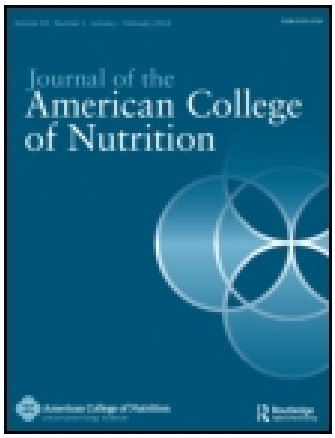

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# Profile Development of Noncommunicable Chronic Diseases in a Brazilian Rural Town

Giuliano Di Pietro PhD[a], Damaris Santana Cardoso[a], Heloisa Mendonça Bernini Soares da Silva[a], Jessyca Costa Santos[a], Jordana Rosa dos Santos[a] & Rodrigo Almeida Simões PhD[a]
[a] Department of Pharmacy (G.D., D.S.C., R.A.S.), Department of Nutrition (H.M.B.S.D.), and Department of Nursing (J.C.S., J.R.D.), Federal University of Sergipe, Sergipe, BRAZIL
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## Original Research

# Profile Development of Noncommunicable Chronic Diseases in a Brazilian Rural Town

**Giuliano Di Pietro, PhD, Damaris Santana Cardoso, Heloisa Mendonça Bernini Soares da Silva, Jessyca Costa Santos, Jordana Rosa dos Santos, Rodrigo Almeida Simões, PhD**

*Department of Pharmacy (G.D., D.S.C., R.A.S.), Department of Nutrition (H.M.B.S.D.), Department of Nursing (J.C.S., J.R.D.), Federal University of Sergipe, Sergipe, BRAZIL*

**Key words: chronic diseases, nutritional epidemiological transition, lifestyle**



**Objective:** To assess the relationship between socioeconomic and anthropometric data, frequency of food consumption, and the development of noncommunicable diseases (NCDs) in patients from a small rural town in northeastern Brazil.

**Methods:** A cross-sectional questionnaire study was performed on patients from the Lagarto City Hospital ($n = 50$) and from family health units ($n = 370$).

**Results:** The 420 patients in the study had one or more NCDs such as hypertension, type 2 diabetes mellitus, and dyslipidemia. The mean age was 63.1 $\pm$ 8.7 years for both sexes. The typical patient was of mixed or black descent (66%), a farmer, and of low socioeconomic status and education; 100% of men and 84% of women were illiterate or had less than 4 years of schooling. Approximately 50% of women and 89% of men were married and most had never used tobacco or were ex-smokers. The body mass index (BMI) of the study population was 29.4 $\pm$ 5.5 kg/m$^2$, where 70% of the patients were type 2 diabetic with waist circumferences of 99.8 $\pm$ 21.2 cm for men and 98.1 $\pm$ 13.9 cm for women. The correlation between BMI and waist circumference was $r = 0.88$. Even with the use of medication, total cholesterol levels of above 240 mg/dL were recorded in 10% of women and about 5% of men. Likewise, 10% of women and 100% of men had triglyceride levels above 200 mg/dL; glucose levels were 133.6 $\pm$ 47.4 mg/dL in men and 110.8 $\pm$ 38.8 mg/dL in women. Blood pressure values were high, even in patients using one or more antihypertensive drugs for at least 2 years (systolic pressure = 128.5 $\pm$ 18.2; diastolic pressure = 86.3 $\pm$ 8.9 mmHg). Indices considered above the limit recommended by the World Health Organization (WHO) were obtained for 60% of women and 100% of men. Our research revealed that this population is characterized by a relatively low intake of fats and oils. Nevertheless, 100% of patients consumed meat every day, 57.6% never consumed processed foods such as candy or soft drinks, and 89% consumed coffee daily. Furthermore, the consumption of fruits was very low: 46.6% of respondents never ate fruit and 7.8% rarely consumed fruit. Likewise, 68.2% reported never eating milk and dairy products. Vegetables were consumed by only 51.4% of the population and 38.5% rarely or never consumed green vegetables. Products made from wheat, maize, cassava, beans, and rice were often consumed by 59.2% of the population.

**Conclusions:** Our results indicate that the studied population is affected by nutritional transition, in which the greater access to carbohydrates and animal proteins is associated with high BMI, with the vast majority overweight and suffering from uncontrolled hypertension despite the use of medications. The high consumption of carbohydrates and animal protein, rapid urbanization, and sedentary lifestyle are the main factors responsible for the epidemic of noncommunicable diseases, especially among people with low income and education. Men are particularly affected, with increased visceral fat characterized by an increased waist circumference.

## INTRODUCTION

Noncommunicable diseases (NCDs), such as hypertension, type 2 diabetes, obesity, cardiovascular disease, and cancer, are a major public health problem in most developed and developing nations, being associated with high mortality rates [1]. Estimates from the World Health Organization indicate that NCDs now account for 58.5% of all worldwide deaths

Address correspondence to: Giuliano Di Pietro, Universidade Federal de Sergipe, Departamento de Farmácia. Av. Marechal Rondon, s/n–Jardim Roza Elze, São Cristóvão, Sergipe 49100-000, BRAZIL. E-mail: dipietrobr@yahoo.com.br

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and 45.9% of the global burden of disease [2]. In Brazil, recent studies indicate that NCDs have become the greatest health issue, strongly affecting the poorest and most vulnerable segments of populations and accounting for 72% of the deaths and 75% of health expenditure in the Unified Health System [1].

