Article/Artigo

Frequency of metabolic syndrome and the food intake patterns in adults living in a rural area of Brazil

Frequência de síndrome metabólica e padrão de ingestão alimentar de adultos vivendo em uma área rural do Brasil

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ABSTRACT

Introduction: Metabolic syndrome (MetS), a risk factor for atherosclerosis and coronary heart disease, is related to an inadequate food intake pattern. Its incidence is increasing among Brazilian adults, including those living in rural areas. Our aim was not only to describe the frequency of MetS in adults with or without MetS but also to compare their food intake pattern as assessed by the healthy eating index (HEI) and serum albumin and C reactive protein (CRP) levels. **Methods:** Men and women (n = 246) living in a small village in Brazil were included. MetS was characterized according to the adult treatment panel (ATP III) criteria. Groups were compared by chi-square, student *t* or Mann-Whitney tests. **Results:** MetS was diagnosed in 15.4% of the cases. The MetS group showed higher CRP (1.8±1.2 vs. 1.0±0.9 mg/dl) and lower albumin (4.3±0.3 vs. 4.4±0.3 g/dl) serum levels compared to the control group. Additionally, the MetS group showed lower scores (median[range]) in the HEI compared to the control group (53.5[31.2-78.1] vs 58[29.7-89.5], respectively). The MetS group also had decreased scores for total fat and daily variety of food intake. **Conclusions:** The results suggest that adults with MetS displayed chronic mild inflammation and a poorer food intake pattern than the control group.

Keywords: Metabolic syndrome. Diet Quality. Healthy eating index. Inflammation.

RESUMO

Introdução: A síndrome metabólica (SM), fator de risco para aterosclerose e cardiopatia isquêmica, está relacionada a uma alimentação inadequada, e sua incidência está aumentando no Brasil, incluindo entre populações rurais. O objetivo deste estudo foi descrever a frequência de síndrome metabólica, e comparar o padrão de ingestão alimentar, avaliado pelo índice de alimentação saudável (*healthy eating index* - HEI), e níveis séricos de albumina e proteina C reativa (PCR) entre adultos com ou sem SM. **Métodos:** Homens e mulheres (n = 246) morando em Inhaumas, pequeno vilarejo do interior da Bahia foram incluídos. SM foi caracterizada de acordo com os critérios do *adult treatment panel* (ATP III). Os grupos foram comparados pelos testes qui-quadrado, teste *t* de student ou Mann-Whitney. **Resultados:** SM foi diagnosticada em 15,4% dos casos. O grupo SM mostrou maiores níveis séricos de PCR (1.8±1.2 vs. 1.0±0.9mg/dl) e menores valores de albumina (4.3±0.3 vs. 4.4±0.3g/dl). O grupo SM apresentou menores notas (mediana [faixa de variação]) do HEI (53.5[31.2-78.1] vs 58[29.7-89.5]), com menores notas para a ingestão de gordura total e variedade de alimentos ingeridos. **Conclusões:** Adultos com SM mostraram resultados compatíveis com diagnóstico de inflamação crônica, e um padrão de ingestão alimentar inadequado em relação ao controle.

Palavras-chaves: Síndrome metabólica. Qualidade da dieta. Índice de alimentação saudável. Inflamação.

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INTRODUCTION

The main concern in public health nutrition has recently shifted from identifying factors associated with a nutrient deficiency to addressing the consequences of excessive or poorly balanced nutrition. Malnutrition and over nutrition tend to coexist in developing countries that are undergoing a rapid nutritional transition[1].

Diets that are characterized by a high consumption of fat (energy-dense), especially saturated fat and cholesterol, with a lower contribution of complex carbohydrates and fibers, have been linked to certain chronic, non-communicable diseases including obesity, ischemic heart disease, stroke, high blood pressure and type-2 diabetes mellitus[1-3].

