographic variables (gross domestic product per capita, Gini index, unemployment rate, coverage of the Family Health Strategy, and municipal human development index) were extrapolated for 2016 from the 2000 and 2010 Demographic Censuses data of the IBGE, obtained from the IBGE Automatic Recovery System[26] and the Atlas of Human Development in Brazil of the UN Development Program in partnership with Brazilian institutions.[27] These variables were selected on the basis of an extensive literature review on the associations of interest and the availability of municipal information.[5,7,8,28]

Statistical Analysis

The authors calculated means and SDs for the continuous variables and percentages for the categorical variables. To verify the association between food environments and CVD, stroke, and IHD mortality rates, crude and adjusted negative binomial regression models were used. The estimates are interpreted using the rate ratios and their respective 95% CIs. Food environments (in tertiles) were the main independent variables (density of unprocessed and ultraprocessed foods). The models were simultaneously adjusted by the covariates mentioned earlier. Multicollinearity, that is, the existence of a linear relationship between the independent variables, was verified by means of the variance inflation factor statistics. All analysis was stratified by sex, considering previous literature regarding CVD mortality. All the analyses were replicated considering the population size of the municipality. All the analyses were carried out using the Stata 14.0 statistical software (Stata Corp, College Station, TX).

RESULTS

Table 1 shows the sociodemographic characteristics of the Brazilian municipalities. The authors observed a gross domestic product per capita of BRL 17,600 for Brazil. The unemployment rate was around 4.6%.

The mean premature CVD mortality rate in the country was 92.88 deaths per 100,000 inhabitants, with differences between men (117.68/100,000 inhabitants) and women (68.16/100,000 inhabitants). The mean age-standardized premature mortality rate for the set of municipalities was 92.94 deaths (Table 2).

The distribution of establishments, considering the size of the Brazilian municipalities, is shown in Appendix Table 1 (available online). The authors verified that as the municipality size increases, the number of establishments selling ultraprocessed foods per inhabitant increases, whereas the density of establishments selling unprocessed and mixed foods decreases.

Tables 3 and 4 present the results of the crude and adjusted negative binomial regression on the association between unprocessed and ultraprocessed establishment density and mortality. From the adjusted analyses, municipalities with little offer of unprocessed foods present a higher risk of increased IHD mortality in women (rate ratio first tertile: 1.08 [95% CI=1.01, 1.15]). By contrast, municipalities where there was a greater offer of ultraprocessed foods showed a higher risk of death from CVD (rate ratio second tertile: 1.17 [95% CI=1.12, 1.22]; rate ratio third tertile: 1.20 [95% CI=1.14, 1.26];

Table 1. Demographic and Socioeconomic Characteristics of the Brazilian Municipalities, 2016 (N=5,558)

Variables	Mean	SD	Minimum	Median	Maximum
Municipal HDI	0.74	0.58	0.51	0.74	0.85
Gini index	0.47	0.92	0.16	0.47	0.92
GDP per capita	17.6	21.6	2.99	12.73	486.34
Unemployment rate (%)	4.56	4.42	0.00	3.39	58.63
ESF coverage (%)	88.14	22.23	0.00	100	100

ESF, family health strategy; GDP, gross domestic product; HDI, human development index.

Table 2. Crude and Age-Standardized Premature Mortality Rate (per 100,000 Inhabitants) From CVD, Stroke, and Heart Attack in Brazil, 2016 (N=5,558)

Crude mortality rates	Mean
General, CVDs	92.88
Sex	
Female	68.16
Male	117.68
General – strokes	36.73
Sex	
Female	31.91
Male	41.67
General, IHD	56.15
Sex	
Female	36.25
Male	76.01
Age-standardized mortality rates	
General, all CVD cause of death	92.94
General, strokes	36.90
General, IHD	56.05

CVD, cardiovascular disease; IHD, ischemic heart disease.