Although the causes of NCDs are complex, lifestyle choices such as poor nutrition, lack of exercise, and smoking have a strong influence on the development of these diseases. In developing countries such as Brazil, diet structure has changed dramatically over recent decades due to the ready availability of cheap vegetable oils, fats, and processed foods. This so-called nutrition transition is characterized by a reduction in nutritional deficits and a significant increase in overweight and obese people, leading to a significant epidemiological transition [3,4]. The specific factors underlying the nutrition transition in Brazil can be traced back to socioeconomic changes in the 1970s, which saw widespread demographic shifts (mainly rural to urban), the introduction of women into the labor market, and mechanization. These changes increased inactivity and where accompanied by dietary shifts in favor of a higher intake of fat. Similar shifts have been seen across developing nations and are constantly associated with the emergence of NCDs [5,6] and cancer [7,8].

Recent data released by the Brazilian Association of Cardiology show that 80% of the adult population is sedentary and 32% of Brazilian adults are obese [9]. Between adolescents, the frequency of overweight males increased from 3.7% (1974–1975) to 21.7% (2008–2009); and in females, growth was 7.6% to 19.4% in the same age range. Obesity also shows an upward trend, going from 0.4% to 5.9% for males and 0.7% to 4.0% in females, compared in same period in Brazil [10]. One of the most at risk areas for NCDs in Brazil is the economically disadvantaged northeast region, due to the high levels of poverty and strong demographic shifts. For example, NCDs have become increasingly present the south-central area of Sergipe state in northeastern Brazil (the study area for this research). The population of 77,678 individuals aged 30–59 years has a rate of diabetes mellitus of 7.72% (compared to 3.33% for the entire state). Likewise, the rate of strokes resulting from uncontrolled hypertension and/or thrombosis is 13.65% compared to 10.03% in Sergipe [12].

The Brazilian government has responded to the increase in obesity and associated chronic diseases through the Family Health Program, using extensive anthropometric measurements such as weight, height, waist circumference (WC), and waist–hip ratio to monitor vulnerable populations [13]. Such monitoring is extremely important for disease detection and control [14]; several studies have shown a strong associations between obesity and various NCDs [5,13,15]. With the exception of individuals with high muscle mass, one of the easiest methods to detect excess visceral fat is through the body mass index (BMI), which is correlated with WC, hypertension, and other diseases [1,16,17].

Good nutrition has been implicated in the prevention and treatment of various NCDs [18,19], and the beneficial effects of a balanced diet and exercise in preventing chronic diseases are widely recognized [2,20–22]. Biochemical rates also provide important insights into the etiology of NCDs. For example, oxidatively modified biomolecules, especially low density lipoproteins (oxLDL), are intrinsic components in the genesis of obesity and have been identified as a factor in pro-atherogenic primary diseases [23].

The objective of this study was to seek associations between patients with NCDs to various risk factors, including socioeconomic status, anthropometric measurements, and frequency of food consumption. Patients came from a small rural town in the Brazilian Northeast and were assessed through a cross-sectional questionnaire study.

## METHODOLOGY

The survey was conducted in the central-south region of Sergipe State in northeast Brazil between October 2011 and July 2012. The participants in the study signed a consent form approved by the Ethics in Human Research Committee (no. 236/2011). Participants were selected at the Regional Hospital of Lagarto City ($n = 50$) and in units of the Family Health Strategy ($n = 370$). Nursing staff contributed to the research and actively recruited patients with chronic diseases.

We consulted the medical records of participants and extracted information on age, gender, weight, height, personal history of NCDs, serum lipids, total cholesterol, triglycerides, glucose, and blood pressure. Subsequently, patients were asked questions related to socioeconomic, lifestyle, and treatment (based on the study by Magno et al. [23]). They also completed an adapted version of the standardized food frequency questionnaire adapted by Di Pietro et al. [24].

Patients (of both sexes) above 50 years of age were preferentially chosen. Socioeconomic status and ethnicity were identified according to the classification of the Brazilian Institute of Geography and Statistics. The study excluded patients with rheumatic, hepatic, renal, endocrine, and neurological diseases and those who were bedridden.

Four hundred twenty individuals were included in the study: 300 females and 120 males, aged 45–75 years. Nevertheless, only 130 individuals (93 females and 37 males) had all of the parameters required for a full statistical analysis. Anthropometric data were measured directly and included weight, height, and waist and hip circumference (to calculate waist-to-hip ratio, WHR) and BMI. Weight was measured with the subject standing and positioned in the center of the scale. BMI (kg/m$^2$) was calculated by dividing weight (in kilograms) by height squared (in meters). Balance accuracy was 0.1 kg and height was measured to the nearest 0.5 cm.

Circumference measurements were carried out at the waist, hips, and abdomen. Waist measurements were taken standing with abdomen relaxed. Waist circumference was taken at the midpoint between the iliac crest and the last rib and hip circumference was taken as the greatest measurement between the waist and thigh. Waist–hip ratio was then calculated and compared with the literature [25].

