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Acute caffeine intake lowers glycemia before and after acute physical exercise in diabetic rats[1]

Ingestão aguda de cafeína reduz a glicemia sanguínea antes e após o exercício físico agudo em ratos diabéticos

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ABSTRACT

Objective

The present study investigated the effects of caffeine supplementation combined with acute physical exercise on the glycemic response of diabetic rats.

Methods

Thirty-two 60-day-old rats with a mean weight of 238±3 g were divided into four groups: control, control caffeine, diabetes, and diabetes/caffeine. Diabetes was induced by 60 mg/kg of streptozotocin intraperitoneally. The control groups received an acute dose of caffeine (6 mg) or saline 60 minutes before exercise. The animals were then forced to swim for 60 minutes carrying a ballast weighing 6% of their body weight, producing lactacidemia compatible with the maximum lactate production during the steady state (5.5 mmol/L). After the acute exercise session, the animals were sacrificed and their blood collected for glucose analysis. The cardiovascular responses were measured before and after supplementation by tail cuff plethysmography. The one-way Analysis

[1] Article based on the dissertation of LA SILVA intitled "*Efeito da ingestão aguda de cafeína na resposta glicêmica e insulínica em ratos diabéticos*". Universidade Estadual do Centro-Oeste; 2012.

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of Variance (Anova) was realized with *post hoc* of Student-Newman-Keuls to analyse the statistical differences between the supplementations, considering $p<0.05$.

Results

Caffeine at a dose of 6 mg/kg did not change the cardiovascular responses. However, compared with the control groups, caffeine reduced the blood glucose (42%, $p<0.05$) of diabetic rats after 60 minutes of exercise.

Conclusion

Acute caffeine ingestion together with exercise can increase glucose uptake without changing cardiovascular responses in animal models.

Indexing terms: Caffeine. Diabetes *Mellitus*. Exercise. Glycemia.

RESUMO

Objetivo

O presente estudo verificou os efeitos da suplementação com cafeína associada ao exercício físico agudo sobre a resposta glicêmica em ratos diabéticos.

Métodos

Foram utilizados 32 animais, com 60 dias de idade, e 238±3 g de peso, divididos em quatro grupos: controle, controle cafeína, diabetes e diabetes/cafeína. O modelo de diabetes foi induzido pela administração intraperitoneal de 60 mg/kg de estreptozotocina. De forma aguda, os animais receberam 6 mg de cafeína ou salina para os grupos-controles 60 minutos antes do exercício físico. Os animais realizaram um protocolo de natação de 60 minutos de exercício físico, com sobrecarga de 6% do peso corporal com lactacidemia compatível com a máxima produção de lactato em estado estável (5,5 mmol/L). Após o exercício físico agudo, foi realizada a eutanásia dos animais para coleta de sangue e análises glicêmicas. Antes e após a prescrição das suplementações, ocorreu a aferição das respostas cardiovasculares por meio de um pletismógrafo de cauda. Foi realizado o teste estatístico Analise de Variância one way *com* post hoc *de* Student-Newman-Keuls *para analisar as diferenças estatísticas entre as suplementações, sendo considerado p<0,05.*

Resultados

A prescrição de cafeína na dose de 6 mg/kg não alterou respostas cardiovasculares. No entanto, a cafeína promoveu uma significante redução na glicemia sanguínea (42%; p<0,05) após 60 minutos do protocolo de exercício nos ratos diabéticos em relação aos grupos-controles.

Conclusão

A ingestão aguda de cafeína associada ao exercício físico agudo pode aumentar a captação de glicose sem alterar as respostas cardiovasculares em modelo animal.