dose−response association), from strokes (rate ratio second tertile: 1.19 [95% CI=1.13, 1.25]; rate ratio third tertile: 1.22 [95% CI=1.15, 1.30]; dose−response association), and from IHD (rate ratio second tertile: 1.19 [95% CI=1.12, 1.25]; rate ratio third tertile: 1.22 [95% CI=1.13, 1.29]; dose−response association). According to the analysis by sex, the greater offer of ultraprocessed foods also increased the risk of CVD mortality in men (rate ratio second tertile: 1.13 [95% CI=1.08, 1.19]; rate ratio third tertile: 1.15 [95% CI=1.09, 1.22]; dose−response association) and in women (rate ratio second tertile: 1.12 [95% CI=1.06, 1.18]) as well as of stroke mortality in men (rate ratio second tertile: 1.18 [95% CI=1.11, 1.26]; rate ratio third tertile: 1.19 [95% CI=1.10, 1.29]; dose−response association) and in women (rate ratio second tertile: 1.09 [95% CI=1.02, 1.17]) and IHD mortality in men (rate ratio second tertile: 1.13 [95% CI=1.06, 1.20]; rate ratio third tertile: 1.14 [95% CI=1.06, 1.23]; dose−response association) and women (rate ratio 2nd tertile: 1.16 [95% CI=1.08, 1.25]; rate ratio 3rd tertile: 1.10 [95% CI=1.01, 1.23]) (Table 4). The directions of the estimates by municipality size did not change substantially. The analyses by municipality size are available in Appendix Tables 2−7 (available online).

DISCUSSION

The objective of this study was to assess the association between food environments and CVD, stroke, and heart attack mortality among the Brazilian population. To the authors' knowledge, this is the first study to test the measures relating to food swamps beside food deserts as predictors of premature mortality rate from CVD and specifically from stroke and IHD in Brazil. Results showed that a lower offer of unprocessed foods increased the risk of heart attack mortality in women, whereas a greater offer of ultraprocessed foods generally increased the risk of premature death from CVDs, strokes, and

Table 3. Crude Rate Ratio and 95% CI of the Association Between Food Density (Healthy and Unhealthy) and CVD and Premature General and Specific Causes of CVD Mortality, a Negative Binomial Regression Model for Brazilian Municipalities (N=5,558) in 2016

Variables	Food environments			
	Healthy food density		Unhealthy food density	
	2nd tertile (≥p33.3; ≤p66.6), rate ratio crude (95% CI)	1st tertile (<p33.3), rate ratio crude (95% CI)	2nd tertile (≥p33.3; ≤p66.6), rate ratio crude (95% CI)	3rd tertile (>p66.6), rate ratio crude (95% CI)
CVDs	1.07 (1.03, 1.11)	1.03 (0.99, 1.07)	1.21 (1.16, 1.25)	1.27 (1.22, 1.31)
Strokes	1.08 (1.04, 1.12)	1.04 (0.99, 1.09)	1.19 (1.14, 1.25)	1.23 (1.18, 1.28)
IHD	1.07 (1.02, 1.12)	1.04 (0.99, 1.09)	1.24 (1.18, 1.30)	1.31 (1.25, 1.37)
CVDs				
Male	1.04 (1.00, 1.08)	1.02 (0.97, 1.06)	1.14 (1.09, 1.19)	1.16 (1.12, 1.21)
Female	0.99 (0.94, 1.03)	1.04 (0.99, 1.08)	1.06 (1.00, 1.11)	0.96 (0.92, 1.01)
Strokes				
Male	1.04 (0.99, 1.09)	1.03 (0.97, 1.08)	1.13 (1.07, 1.20)	1.12 (1.06, 1.17)
Female	0.99 (0.94, 1.04)	1.00 (0.95, 1.06)	1.03 (0.97, 1.10)	0.94 (0.88, 0.99)
IHD				
Male	1.04 (0.99, 1.09)	1.02 (0.97, 1.07)	1.15 (1.10, 1.22)	1.20 (1.14, 1.26)
Female	0.98 (0.92, 1.04)	1.08 (1.01, 1.15)	1.09 (1.02, 1.16)	0.92 (0.92, 1.05)

CVD, cardiovascular disease; IHD, ischemic heart disease.

Table 4. Adjusted Rate Ratio and 95% CI of the Association Between Food Density (Healthy and Unhealthy) Premature General and Specific Causes of CVD Mortality, a Negative Binomial Regression in the Brazilian Municipalities (N=5,558) in 2016