Information on lipid profile and glucose levels was obtained from medical records. Data were originally derived from 10 mL of blood collected in silicone tubes without anticoagulant and subjected to biochemical tests. Total lipids, triglycerides, and total cholesterol were measured by a colorimetric method.

The food frequency questionnaire is divided into food groups and each participant answered the frequency of use according to the following classification: never, rarely (less than once in the last 6 months), once per month, twice a month, 3 times per month, or every week [24].

Data were summarized through means and standard deviations (±SD) or proportions for the entire population and for men and women separately. Statistical analysis was performed using SPSS Statistics Desktop, ver. 22.0.0 (SPSS Inc., Chicago, IL).



## RESULTS AND DISCUSSION

A total of 420 patients with one or more NCDs (hypertension, type 2 diabetes mellitus, and dyslipidemia) were interviewed. The mean age of the subjects was 63.1 ± 8.7 years for both sexes (Table 1). Advanced age is a predisposing factor for the emergence of some NCDs, especially hypertension; blood pressure increases with age have been observed in other studies [5,6,16].

The majority of respondents self-identified as mixed race or black (66%; Table 1). Studies have shown increased salt sensitivity and salt intake in African Americans, characteristics that are associated with higher blood pressure. This effect may be related to the levels of plasma renin and angiotensin, which are higher in people of African descent than in Caucasians [17].

About 92% of male respondents and 27% of females were farmworkers. This population often works temporarily on orange, corn, tobacco, and pepper farms or engages in subsistence farming. Of the households interviewed (3.5 ± 1.9 persons per household), 91% had incomes of US$9.00 or less per day (Table 1). A similar study recently demonstrated that high blood pressure is prevalent among a low-income population residing in rural Thohoyandou, South Africa [6].

This low per capita income is associated with a low level of education, with 32% of men illiterate and 68% with less than 4 years of education (Table 1). Among women, 25% were illiterate and 59% had less than 4 years of education. Nevertheless, the causal association between low income, low education, and high blood pressure is by no means certain. Thawornchaisit et al. found no association between hypertension and income or education in Sukhothai Thammathirat Open University Students in the National Thai Cohort Study from 2005 to 2009 [5].

**Table 1.** Ethinicity, Social and Economic Status, and Lifestyle Data for the Individuals Studied

| | Male | Female | Population |
|---|---|---|---|
| Age (years) | 63.6 ± 8.0 | 62.9 ± 9.1 | 63.1 ± 8.7 |
| Ethnicity, % (*n*) | | | |
| White | 59 (22) | 25 (23) | 35 (45) |
| Mixed race | 41 (15) | 59 (55) | 54 (70) |
| Black | — | 16 (15) | 12 (15) |
| Profession, % (*n*) | | | |
| Farmer | 92 (34) | 27 (25) | 45(59) |
| Autonomous | 8 (3) | 13 (12) | 12 (15) |
| Domestic | — | 12 (11) | 8 (11) |
| Retiree or pensioner | 24 (9) | 25 (32) | 31 (41) |
| Other[b] | — | 14 (13) | 10 (13) |
| Economic status (dollars per day)[c], % (*n*) | | | |
| Less than 3 | 38 (14) | 35 (33) | 36 (47) |
| Between 3 to 9 | 63 (22) | 49 (49) | 55 (71) |
| More than 9 | 1 (1) | 12 (11) | 9 (12) |
| Persons per household | 3.8 ± 2.1 | 3.4 ± 1.8 | 3.5 ± 1.9 |
| Education, % (*n*) | | | |
| Graduate | — | 4 (4) | 3 (4) |
| Less than 11 years | — | 12 (11) | 8 (11) |
| Less than 5 years | 68 (25) | 59 (55) | 62 (80) |
| Illiterate | 32 (12) | 25 (23) | 27 (35) |
| Marital status, % (*n*) | | | |
| Married | 84 (31) | 50 (47) | 60 (78) |
| Divorced | 16 (6) | 13 (12) | 14 (18) |
| Widower | — | 28 (26) | 20 (26) |
| Single | — | 9 (8) | 6 (8) |
| Smoking, % (*n*) | | | |
| Yes | 19 (7) | 6 (6) | 10 (13) |
| No | 81 (30) | 94 (87) | 90 (117) |
| Ex-smoker | 60 (22) | 39 (36) | 45 (58) |
| Alcoholism, % (*n*) | | | |
| Yes | 8 (3) | 6 (6) | 7 (9) |
| No | 92 (34) | 94 (87) | 93 (121) |
| Recovering alcoholic | (15) | (2) | (17) |
| Physical activity, % (*n*) | | | |
| Yes | 32 (12) | 29 (27) | 30 (39) |
| No | 68 (25) | 71 (66) | 70 (91) |
| Pathology, % (*n*) | | | |
| Diabetes | 43 (16) | 34 (32) | 37 (48) |
| Hypertension | 100 (37) | 87 (81) | 91 (118) |
| Dyslipidemia | — | 39 (36) | 28 (36) |

BMI = body mass index (kg/m$^2$), LDL = low-density lipoprotein (mg/dL), HDL = high-density lipoprotein (mg/dL), VLDL = very low-density lipoprotein (mg/dL).
[a]Data are shown as average, percentage (%), or standard deviation (media ± SD).
[b]Cook, waiter, basic education teacher.
[c]US$1 = R$2.50.