Termos de indexação: *Cafeína. Diabetes* Mellitus*. Exercício. Glicemia.*

INTRODUCTION

Diabetes *Mellitus* (DM) is a metabolic disorder characterized by a change in the homeostasis of energy substrates, causing hyperglycemia secondary to low pancreatic secretion of the hormone insulin or low response of peripheral insulin receptors to the hormone[1]. Its prevalence is increasing exponentially, acquiring pandemic characteristics in many countries. In Brazil the mean occurrence of adult diabetes (individuals aged 18 years or more) is 5.2%, representing 6,399,187 people who confirmed having the disease. The prevalence increases with age: DM affects 18.6% of the population aged more than 65 years[2].

In diabetes *Mellitus*, the clinical picture resultant from the metabolic disorder characteristic of the syndrome could be controlled by non-pharmacological treatments, such as physical exercise or dietary substances that can improve the metabolic status and its consequences. Clinical studies have shown that caffeine intake before

exercise increases fat oxidation and carbohydrate uptake by activated muscle cells[3], possibly improving the metabolic status of diabetic patients. Verguawen *et al.*[4] have shown that caffeine can increase skeletal muscle glucose uptake in rats by increasing the intracellular concentration of calcium ions (Ca^{2+}) and the expression of Adenosine Monophosphate-Activated Protein Kinase (AMPK), which may be an interesting strategy to reduce insulin resistance in skeletal muscle and control glycemia in diabetics.

Caffeine is an alkaloid from the methylxanthine group (1,3,7-trimethylxanthine) that is rapidly absorbed by the gastrointestinal tract and metabolized by the liver. Its biological half-life varies from 2.5 to 4.5 hours[5]. Caffeine's main mechanisms of action include the intracellular mobilization of Ca^{2+}, catecholamine increase, and adenosine receptor antagonism[6].

Caffeine stimulates insulin secretion by pancreatic β-cells by increasing intracellular Ca^{2+} [7]. In skeletal muscle caffeine can increase the expression of Glucose Transporter type 4 (GLUT4) by increasing intracellular Ca^{2+} concentration and AMPK expression[7,8]. Caffeine also antagonizes the adenosine receptors involved in glycogenolysis and gluconeogenesis found in the cell membranes of hepatocytes[9].

Physical exercise promotes important changes in glucose homeostasis and possibly a rapid blood glucose decrease in diabetics. This action can be observed by monitoring glycemia during planned physical activity[3,10]. The ingestion of energy substrates or substances that promote glycemic control is a good strategy for preventing a sharp increase in blood pressure or rebound hypoglycemia during and after physical activity[11].

Preclinical (animal model) investigations of the mechanism by which caffeine benefits diabetics or how the benefits are optimized are still scarce. Some data have suggested that caffeine or aerobic exercise may increase cellular glucose uptake and thereby reduce insulin resistance. However, the effect of associating both strategies for metabolically controlling diabetes is unknown. Hence, a study showing the potential effects of caffeine on lipid metabolism, glycemic and insulin control, and insulin response, further enhanced by physical activity, could encourage new diabetes treatment strategies.

Thus, the objective of the present study is to verify the effects of caffeine and acute physical exercise on the glycemic and cardiovascular response of diabetic rats.

METHODS

Thirty-two 60-day-old Wistar rats with a mean weight of 238±3 g were kept at a room temperature of 23±2 °C, controlled moisture of 55%±10%, and an inverse 12-hour light/dark cycle.

The study was approved by the local Animal Research Ethics Committee under Protocol number 026/2011.

Experimental design

The animals were divided into four groups: (1) Control, (2) Control Caffeine, (3) Diabetes, and (4) Diabetes/Caffeine. The diabetic groups were given intraperitoneally 60 mg/kg of Streptozotocin (STZ) (Sigma, St. Louis, EUA) dissolved in a 0.01M citrate buffer (pH 4.5) after a 12-hour fast. The diabetic groups consisted of animals with a fasting blood glucose level >250 mg/dL, as classified by a previous study[12].

After an 8-hour fast, the rats received by gavage either 6 mg/kg of caffeine (same dosage used by Graham *et al.*[3]) diluted in water or a placebo (0.9% NaCl solution). These supplements were administered 60 minutes before the exercise protocol because of caffeine's biological half-life[6].