Variables	Food environments			
	Healthy food density		Unhealthy food density	
	2nd tertile (≥p33.3; ≤p66.6), adjusted rate ratio (95% CI)	1st tertile (<p33.3), adjusted rate ratio (95% CI)	2nd tertile (≥p33.3; ≤p66.6), adjusted rate ratio (95% CI)	3rd tertile (>p66.6), adjusted rate ratio (95% CI)
CVDs	1.03 (0.99, 1.07)	1.03 (0.99, 1.07)	1.17 (1.12, 1.22)	1.20 (1.14, 1.26)
Strokes	1.04 (0.99, 1.09)	1.03 (0.99, 1.08)	1.19 (1.13, 1.25)	1.22 (1.15, 1.30)
IHD	1.03 (0.98, 1.08)	1.04 (0.99, 1.09)	1.19 (1.12, 1.25)	1.21 (1.13, 1.29)
CVDs				
Male	1.02 (0.98, 1.06)	1.02 (0.98, 1.06)	1.13 (1.08, 1.19)	1.15 (1.09, 1.22)
Female	1.01 (0.97, 1.06)	1.03 (0.99, 1.08)	1.12 (1.06, 1.18)	1.07 (0.99, 1.14)
Strokes				
Male	1.02 (0.97, 1.07)	1.02 (0.97, 1.08)	1.18 (1.11, 1.26)	1.19 (1.10, 1.29)
Female	1.02 (0.97, 1.07)	1.00 (0.95, 1.06)	1.09 (1.02, 1.17)	1.04 (0.95, 1.13)
IHD				
Male	1.02 (0.97, 1.07)	1.02 (0.97, 1.07)	1.13 (1.06, 1.20)	1.14 (1.06, 1.23)
Female	1.00 (0.94, 1.07)	1.08 (1.01, 1.15)	1.16 (1.08, 1.25)	1.10 (1.00, 1.21)

Note: Healthy food density: Ref. third tertile; unhealthy food density: Ref. first tertile. Analyses were adjusted by HDI, GDP per capita, unemployment rate (%), Gini index, and ESF coverage (%).
CVD, cardiovascular disease; ESF, family health strategy; GDP, gross domestic product; HDI, human development index; IHD, ischemic heart disease.

IHD. The authors also observed that a greater offer of ultraprocessed foods increased the risk of heart attack mortality in men and women as well as of death from CVDs and strokes in men. The results of this study support the position that food swamps can play an even greater role than food deserts in premature CVD and cause-specific mortality rates at a municipal level. Notably, this trend remained even after the replication of the analyses by municipality size. It was also reported in the study by Peres et al. (2021) in Brazil, which showed a greater presence of establishments selling ultraprocessed foods around schools and also found that most schools were located in food swamps.[29]

Despite the observed associations, the relationship between food environments and premature CVD mortality is still quite controversial. The present results align with the literature that posits that these environments heighten the effects of a poor diet, compromising cardiovascular health.[5,7,28,30−32] These findings are consistent despite the ecologic design of this study and differences in the methodologies used across studies for assessing food environments, which makes direct comparison difficult. However, results are similar to those of other studies that show the influence of food environments, such as swamps and deserts, on CVD morbimortality.[5−8] Studies in the U.S. revealed that cardiovascular health was intimately connected to access to food retailers, particularly of healthy foods, but only for residents who experienced more severe economic deprivation.[8] The influence of food deserts on cardiovascular complications was also evaluated in 457 patients with heart failure in the U.S.[7] After adjustments for baseline demographic and clinical characteristics, Morris et al. observed that living in food desert areas was associated with an increased risk of recurrent hospitalization because of all causes (rate ratio=1.39; 95% CI=1.19, 1.63) and cause-specific heart failure (rate ratio=1.30; 95% CI=1.02, 1.65). The results are similar to those of the cohort study conducted by Saluja et al.[28] in Australia. In that study, the density of fast food establishments was positively associated with the incidence of AMI, an association that remained even after adjusting for age, obesity, hyperlipidemia, hypertension, smoking, diabetes, and socioeconomic level.[28] In the Netherlands, the presence of a fast food restaurant within a 1 km radius in a residential setting was associated with a higher chance of CVDs and coronary heart diseases than the absence of these conditions.[33]

This findings differ from those of other published studies.[5,6,34,35] When examining the influence of food deserts over cardiovascular risk factors and subclinical vascular disease in 1,421 adult individuals from the metropolitan area of Atlanta, Kelli et al. (2017) observed not only negative alterations in the cardiovascular risk profile but also an increase in the markers of oxidative stress, inflammation, and arterial stiffness compared with those of other nondesert conditions[5]; however, these associations were driven by the income of the area and not by access to unhealthy foods. Similar results were reported using a population of individuals from the Emory Cardiovascular Biobank cohort, whose objective was to evaluate the influence of environments with poor access to healthy foods on adverse cardiovascular events (CVDs, IHD).[6] However, the influence of food environments on heart outcomes should be viewed with caution. SES may reduce these events, whereby individuals with a higher socioeconomic level may be able to use their own economic resources to protect themselves from the adversities of unhealthy food environment. As an example, a study carried out in the municipality of Campinas, Brazil showed inequalities in this distribution. Regions with higher income and lower percentages of Black and mixed-race people had a higher concentration of all types of commercial food establishments, such as agroecologic fairs and hyper/supermarkets, than most vulnerable regions.[36] Similar results were observed in Minas Gerais.[37]