The prevalence of married women was 50% and that of married men was 89% (Table 1). According to a previous study, the prevalence of hypertension among older women with 3 or more children, married, dark skin, and low income is 56%, 10%, 35%, and 34%, respectively [5,16], which is in general accordance with our findings.

Most patients included in the survey reported ever having used tobacco, and alcohol consumption was low (7%). However, 70% of the population was sedentary, which is a risk for

**Table 2.** Anthropometric, Biochemical, and Pathology Data for the Individuals Studied[a]

| | Male | Female | Population |
|---|---|---|---|
| Age (years) | 63.6 ± 8.0 | 62.9 ± 9.1 | 63.1 ± 8.7 |
| Weight | 78.2 ± 18.0 | 72.0 ± 16.2 | 73.7 ± 16.9 |
| Height | 1.65 ± 0.08 | 1.55 ± 0.08 | 1.58 ± 0.09 |
| BMI | 28.4 ± 5.0 | 29.7 ± 5.7 | 29.4 ± 5.5 |
| Abdomen | 100.7 ± 23.0 | 103.7 ± 12.0 | 102.9 ± 15.9 |
| Waist | 99.8 ± 21.2 | 98.1 ± 13.9 | 102.9 ± 15.9 |
| Hip | 102.3 ± 22.1 | 106.5 ± 10.7 | 105.3 ± 14.9 |
| Waist–hip ratio | 0.98 ± 0.07 | 0.92 ± 0.13 | 0.94 ± 0.12 |
| LDL | 95.6 ± 36.2 | 109.9 ± 39.6 | 105.8 ± 39.0 |
| HDL | 54.4 ± 12.9 | 50.8 ± 12.5 | 51.8 ± 12.6 |
| VLDL | 32.7 ± 8.5 | 30.6 ± 10.4 | 31.2 ± 10.0 |
| Cholesterol | 184.2 ± 26.1 | 193.6 ± 35.1 | 191.0 ± 33.0 |
| Triglicerides | 163.7 ± 42.6 | 152.8 ± 52.2 | 155.9 ± 49.8 |
| Glucose | 133.6 ± 47.4 | 110.8 ± 38.8 | 117.0 ± 42.4 |
| Pressure (mmHg) | | | |
| Systolic | 134.9 ± 15.0 | 126.0 ± 18.8 | 128.5 ± 18.2 |
| Diastolic | 88.4 ± 9.9 | 85.5 ± 8.4 | 86.3 ± 8.9 |

BMI = body mass index, LDL = low-density lipoprotein, HDL = high-density lipoprotein, VLDL = very low-density lipoprotein.
[a]Data are shown on average, standard deviation (median ± SD).



chronic NCDs [5]. Indeed, physical inactivity is as important risk factor for obesity because an improper diet has a direct relationship with the incidence of type 2 diabetes mellitus in adults, regardless of BMI or family history of diabetes [18]. Correspondingly, lifestyle changes that include increased physical activity and a balanced diet are effective intervention options for people with pre-diabetes who want to prevent progression to type 2 diabetes mellitus [20].

A cross-sectional study in India with 1366 rural participants and 2536 urban participants evaluated travel mode (walking, cycling, and public transport) and the duration of the journey from home to work [27]. They used logistic regression models adjusted for age, sex, social class, standard of living, occupation, location, leisure time physical activity, daily fat intake, smoking, and alcohol use. Rural residents were significantly more likely to use a bicycle (68.3% vs 15.9%, $p < 0.001$) than urban residents. The prevalence of being overweight or obese was 50.0% in participants who traveled to work by private transport, 37.6% by public transport, 24.2% by bicycle, and 24.9% by walking [27].

Given the strong association between obesity and NCDs, anthropometric measurement is an important strategy for the detection and control of NCDs [9]. For example, studies have shown that BMI and WC are significantly associated with hypertension and other diseases [1,5,6,16]. Monitoring body shape thus assists in treatment and encourages patients to improve their health. Measuring WC can also provide information on health risks for cardiovascular disease. In a study in South Africa [15], the strongest correlations were found between WC and WHR and risk factors such as an increase in diastolic pressure and fasting glucose concentration.

The BMI of the study population was 29.4 ± 5.5 kg/m$^2$. The overall prevalence of participants above the BMI recommended by the WHO (27.8 for men and 27.3 for women) was 70%. Most individuals surveyed are classified as obese [8]. The average waist circumference was 99.8 ± 21.2 cm for men and 98.1 ± 13.9 cm for women, significantly higher than the upper limit recommended by the WHO (up to 94 cm for men and 80 cm for women) [9]. Approximately 83% of men had a WHR less than or equal to 1 (0.98 ± 0.07), and 93% of women had a WHR greater than 0.8 (0.92 ± 0 13).

The anthropometric profile of our participants is significantly poorer than that reported in other studies from Brazil. In a study of employees of a hospital in Sao Paulo, Sarno and Monteiro reported that 52.5% of respondents had a BMI greater than 25 [13]. However, 62% of men and 44.5% of women had waist circumferences within the parameters recommended by the WHO [13].