Metabolic syndrome (MetS) is characterized by abdominal obesity, systemic arterial hypertension, insulin resistance, high serum triglycerides levels and decreased serum HDL-cholesterol. It is associated with a chronic subclinical inflammatory state, as documented by increases in serum C-reactive protein and an increased risk of type 2 diabetes mellitus, atherosclerosis and overall mortality. MetS prevalence is increasing in both developed and developing countries as a result of complex interactions of genetic, metabolic and environmental risk factors, as well as an inadequate food intake pattern[4].

Lifestyle and diet changes have occurred with industrialization, urbanization, economic development and market globalization. These changes have left a significant impact on the health and nutritional status of a population, particularly in developing countries[2]. Brazil is rapidly shifting from a country with problems of dietary deficits to one of dietary excesses, but regional inequalities still exist. About 20 million Brazilians living in rural areas are progressively adopting a Western dietary pattern and a more sedentary lifestyle[5].

As income rises in these areas, the food intake pattern changes from a diet based on staples, such as cereal, beans, vegetables, roots and tubers, toward one of a higher consumption of meat and processed foods, including refined sugar and vegetable oils[2,5-8].

The healthy eating index (HEI) is a measure of diet quality. It incorporates both nutrient recommendations and dietary guidelines and has been used to assess and monitor overall diet quality, nutrition education, and health promotion[1,9]. Therefore, the aim of this study was to describe the frequency of MetS and to compare the food intake pattern, assessed using the HEI and serum albumin and C reactive protein (CRP) levels, between adults, with or without MetS, living in a rural area of Brazil.

METHODS

This cross-sectional study was performed in Inhaumas, a small district of Santa Maria da Vitória, Bahia, Brazil (13° 03´ 04.16" S; 44° 37' 19.81" W) in 2005 (June, October, and December) and 2006 (April and May). As with other inland small towns with poor infrastructure, people living in Inhaumas have limited access to tap water and inadequate disposal of sewage. They consume a basic diet composed of rice, beans, cassava or corn flour, and soybean oil, plus food produced from traditional subsistence farming.

The sample size was calculated using an estimated prevalence of MetS of 30% [range: 28-32%][10]. The study was approved by the research ethical committee of *Universidade Federal do Triângulo Mineiro*, City of Uberaba, Brazil, and all participants gave informed consent to participate.

According to the National Cholesterol Education Program Adult Treatment Panel III (NCEP/ATP III), MetS is diagnosed when at least three of the following criteria exist: central obesity, assessed by waist circumference > 102cm in men and > 88cm in women; systolic blood pressure/diastolic blood pressure ≥ 130/85mmHg; fasting glucose ≥ 110mg/dL; serum triglycerides ≥ 150mg/dL; and HDL cholesterol<40mg/dL for men and <50mg/dL for women[11].

Blood pressure was measured by a trained nurse using a mercury sphygmomanometer with the patient in a sitting position after a 5min rest. People who had blood pressure higher than 130/85 mmHg had their blood pressure taken again to make a diagnosis of high blood pressure[11].

Because of the excellent correlation between capillary blood glucose (measured with the glucose dehydrogenase method) with venous glucose (correlation coefficient of 0.9819)[12], capillary blood glucose concentrations were determined by the Accu-Check Inform System (Accu-Check Advantage®-Roche Diagnostics). Blood glucose values higher than 110mg/dL were repeated for confirmation[11]. Serum triglycerides and HDL-cholesterol were analyzed enzymatically. Serum urea, creatinine, uric acid and albumin measurements were measured using the Cobas Integra 400® (Roche Diagnostics). High-sensitivity C-reactive protein, an established marker of low-grade inflammation and a predictor of atherosclerosis, was measured using turbidimetry (Cobas Integra 400®; Roche Diagnostics)[13].

Anthropometry included weight, height, arm circumference and triceps skin fold determinations. Height was measured without shoes to the nearest 0.1cm using a measuring tape. Weight was measured to the nearest 0.1kg after voiding, without shoes, and wearing light clothing. Waist circumference was measured at a level midway between the lower costal margin and iliac crest at the end of a normal expiration to the nearest 0.5cm[14]. The triceps skin fold was measured on the non-dominant arm using a Holtain® skin fold caliper at a point halfway down the arm between the scapula acromion and the ulna olecranon[15]. Body mass index (BMI) was calculated as weight in kilograms divided by height in square meters (kg/m^2)[16].