Exercise protocol

All animals were adapted to water by allowing them to swim 10 minutes a day for seven days before the experimental protocol began. On the test day, after receiving the supplements, all

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animals performed a 60-minute, predominantly aerobic swimming exercise carrying a ballast weighing 6% of their bodyweight, which induced lactacidemia compatible with the maximum lactate production during the steady state (5.5 mmol/L). This protocol, proposed by Gobatto *et al.*[13], uses a 40 cm-deep tank with water heated to 30 °C ± 1 °C.

Determination of blood pressure and heart rate

Heart Rate (HR), Systolic Blood Pressure (SBP), and Diastolic Bood Pressure (DBP), were determined by tail cuff plethysmography (Insight®, *Ribeirão Preto*, Brazil). All animals were familiarized with the device by undergoing three measurements a day for five days before the experimental protocol. On the test day, before and after the supplements and before the exercise session, the HR and blood pressure of each animal were measured at least three times. Heart rate, SBP, and DBP were recorded by the device's software after each measurement.

Glycemic analyses

Blood glucose was measured before and after the gavage by tail vein puncture. Approximately 25 µL of blood were collected and analyzed by the glucose meter ACCU-CHEK® Active (Roche, Switzerland).

The rats were sacrificed immediately after the exercise protocol, and their blood were collected and stored in tubes containing fluoride for enzymatic analysis of blood glucose. The samples were centrifuged at 1500 rpm for ten minutes to separate the serum and analyzed by a semiautomatic biochemical analyzer Diaglobe CA-2006® (New York, United States of America) using the BioSystems kit (Barcelona, Spain).

Statistical analysis

All results were expressed as mean ± Standard Error of the Mean (SEM). The statistical analyses relied on one-way Analysis of Variance (Anova). The significance level was set at 5% ($p<0.05$). When appropriate, the differences between the groups were determined by the *post hoc* Student-Newman-Keuls test.

RESULTS

Caffeine intake did not change the cardiovascular variables significantly (Table 1).

The blood glucose of the Diabetes/Caffeine group decreased by 25% (from 403 mg/dL to 311 mg/dL; $p<0.05$) 60 minutes after the ingestion of 6 mg/kg of caffeine (without exercise) compared with the fasting group. The blood glucose of the Diabetes group was 42% higher than that of the Diabetes/Caffeine group (Diabetes=387 mg/dL and Diabetes/Caffeine=187 mg/dL; $p<0.05$) after the physical activity protocol (Figure 1).

Table 1. Cardiovascular responses before and after the respective supplementations before exercise (n=32).

Groups	HR (bpm)				SBP (mm/Hg)				DBP (mm/Hg)			
	Before ingestion		After ingestion		Before ingestion		After ingestion		Before ingestion		After ingestion	
	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
Control	375	± 5	336	± 6	124	± 2	126	± 3	79	± 4	80	± 4
Control caffeine	450	± 24	359	± 28	125	± 1	126	± 2	83	± 3	81	± 3
Diabetes	434	± 17	433	± 17	126	± 1	120	± 5	82	± 2	81	± 2
Diabetes/Caffeine	436	± 19	433	± 25	123	± 2	123	± 1	81	± 3	82	± 3

Note: The data are expressed as Mean ± Standard Error of the Mean (SEM). The intra- and intergroup comparisons were done by Student-Newman-Keuls *post hoc* one-way Analysis of Variance.