Kruger et al. assessed the relationship between anthropometric measurements and risk factors for NCDs in South African black women ($n = 1040$), demonstrating a significant correlation between obesity (particularly WC) and risk of chronic diseases [15]. Another study in Asian patients with type 2 diabetes ($n = 88$) showed that hypertension, dyslipidemia, and cardiovascular disease are significantly higher in patients with abdominal obesity [17]. Cancers have also been linked to obesity. A recent study of female patients ($n = 400$) treated at the National Institute of Oncology in Rabat, Morocco, found significant associations between breast cancer, high BMI, and lack of physical activity [8]. Conversely, a protective effect for physical activity was detected [8]. Similarly, a U.S. cohort study of 35,215 women in Iowa supports the hypothesis that high intakes of sucrose and obesity increase the risk of colon cancer and also raises questions about the potentially negative influence of meat, fat, protein intake, and reduced physical activity [28].

Based on the WHO classification, 70% of hypertensive people are overweight, increasing their predisposition to the development of other chronic diseases. In our study, men who had a high BMI also had more fat in the abdominal region ($r = 0.88$), although this was not observed in women. Nevertheless, both sexes were generally overweight, sedentary, and hypertensive. The results of this research indicate that obesity is endemic in some low-income northeast Brazilian communities and is strongly related to the development of chronic NCDs.

Biochemical rates can be used to help to understand the etiology of NCDs. The number of individuals with low levels of total cholesterol (<200 mg/dL as recommended by the WHO) was 60%, with a mean of 191.0 ± 33.0 mg/dL (Table 2). However, 10% of women and 5% of men had values above 240 mg/dL (Table 2). Likewise, only 10% of the women had values greater than 200 mg/dL of triglycerides (152.8 ± 52.2 mg/dL), as did 100% of the men (163.7 ± 42.6 mg/dL; Table 2). It should be noted that the hypocholesterolemic diet and specific

medications used to control this condition are not always followed correctly by patients.

Moreover, even with the use of drugs, plasma glucose levels showed high average values for both men (133.6 ± 47.4 mg/dL) and women (110.8 ± 38.8 mg/dL). A similar pattern occurred for blood pressure, where about 70% of patients had increased values even when making use of one or more antihypertensive medications for at least 2 years.

Arterial blood pressure above the limit recommended by the WHO (120/80 mmHg) was recorded in 60% of women and 100% of men. In the studies of National Cholesterol Education Program Adult Treatment Panel III (2001 and 2004), International Diabetes Federation, and American Heart Association/Institute, of 8925 hypertensive patients treated only 35.8% had controlled hypertension. The risk of lack of control of blood pressure increases with age, waist circumference, serum triglycerides, and high-density lipoprotein cholesterol, associated with a lower efficacy of antihypertensive therapy [16].

Systemic hypertension is identified as a serious public health problem in the world and an important risk factor for other cardiovascular, cerebrovascular, and kidney diseases, accounting for about 40% of deaths from stroke and 25% of deaths from coronary artery disease and diabetes [19]. All individuals included in the survey are regularly monitored by the Family Health Program.

The importance of government programs is illustrated by the U.S. National Health and Nutrition Examination Survey (2007–2010), which evaluated the health conditions of a sample of 1042 uninsured adults between 19 and 64 years old with income not exceeding 138% of the federal poverty level, compared to 471 low-income adults enrolled in Medicaid. Almost a third (30.1%) of noninsured adults had hypertension, hypercholesterolemia, and diabetes, and 80.1% had at least one of these 3 conditions, compared to 63.4% of adults enrolled in Medicaid [18].

Good nutrition has been implicated in the prevention and treatment of various diseases [10,11] and there is good evidence, especially in low-and middle-income countries, that the burden of obesity is shifting onto the poor [4]. Although the environmental determinants of obesity are likely to differ somewhat between countries [29], there appears to be an almost universal shift toward diets dominated by higher consumption of caloric sweeteners, animal foods, and edible oils. Moreover, activity patterns in work, leisure, travel, and home are also shifting rapidly to reduced energy expenditure. Underlying factors in these changes include large-scale declines in food prices, increased access to supermarkets, and urbanization of rural areas are [30].

A good example is India, whose population has undergone a 7% reduction in energy gained from carbohydrates and a 6% increase in energy derived from fats over the last 30 years (1973–2004). The decreased intake of coarse cereals, pulses, fruits, and vegetables and the growing consumption of salted meat products, along with the declining levels of physical activity due to rapid urbanization, have resulted in increasing levels of obesity, atherogenic dyslipidemia, subclinical inflammation, metabolic syndrome, type 2 diabetes mellitus, and coronary heart disease [31].

NCDs have even increased in southern Mediterranean countries. In 2002, over 60% of all deaths in the southern Mediterranean were attributable to NCDs: cardiovascular diseases caused 34.3% to 52% of all deaths, making it the leading cause of death. In almost all southern Mediterranean countries, cardiovascular risk factors increase with age and obesity, mostly affecting women. These data are associated with changing lifestyles in the region, such as a decreasing intake of whole grains and an increase in the consumption of animals and vegetable oils. Protein and carbohydrate are contributing more to energy consumption, whereas fiber intake is generally lower and consumption of short-chain fatty acids is higher. Furthermore, a more sedentary lifestyle plays a critical role in the development of body fat and may be a risk factor for the onset of metabolic syndrome [32]; that is, the occurrence of disturbed glucose and insulin metabolism, overweight and abdominal fat distribution, mild dyslipidemia, and hypertension associated with development of type 2 diabetes mellitus and cardiovascular disease.