Estimates of body fat and lean mass were derived from resistance and reactance measurements with Bioelectrical Impedance Analysis using an RJL Bioelectric Impedance Analyzer (BIA 103-A Detroit, MI, USA).

The 24h dietary recall method was performed and an in-depth interview was conducted by a trained dietary interviewer. Information about the subject's total food and drink intake, including quantity and quality of foods, over the past 24 hours period was obtained[17, 18]. To accurately estimate the quantity of food, kitchen utensils with pre-established weights including spoons, ladles, cups, skimmers and plates, were used. Data were analyzed using the Virtual Nutri® v.1.5 program (São Paulo, Brazil), a validated software for assessing Brazilian foods and culinary measurements[19].

The subject's food intake pattern was assessed with the healthy eating index, an indicator of diet quality developed by the US Department of Agriculture to track the quality of the American diet over time and to guide nutrition promotion activities. The HEI has 10 equally weighted components that represent different dietary guidelines in a healthful diet. Components 1 through 5 measure the degree to which an individual diet conforms to the serving recommendations of the USDA Food Guide Pyramid for the five major food groups: grains, vegetables, fruits, dairy and meat. Component 6 measures fat consumption as a percentage of total energy intake. Component 7 is based on consumption of saturated fat as a percentage of total energy intake, and component 8 focuses on cholesterol intake. Component 9 measures sodium intake, and component 10 is based on the variety of foods in a persons 's diet. For each component, scores range from 0 to 10. Individuals with intakes between the minimum and maximum ranges were assigned scores proportionately[20]. Thus, the overall index has a range from 0 to 100[1].

Continuous variables with normal distribution were expressed as the mean ± standard deviation, and they were compared using the *t* Student test. The Mann-Whitney test was used for variables with non-normal distribution, which are expressed as median and range. Fisher's exact test was used to compare frequency distributions between groups. A value $p < 0.05$ was considered statistically significant[21].

RESULTS

Of 246 subjects, a total of 38 (15.4%) MetS cases were diagnosed. Individuals with MetS were older than those without MetS (**Table 1**). Groups were paired in relation to a male: female ratio, lean body mass measured by bioelectrical impedance analysis, serum urea and uric acid. Individuals with MetS had higher serum creatinine and C-reactive protein and lower serum albumin levels relative to the control group.

As expected, individuals with MetS had higher values for waist circumference, blood pressure levels, serum triglyceride and blood glucose and lower HDL-cholesterol levels relative to the control group. The MetS group also had a higher body weight, body mass index (BMI), triceps skin fold, arm circumference and fat body mass (**Table1**).

Table 2 displays the median and range of the diet servings ingested per day, contrasting both groups. It also displays the amount of total and saturated fat (%), daily cholesterol and sodium intake (mg), and variety of food consumed per day.

TABLE 1 -Demographical, clinical and laboratory data, anthropometry and bioelectric impedance analysis (BIA) characteristics of the control or metabolic syndrome group in Inhaúmas, State of Bahia, Brazil, 2006.

	Control group (n = 208)	Metabolic syndrome group (n = 38)
Age (y)*	40.1 ± 16.1	56.1 ± 15.7
Male: female ratio	80 : 128	11 : 27
Body weight (kg)*	56.4 ± 8.6	63 ± 9.2
BMI (kg/m²)*	22.7 ± 2.9	25.9 ± 3.4
Arm circumference (cm)*	26.9 ± 2.8	28.9 ± 3.2
Triceps skinfold (mm)*	13.8 ± 6.9	17.9 ± 7.9
Lean body mass (kg; analyzed by BIA)	43.5 ± 8.3	42.1 ± 9.5
Fat body mass (kg; analyzed by BIA)*	12.8 ± 6.7	20.8 ± 9.2
Waist circumference (cm)*	79.4 ± 9	91.5 ± 10.4
High blood pressure (%; n)*	23.6 (49)	78.9 (30)
Serum triglyceride (mg/dL)*	119.2 ± 55.5	209.8 ± 73.7
Serum HDL-cholesterol (mg/dL)*	39.6 ± 16.2	28.7 ± 8.5
Blood glucose (mg/dL)*	87.6 ± 9.3	95.4 ± 8.4
Serum urea (mg/dL)	23.6 ± 7.9	24.7 ± 8.7
Serum creatinine (mg/dL)*	0.8 ± 0.2	0.9 ± 0.3
Serum uric acid (mg/dL)	4.1 ± 1.3	4.3 ± 0.9
Serum albumin (g/dL)*	4.4 ± 0.3	4.3 ± 0.3
Serum C-reactive protein (mg/dL)*	1.0 ± 0.9	1.8 ± 1.2