HR: Heart Rate; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

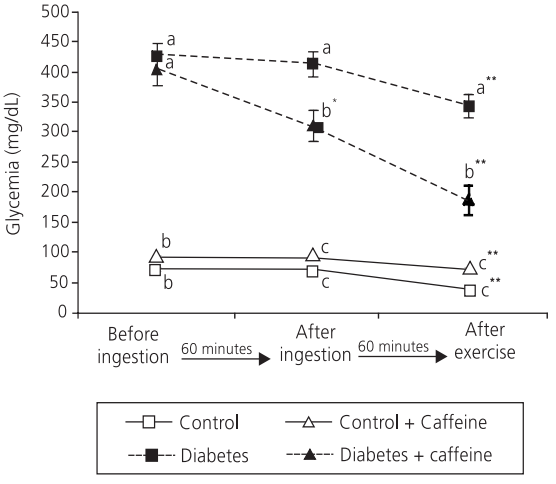

Figure 1. Glycemia variation according to supplementation. The values are expressed as means ± standard error of the mean (n=32).

Note: *Indicate intragroup statistical differences before and after supplementation ($p<0.05$); **Indicate intragroup statistical differences before and after exercise ($p<0.05$); Different letters (a, b, c, d) indicate statistical differences between the groups ($p<0.05$; Student-Newman-Keuls test after one-way analysis of variance).

DISCUSSION

Glycemic control promoted by diet and exercise greatly helps to prevent the frequent bouts of hyperglycemia and hypoglycemia experienced by diabetics before and after exercise. Moreover, glycemic control promotes a positive long-term impact on the clinical status of diabetics, delaying the tissue damage associated with this metabolic disorder. Caffeine intake significantly decreased STZ-induced hyperglycemia in the study rats before and after exercise.

Although the study STZ-induced diabetes model kills 10% to 30% of pancreatic β-cells[14], caffeine intake associated with acute physical activity reduced hyperglycemia by 19%, lowering blood glucose from 436 mg/dL to 343 mg/dL. Therefore, caffeine may stimulate insulin secretion by pancreatic β-cells as has been demonstrated by other studies: its activity cascade and amplification pathways promote insulin secretion by blocking Adenosine Triphosphate (ATP)-sensitive potassium channels in the pancreas, increasing calcium concentration[15,16]. Additionally, caffeine has also promoted the expression of GLUT4 in the skeletal muscle of animals not exposed to acute physical activity even in dosages (7.6 mg/dL)[7] similar to the present dosage (6 mg/dL). Caffeine may act in two fronts: first, it increases the number of glucose transporters, promoting lower insulin resistance; and second, it stimulates insulin secretion, which, together with the predominantly aerobic exercise and low lactate threshold, results in better skeletal muscle glucose signaling and uptake efficiency, which in turn attenuates the hyperglycemic status in the study model of diabetes.

It is well established that physical exercise may increase insulin sensitivity, GLUT4 expression, and glycogen synthase activity in the muscle cells of type-2 diabetics, and this effect may last as much as 48 hours[17,18].

Caffeine also increases incretins, such as Glucagon-Like Peptide 1 and Glucose-Dependent Insulinotropic Polypeptide, so in theory, it may increase insulin secretion[19]. The intake of 180mg of caffeine by type-2 diabetics increases blood glucose uptake during the Oral Glucose Tolerance Test, contrary to the group that consumed a decaffeinated beverage[20].

Noordzij *et al.*[21] showed that caffeine's stimulation of the cardiovascular system is directly proportional to the amount of caffeine consumed. The effect of caffeine on cardiovascular responses arises from the classic effect of caffeine of increasing catecholamine release, directly affecting the sympathetic nervous system and consequently increasing blood pressure[6,22]. However, significant differences between the groups did not occur in the present study, possibly because of the caffeine dosage used (6 mg/kg).

CONCLUSION

Caffeine decreased glycemia significantly without promoting cardiovascular changes. Future studies should try to better clarify caffeine's dose-

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response effect before and after physical activity, which may indicate that caffeine intake is an interesting strategy to control glycemia.

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CONTRIBUTORS

LA SILVA collected data, searched the literature, performed the statistical analyses, created and interpreted the graphs, wrote the manuscript, and discussed the results. RA PEREIRA collected data and wrote the manuscript. JA TÚRMINA collected data and searched the literature. II KERPPERS wrote the manuscript and discussed the results. LR ALTIMARI wrote the manuscript and discussed the results. CRM MALFATTI performed the statistical analyses, created and interpreted the graphs, wrote the manuscript, and discussed the results.