Studies in the Eastern Mediterranean region also record mortality rates from cardiovascular disease and diabetes ranging from 179.8 to 765.2 per 100,000 population, with even higher rates in poor countries in this region. The prevalence of metabolic syndrome was very high, ranging between 19% and 45%. The prevalence of overweight and obese individuals has reached an alarming level, ranging from 25% to 82%, with higher prevalence among women. Once again, these trends have been driven by a nutritional transition in the form of a low intake of fruits and vegetables, urbanization, sedentary lifestyle, hypertension, and smoking [33].

The universality of these trends can be seen in studies from culturally diverse nations. For example, a study of 15-to 64-year-old men and women in Mongolia found that 9 out of 10 people in the study had at least one risk factor for the development of NCDs. One in 5 people had 3 or more risk factors and one in 2 men aged 45 years and over were at high risk for the development of NCDs [34].

In Brazil, a groundbreaking ecological analysis in São Paulo City on the environmental factors associated with being overweight indicated that the average prevalence of overweight people was 41.69% (95% confidence interval, 38.74–44.64). Among the many insights into the drivers of dietary habits, the researchers found a positive correlation between regular consumption fruits and vegetables and a higher density of specialty food markets ($r = 0.497$; $p < 0.001$) [29].

The participants in our study were characterized by a relatively low intake of fats and oils, with 56.4% of subjects never consuming and 7.9% rarely consuming foods from this group,

**Table 3.** Food Frequency Data for the Individuals Studied

| | Male | Female | Population |
|---|---|---|---|
| **Fats and oils** | | | |
| **Never** | 62.9 | 54.0 | 56.4 |
| **Rarely** | 2.7 | 9.8 | 7.9 |
| **Once per month** | 3.4 | 5.8 | 5.1 |
| **Twice a month** | 4.1 | 4.7 | 4.5 |
| **Three times per month** | 2.4 | 1.0 | 1.4 |
| **Every week** | 24.5 | 24.8 | 24.7 |
| **Candy, drinks, and processed food** | | | |
| **Never** | 62.6 | 55.7 | 57.6 |
| **Rarely** | 6.4 | 10.6 | 9.4 |
| **Once per month** | 2.8 | 4.3 | 3.9 |
| **Twice a month** | 3.6 | 5.7 | 5.1 |
| **Three times per month** | 2.8 | 1.0 | 1.5 |
| **Every week** | 21.8 | 22.7 | 22.4 |
| **Fruits and juices** | | | |
| **Never** | 51.5 | 44.6 | 46.6 |
| **Rarely** | 4.9 | 9.0 | 7.8 |
| **Once per month** | 6.9 | 5.0 | 5.5 |
| **Twice a month** | 8.1 | 6.8 | 7.2 |
| **Three times per month** | 3.6 | 1.4 | 2.0 |
| **Every week** | 25.0 | 33.2 | 30.9 |
| **Milk and dairy products** | | | |
| **Never** | 69.6 | 67.6 | 68.2 |
| **Rarely** | 3.0 | 6.0 | 5.2 |
| **Once per month** | 1.0 | 3.2 | 2.6 |
| **Twice a month** | 4.1 | 4.0 | 4.0 |
| **Three times per month** | 0.0 | 0.0 | 0.0 |
| **Every week** | 22.3 | 19.1 | 20.0 |
| **Green vegetables** | | | |
| **Never** | 34.9 | 32.4 | 33.1 |
| **Rarely** | 3.0 | 6.4 | 5.4 |
| **Once per month** | 3.0 | 3.6 | 3.4 |
| **Twice a month** | 9.1 | 4.4 | 5.8 |
| **Three times per month** | 0.0 | 1.3 | 0.9 |
| **Every week** | 49.9 | 52.0 | 51.4 |
| **Beans and carbohydrates** | | | |
| **Never** | 15.3 | 15.4 | 15.4 |
| **Rarely** | 10.8 | 14.2 | 13.2 |
| **Once per month** | 4.5 | 3.4 | 3.7 |
| **Twice a month** | 5.4 | 2.3 | 3.2 |
| **Three times per month** | 6.8 | 4.7 | 5.3 |
| **Every week** | 57.2 | 60.0 | 59.2 |

Data are shown as a percentage (%).

compared to 24.7% who used this food group frequently (Table 3). However, 100% of subjects frequently consumed meat, with a preference for lean meats such as fish, chicken, or red meat without fat.

In the group that includes sweets, soft drinks, and processed foods, 57.6% of the population reported never consuming foods from this group, and 22.4% consumed frequently (Table 3). The highest frequency of consumption was for coffee, which is consumed daily by 89% of subjects. Moreover, the consumption of fruits was very low, with 46.6% never eating fruits and 7.8% rarely consuming fruits. Only 30.9% of respondents ate fruits frequently. Likewise, milk and dairy products are consumed at a low frequency, with 68.2% of the participants never eating these products and only 20% consuming them frequently. Nevertheless, 51.4% of the population often consume green vegetables, with 38.5% rarely or never consuming green vegetables.