*p < 0.05. BMI: body mass index. BIA: bioeletric impedance analysis.

TABLE 2 - Number of servings, amount of total and saturated fat, cholesterol and sodium intake and amount of food consumed on a daily basis by the control or metabolic syndrome groups in Inhaúmas, State of Bahia, Brazil, 2006.

	Control group (n = 208)	Metabolic syndrome group (n = 38)	Criteria for score of 10
Grains	4.1 (0.4-13.7)	3.4 (0.7-9.1)	6-11 servings
Vegetables*	0 (0-8.6)	0 (0-4.2)	2-4 servings
Fruits*	0 (0-5.6)	0 (0-2.9)	3-5 servings
Milk and dairy products	0 (0-3.8)	0 (0-2.2)	2-3 servings
Meat*	0.75 (0-3.5)	0.44 (0-2.2)	2-3 servings
Total fat*	33.0 (13.8-94.4)	38.4 (21.3-61.8)	30% or less energy from fat
Saturated fat*	6.8 (1.8-15.1)	7.5 (3.1-18.5)	10% or less energy from fat
Cholesterol	74.4 (3-555.2)	64.0 (3-321.5)	300mg or less
Sodium	759.6 (16.6-4248.9)	648.1 (63.6-2670.9)	2,400mg or less
Variety*	7 (3-16)	6 (3-11)	8 or more different types of foods in a day

*p < 0.05

TABLE 3 -Scores of healthy eating index (HEI) components of the control or metabolic syndrome groups living in Inhaúmas, State of Bahia, Brazil, 2006.

	Control group (n = 208)	Metabolic syndrome group (n = 38)
Grains	6.6 (0.7-10)	5.7 (1.2-10)
Vegetables	0 (0-10)	0 (0-10)
Fruits	0 (0-10)	0 (0-10)
Milk	0 (0-10)	0 (0-8.8)
Meat	3.7 (0-10)	2.2 (0-10)
Total fat*	7.4 (0-10)	4.4 (0-10)
Saturated fat	10 (0-10)	10 (0-10)
Cholesterol	10 (0-10)	10 (0-10)
Sodium	10 (0-10)	10 (0-10)
Variety*	8 (0-10)	6 (0-10)
Total*	**58.0 (29.7-89.5)**	**53.5 (31.2-78.1)**

* p < 0.05.

The mean HEI score for both groups was 56.9 (range: 12-99). The best scores in the control or metabolic syndrome groups were for saturated fat, cholesterol, and sodium consumption. Mean component scores were the lowest for vegetables, fruits, and milk and dairy products. In relation to the metabolic syndrome group, individuals in the control group had higher scores for total fat consumption and variety of daily food consumption (**Table 3**).

DISCUSSION

The frequency of MetS was 15.4% among adults living in this rural Brazilian community, with a similar percentage of cases in women (17.5%) and men (11.9%). Despite the fact that a universally accepted definition of MetS is needed for clinical and population-based studies, the NCEP-ATP III has been used extensively and helps to predict risks of diabetes mellitus and cardiovascular diseases. Moreover, a recent study of people living in Korea showed a very high correlation between the International Diabetes Federation and ATP-III definitions[22].