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Resveratrol reduces chronic inflammation and improves insulin action in the myocardium of high-fat diet-induced obese rats

Resveratrol reduz a inflamação crônica e melhora a ação da insulina em miocárdio de ratos com obesidade induzida por dieta hiperlipídica

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ABSTRACT

Objective

To evaluate the effects of resveratrol on insulin signaling and inflammation pathway in the myocardium of high-fat diet-induced obese rats.

Methods

Thirty Wistar rats were divided into a control group (n=10, standard diet), obese group (n=10, high-fat diet), and obese supplemented with resveratrol group (n=10, 20 mg/kg/day) for eight weeks. An insulin tolerance test was performed at the end of the study period "0" (without insulin), 5, 10, 15, 20, 25, and 30 minutes after an intraperitoneal injection of insulin (2 U/kg). Body and epididymal adipose tissue were weighed. Fragments of the myocardium were extracted for Western blot analyses of insulin pathway and proinflammatory molecules.

Results

Resveratrol increased the rate of glucose disappearance, phosphorylation of the insulin receptor, insulin receptor substrate 1, and protein kinase B; and reduced expression of tumor necrosis factor alpha and of the molecules

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involved in proinflammatory signal transduction, namely Ikappa B kinase and nuclear factor kappa B complex. The results also suggest that higher insulin sensitivity and lower levels of proinflammatory molecules occurred regardless of weight and epididymal adipose tissue loss.

Conclusion

Resveratrol increases insulin action and reduces inflammatory molecules in the myocardium.

Indexing terms: Obesity. Resveratrol. Insulin resistance. Inflammation.

RESUMO

Objetivo

Avaliar o efeito do resveratrol sobre a via de sinalização da insulina e melhora do quadro inflamatório no miocárdio de ratos Wistar obesos induzidos por dieta.

Métodos

Ratos Wistar foram divididos em grupos: *controle (dieta padrão para roedores), obeso (dieta hiperlipídica) e obeso suplementado com resveratrol (20 mg/kg/dia), por 8 semanas (n=10). Ao final do período experimental, realizou-se o teste de tolerância à insulina, nos tempos 0 (sem insulina), 5, 10, 15, 20, 25 e 30 minutos após injeção intraperitoneal de insulina (2 U/kg). O peso corporal e o tecido adiposo epididimal foram mensurados. Fragmentos do miocárdio foram extraídos para análises da via da insulina e moléculas pró-inflamatórias através de Western blot.*

Resultados

Os resultados indicam que a intervenção com resveratrol aumenta a constante de decaimento da glicose, fosforilação do receptor de insulina, substrato do receptor de insulina e da proteína quinase B. A suplementação de resveratrol também reduziu os níveis proteicos do fator de necrose tumoral alfa e de moléculas envolvidas com a transdução do sinal pró-inflamatório (quinase indutora do kappa B e fator nuclear kappa B). Os resultados ainda sugerem que a melhora na sensibilidade à insulina e a redução das moléculas pró-inflamatórias ocorreram independentemente da perda de peso corporal e da redução do tecido adiposo epididimal.

Conclusão

A suplementação de resveratrol aumenta a sensibilidade à insulina, o que está relacionado à redução de fatores inflamatórios no miocárdio.

Termos de indexação: *Obesidade. Resveratrol. Resistência à insulina. Inflamação.*

INTRODUCTION

The rapid increase in the prevalence of obesity shows that environmental changes, such as inappropriate eating patterns and little physical activity, are determinants in the increase of the global obesity epidemic[1]. Obesity is a decisive risk factor for diseases such as diabetes Mellitus type 2, high blood pressure, and cardiovascular diseases[2,3]. Morbidly obese patients are at greater risk of sudden death and cardiac problems[4]. A change in insulin sensitivity is an important link between these diseases. Insulin resistance occurs in the heart of obese rats, leading to a reduction in the amount and translocation of the protein Glucose Transporter type 4 (GLUT4) to the sarcolemma[5]. Although the mechanisms that lead to insulin resistance have been widely studied in skeletal muscle, more studies on the cardiac tissue are necessary, along with possible pharmacological or non-pharmacological therapies.