Another group of widely consumed foods in the region is carbohydrates. Products made from wheat, maize, cassava, beans, and rice are often consumed by 59.2% of the participants, supporting the thesis that high consumption of carbohydrates leads to weight gain and associated NCDs. Studies on children's consumption of carbohydrates, especially fiber intake, and associations with health throughout life are rare. In general, increased consumption of whole grains and reduced sucrose intake are considered healthy. In the long-term STRIP controlled trial designed to reduce children's exposure to known risk factors for atherosclerosis, the intake of carbohydrates was investigated in detail in children between 13 months and 9 years. The intervention was successful in decreasing the intake of saturated fat and cholesterol during childhood and adolescence. The study also indicates that a high intake of fiber was associated with lower concentrations of total serum cholesterol, whereas increases in the consumption of carbohydrates, sucrose, and fructose are associated with a rise in serum triglycerides [36].

## CONCLUSIONS

Our results indicate that the participants from a rural town in northeastern Brazil have been affected by a nutrition transition, caused by greater access to carbohydrates and proteins, leading to high BMIs. All subjects included in this research were participating in government NCD control programs; the vast majority are overweight with uncontrolled hypertension despite taking medications. The high consumption of carbohydrates and animal protein due to rapid urbanization and sedentary lifestyle are the main factors responsible for the advancing epidemic of NCDs in this area. The epidemic is especially severe among people of low income and low education, with men being more affected by increases in visceral fat, characterized by increased WC.

If our research is typical of northeast Brazil, the consequences of such uncontrolled obesity, poor nutrition, and lifestyle will accrue over in the coming years, with increased incidences of vascular disease, renal disease, and myocardial infarction. Increasing morbidity will, in turn, provoke significant increases in state and federal government spending in the public health system and social assistance. Thus, there is an urgent need for the implementation of prevention policies for NCDs, especially among children and adolescents, with a focus on reducing the intake of salt, fat, and processed food and increasing consumption of fruits and vegetables as well as physical activity.

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## REFERENCES

1. Carvalho GQ, Alfenas RCG: Glycemic index: a critical analysis of its use as a tool to prevent and treat cardiovascular risk factors. Revista Nutrição 21:577–587, 2008.
2. World Health Organization: Global status report on noncommunicable diseases 2010. 2011. Accessed at: http://www.who.int/nmh/publications/.
3. Batista Filho M, Rissin A: Nutritional transition in Brazil: geographic and temporal trends. Caderno Saúde Pública 19:S181–S191, 2003.
4. Popkin BM, Gordon-Larsen P: The nutrition transition: worldwide obesity dynamics and their determinants. Int J Obes 28:S2–S9, 2004.
5. Thawornchaisit P, de Looze F, Reid CM, Seubsman SA, Sleigh AC, and the Thai Cohort Study Team: Health risk factors and the incidence of hypertension: 4-year prospective findings from a national cohort of 60,569 Thai Open University students. BMJ Open 3, 2013.
6. Goon D, Amusa L, Mhlongo D, Khoza L, Anyanwu F: Elevated blood pressure among rural South African children in Thohoyandou, South Africa. Iran J Public Health 42:489–496, 2013.
7. Bertrand KA, Giovannucci E, Zhang SM, Laden F, Rosner BA, Birmann BM: A prospective analysis of body size during childhood, adolescence, and adulthood and risk of non-Hodgkin lymphoma. Cancer Prev Res 6:864–873, 2013.
8. Laamiri FZ, Otmani A, Ahid S, Barkat A: Lipid profile among Moroccan overweight women and breast cancer: a case-control study. Int J Gen Med 6:439–445, 2013.
9. Navarro AM, Stedille MS, Unamuno MRDL, Marchini JS: Distribuição de gordura corporal em pacientes com e sem doenças crônicas: uso da relação cintura-quadril e do índice de gordura do braço (Body fat distribution in patients with and without chronic diseases: use of the waist-hip ratio and arm fat index). Revista Nutrição 14:37–41, 2001.
10. Brazilian Ministry of Health: VIGITEL (Telephone Survey Surveillance System for risk and protective factors for Chronic Diseases). Brasília: Ministério da Saúde, 2010. Accessed at: http://portal.saude.gov.br
11. Meetoo D: Chronic diseases: the silent global epidemic. Br J Nurs 17:1320–1325, 2008.
12. Brazilian Ministry of Planning, Budget and Management; Brazilian Institute of Geography and Statistics: Census 2010 - characteristics of the population and households. Results of the universe. Rio de Janeiro: IBGE, 2011. Accessed at: http://biblioteca.ibge.gov.br
13. Sarno F, Monteiro CA: Relative importance of body mass index and waist circumference for hypertension in adults. Revista Saúde Pública 41:788–796, 2007.
14. Castro SH, Mato HJ, Gomes MB: Anthropometric parameters and metabolic syndrome in type 2 diabetes. Arquivo Brasileiro de Endocrinologia Metabologia 50:450–455, 2006.
15. Kruger HS, Venter CS, Vorster HH: Obesity in African women in the North West Province, South Africa is associated with an increased risk of non-communicable diseases: the THUSA study. Br J Nutr 86:733–740, 2001.
16. Cortez-Dias N, Martins SR, Belo A, Fiuza M: Association of metabolic risk factors with uncontrolled hypertension: comparison of the several definitions of metabolic syndrome. J Hypertens 31:1991–1997, 2013.
17. Nagao H, Kashine S, Nishizawa H, Okada T, Kimura T, Hirata A, Fukuda S, Kozawa J, Maeda N, Kitamura T, Yasuda T, Okita K, Hibuse T, Tsugawa M, Imagawa A, Funahashi T, Shimomura I: Vascular complications and changes in body mass index in Japanese type 2 diabetic patients with abdominal obesity. Cardiovasc Diabetol 12:1–9, 2013.
18. Decker SL, Kostova D, Kenney GM, Long SK: Health status, risk factors, and medical conditions among persons enrolled in Medicaid vs uninsured low-income adults potentially eligible for Medicaid under the Affordable Care Act. JAMA 309:2579–2586, 2013.
19. Cervato AM: "Intervenção Nutricional Educativa: Promovendo a Saúde de Adultos e Idosos em Universidades Abertas à Terceira Idade." (Nutrition education intervention: The adults and elderly health promotion at Open Universities to third age.) São Paulo, Brazil: Tese de Doutorado (Doctoral thesis), USP, 1999.
20. Burr JF, Rowan CP, Jamnik VK, Riddell MC: The role of physical activity in type 2 diabetes prevention: physiological and practical perspectives. Phys Sportsmed 38:72–82, 2010.
21. Kitsantas P, Wu H: Body mass index, smoking, age and cancer mortality among women: a classification tree analysis. J Obstet Gynaecol Res 39:1330–1338, 2013.
22. Miller ER III, Erlinger TP, Sacks FM, Svetkey LP, Charleston J, Lin PH, Appel LJ: A dietary pattern that lowers oxidative stress increases antibodies to oxidized LDL: results from a randomized controlled feeding study. Atherosclerosis 183:175–182, 2005.
23. Magno LAV, Talbot J, Talbot T, Santos AMB, Souza RP, Marin LJ, Moreli ML, Melo PRS, Corrêa RX, Rios-Santos F, Di Pietro G: Glutathione S-transferase variants in a Brazilian population. Pharmacology 83:231–236, 2009.
24. Di Pietro PF, Medeiros NI, Vieira FG, Fausto MA, Belló-Klein A: Breast cancer in southern Brazil: association with past dietary intake. Nutrição Hospitalar 22:565–572, 2007.
25. Duarte ACG: "Avaliação Nutricional—Aspectos Clínicos e Laboratoriais." (Nutritional Evaluation—Clinical and Laboratory Aspects.) Atheneu, Brazil: 2007.
26. Pena SDJ, Di Pietro G, Fuchshuber-Moraes M, Genro JP, Hutz MH, Kehdy FSG, Fabiana Kohlrausch F, Magno LAV, Montenegro RC, Moraes MO, Moraes MEA, Moraes MR, Ojopi EB, Perini