Dissimilar results were also found in a cohort study conducted by Lovasi et al.,[35] who studied the association between food environments and CVD mortality in Americans. The presence of healthy foods in retail was not associated with a reduction in CVD deaths (hazard ratio=1.03; 95% CI=1.00, 1.07) or all-cause mortality (hazard ratio=1.05; 95% CI=1.04, 1.06) in models adjusted for sex, age, marital status, birth, Black race, Hispanic ethnicity, educational achievement, income, mean family income, population density, and density of destination for walking.

In a subgroup analysis, an increase in the offer of ultraprocessed foods was associated with a rise in premature CVD, stroke, and IHD mortality in adult men. Among women, there was no statistically significant association, except for AMI. This result may be aligned with the fact that men seek health services less,[38,39] work-related issues, difficulty in accessing the services, and the lack of a specific unit focused on men's health, which may be attributed to this condition of the greater vulnerability of cardiovascular health.[38,40,41]

In general, potential explanations for observed associations are suggested, highlighting the importance of further exploration of the influence of food environments (swamps/deserts) on cardiovascular health: (1) residents in food swamps tend to have low-quality diets, marked by a greater intake of hypercaloric foods that are poor in micronutrients[5,42]; (2) they travel long distances to be able to obtain healthy food options, thus spending more time from their daily schedule and consequently reducing time for physical exercise or leisure activities[43]; and (3) those who live in food deserts/swamps are often more economically deprived than those who do not live there.[6−8] It also cannot be ignored that living in a food desert/swamp can foster poor health behaviors, such as smoking.[28]

LIMITATIONS

The main limitation of this study derives from the impossibility of extrapolating the conclusions reached on the basis of data aggregated at a municipal level for the population at an individual level, an inference problem known as ecologic fallacy. Another possible limitation is the quality and reliability of the secondary data. With regard to this, data were obtained from government sources, such as health information systems, national surveys, and demographic censuses, which are known for having high-quality standards. Unfortunately, these variables were not available for use in this study. As opposed to the use of the database elaborated by CAISAN, this is a robust database and can be used in other studies aiming to explore food environments in Brazil, despite only evaluating the number of establishments (unprocessed/mixed/ultraprocessed) per capita. However, this database only identifies the level of offer at the municipal level, not taking into consideration the geographic distance and obstacles to accessing the sales points, which could be measured if the data were geocoded.

CONCLUSIONS

The results of this study among Brazilian municipalities indicate an increase in the risk of CVD, stroke, and IHD mortality, especially in municipalities where there was a greater offer of unhealthy foods, particularly ultraprocessed foods; these are of low nutritional quality and derive from unsustainable food systems. Initiatives seeking to minimize the effects of these unhealthy environments are urgently needed, but the question of food deserts/swamps is undoubtedly more complex than the simple existence of retail establishments. Thus, a set of initiatives should be considered, ranging from fostering the production of agroecologic and organic foods to the implementation of economic instruments and tax measures such as taxation on food products with high saturated fat, sugar, and salt content. It is also impossible to ignore incentivizing food and nutritional education actions on the basis of food guides with the aim of supporting and encouraging the adoption of healthy and sustainable eating habits. Future studies should be incentivized with the aim of evaluating the efficacy of intervention strategies that can reduce the detrimental effect of residing in unhealthy food environment (food deserts/swamps). Furthermore, it will be important to observe these effects on other outcomes such as other noncommunicable diseases, especially cancer.

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CREDIT AUTHOR STATEMENT

The authors' contributions were as follows: Audêncio Victor, Rita de Cássia Ribeiro Silva, and Maurício L. Barreto Conceptualization. Audêncio Victor, Natanael de Jesus Silva, and Andréa Ferreira collected Data curation and Formal analysis. Audêncio Victor, Andréa Ferreira, and Rita de Cássia Ribeiro Silva outlined the analytical strategy. Audêncio Victor and Natanael de Jesus Silva performed the statistical analyses, interpreted the results, and drafted the manuscript. Rita de Cássia Ribeiro Silva, Tereza Campello, and Maurício L. Barreto interpreted the results and critically reviewed the manuscript, and all authors have read.

SUPPLEMENTAL MATERIAL

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