There are few studies on the prevalence of MetS among people living in rural areas of the world. In a small village of Tyungyulyu (Russia), the prevalence of MetS was 10% (8% of males and 12% of females)[23]. Preliminary results of a study of cardiovascular and metabolic risk factors being conducted in the rural area of Korea showed a prevalence of MetS of 38.6% (36.6% of males and 40% of females, p = 0.20)[24]. In the United States, the Bogalusa Heart Study (1995-1996) conducted in the semi-rural community of New Orleans showed an overall occurrence of MetS in young adults of 12.2 %(14.9% of males and 10.4% of females)[25].

The prevalence of MetS in Brazil varies from 15.8% among young adults living in Vitoria City, State of Espírito Santo, to 21.6% in Virgem das Graças, a rural community in the Jequitinhonha Valley, State of Minas Gerais[26], to 30% among adults living in rural areas of de Bahia[27], to 47.4% among Japanese-Brazilian men living in Bauru, a city located in the mid-western region of the State of São Paulo[28].

Similar to the research of Salaroli et al.,which studied MetS in urban settings in Brazil[29], our results show that in males, the most frequent trait of MetS was high blood pressure followed by hypertriglyceridemia and low HDL-c levels. In the present study, results show that in females, the most frequent MetS criterion were low serum HDL-c levels, hypertriglyceridemia, and abdominal obesity. It is noteworthy that, despite a high prevalence of HBP (high blood pressure) in both groups, the MetS and control groups had a similar low daily intake of sodium. However, this may be because the HEI method considers only the intrinsic sodium content in food.

As in other studies that document the presence of chronic mild inflammation in obesity[30] and metabolic syndrome[31], adults with MetS showed increased C-reactive protein and lower albumin serum levels than the control group members. In the MetS group, the increased serum CRP levels are due to higher levels of proinflammatory chemokines and cytokines, which are related to systemic and vascular low-grade inflammation and associated with abdominal obesity. This low-grade vascular inflammation is considered a marker of endothelial dysfunction[31].

The lower serum albumin levels in the MetS group are not readily understood. A chronic low-grade albuminuria has been noted in patients with MetS without diabetes mellitus[32,33], which could explain the lower albumin serum levels in patients with MetS. These lower serum albumin levels could also be due to decreased hepatic albumin synthesis or to increased albumin catabolism associated with chronic inflammation[34]. Moreover because systemic endothelial dysfunction is a destructive element of metabolic syndrome[35], one could conjecture a role for enhanced endothelial permeability allowing for increased albumin passage from the vascular into extravascular space to explain these findings.

Both groups (with or without MetS) had low scores for the consumption of vegetables, fruits, milk and dairy products. The MetS group had lower overall median scores relative to the control group (53.5 vs 58). These low scores were mainly driven by excessive total fat intake and a low variety of daily food consumption.

The HEI was proposed by Kennedy et al. as a single summary measurement of the dietary quality of the American population. Nutrient intake scores obtained by the HEI correlate very well with biomarkers of fruits and vegetables intake[36]. In addition to the mean HEI score of 63.9 found by Kennedy et al. in their original work, other studies have found mean scores around 60.1[37], with lower scores for total fat and food variety. The HEI was also applied by Fisberg et al. in a cross-sectional study of 3,454 adults living in large or medium sized cities in the State of São Paulo. This group found a mean HEI score of 60.4, with the lowest scores for vegetables, fruits, and dairy products consumption[38].

Our findings are not surprising. In Brazil, approximately 44 million people are threatened by hunger and many receive governmental funds (*Fome Zero*) to buy inexpensive food such as vegetable oils and starchy food. Those living in remote rural areas seem to have few food options because fruits and vegetables are locally scarce most of the year.

Dietary guidelines for the Brazilian population give equal priority to the prevention and control of nutrition deficiencies, food-related transmissible diseases and non-communicable chronic diseases. The findings of this study should be confirmed by studies conducted in other regions of Brazil. Nonetheless, our findings suggest that Brazilian guidelines should also include child and adult dietary education and promotion of a healthy lifestyle and behavior. Special emphasis should be given to individuals with MetS.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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