JA, Racciopi C, Ribeiro-dos-Santos AKC, Rios-Santos F, Romano-Silva MA, Sortica VA, Suarez-Kurtz G: The genomic ancestry of individuals from different geographical regions of Brazil is more uniform than expected. PLoS ONE 6:e17063, 2011.

27. Millett C, Agrawal S, Sullivan R, Vaz M, Kurpad A, Bharathi AV, Prabhakaran D, Reddy KS, Kinra S, Smith GD, Ebrahim S, Indian Migration Study Group: Associations between active travel to work and overweight, hypertension, and diabetes in India: a cross-sectional study. PLoS Med 10(6):e1001459, 2013.
28. Bostick RM Potter JD, Kushi LH, Sellers TA Steinmetz KA, McKenzie DR, Gapstur, SM, Folsom AR: Sugar, meat, and fat intake, and non-dietary risk factors for colon cancer incidence in Iowa women (United States) Cancer Causes Control 5:38–52, 1994.
29. Jaime PC, Duran AC, Sarti FM, Lock K: Investigating environmental determinants of diet, physical activity, and overweight among adults in Sao Paulo, Brazil. J Urban Health 88:567–581, 2011.
30. Popkin BM: Global changes in diet and activity patterns as drivers of the nutrition transition. Nestle Nutr Workshop Ser Pediatric Program 63:1–10, 2009.
31. Misra A, Singhal N, Sivakumar B, Bhagat N, Jaiswal A, Khurana LJ: Nutrition transition in India: secular trends in dietary intake and their relationship to diet-related non-communicable disease. Diabetes 3:278–292, 2011.
32. Belahsen R, Rguibi M: Population health and Mediterranean diet in southern Mediterranean countries. Public Health Nutr 9:1130–1135, 2006.
33. Musaiger AO, Al-Hazzaa HM, and the Nutrition and Health Studies Unit: Prevalence and risk factors associated with nutrition-related noncommunicable diseases in the Eastern Mediterranean region. Int J Gen Med 5:199–217, 2012.
34. Bolormaa N, Narantuya L, De Courten M, Enkhtuya P, Tsegmed S: Dietary and lifestyle risk factors for noncommunicable disease among the Mongolian population. Asia Pac J Public Health Suppl 20:23–30, 2008.
35. Lee HA, Park H: Overview of noncommunicable diseases in Korean children and adolescents: focus on obesity and its effect on metabolic syndrome. J Prev Med Public Health 46:173–182, 2013.
36. Niinikoski H, Ruottinen S: Is carbohydrate intake in the first years of life related to future risk of NCDs? Nutr Metab Cardiovasc Dis 22:770–774, 2012.

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