Insulin is an anabolic hormone secreted by the pancreas in response to an increase in blood glucose[6]. Insulin action begins with insulin binding to a specific membrane receptor, called Insulin Receptor (IR)[7]. IR activation promotes tyrosine phosphorylation in various substrates, including Insulin Receptor 1 (IRS-1) and 2 (IRS-2)[8]. Phosphorylation of the IRS proteins exposes binding sites for another cytosolic protein called

Phosphatidylinositol 3-Kinase (PI3-K), activating it[9,10]. Phosphatidylinositol 3-Kinase activation increases serine phosphorylation of the protein kinase B (Akt). The Akt protein is a serine/threonine-specific protein kinase expressed in muscle tissue[11]. Through phosphorylation, the Akt protein is capable of activating many metabolic effects, such as glucose uptake as well as glycogen and protein synthesis.

Many molecules or molecular pathways of intracellular signal transduction can interfere with the insulin transduction pathway, possibly leading to insulin resistance. Of these, the literature mentions the importance of proinflammatory cytokines for the development of insulin resistance, especially IKappa B Kinase (IKK)/Nuclear Factor Kappa B (NF-κB) transcription factor pathway and Tumor Necrosis Factor alpha (TNFα)[12].

Some nutrients increase insulin action significantly[13,14], such as resveratrol (3,5,4'-trihydroxystilbene), a phytoalexin found in plants and some foods, including peanuts, mulberries, and grapes[15]. Resveratrol provides cardiovascular protection[16], inhibits platelet aggregation[17], reduces inflammatory factors[18], and improves glucose homeostasis[19]. The effects of resveratrol supplementation were investigated in insulin-resistant[20], high-fat diet-induced obese rats[21], and found to improve glucose homeostasis and whole-body insulin sensitivity. However, neither the proinflammatory pathway nor the myocardium was assessed. Hence, the present study assessed whether resveratrol supplementation reduces inflammation and improves the insulin signal transduction pathway in the myocardium of obese rats.

METHODS

Characterization of the animals and diet

Thirty four-week-old male Wistar rats weighing approximately 115 g were obtained from the *Universidade do Extremo Sul Catarinense* (Unesc) Laboratory Animal Facility. They were kept in 12/12-hour light/dark cycle at a temperature of 20ºC to 22ºC. After one week of adaptation to the new environment, the animals were first divided into two groups: a lean group fed with standard rodent chow (Nuvital Nutrientes S.A., *Colombo*, PR, Brazil) (carbohydrates: 70.0%; proteins: 20.0%; fats 10.0%, totaling 3.8 kcal/g) (n=10) called control group; and a group fed a high-fat diet (carbohydrates: 38.5%; proteins: 15.0%; fats 46.5%, totaling 5.4 kcal/g) (n=20) for eight weeks. Both groups were given water daily. Once the animals became obese, they were submitted to the Intraperitoneal Insulin Tolerance Test (ITT) to verify their insulin resistance. The obese animals were then subdivided randomly into two groups: high-fat diet-induced obese rats (obese, n=10) and obese rats receiving resveratrol supplementation (obese+resv, n=10).

All experiments were compliant with the principles and procedures established by the *Colégio Brasileiro de Experimentação Animal* (COBEA, Brazilian College of Animal Experimentation) and approved by Unesc's Research Ethics Committee under Protocol number 20/2011.

Resveratrol Supplementation Protocol

The supplemented animals received 20 mg/kg of resveratrol by gavage once a day for eight weeks. Resveratrol 100% pure was purchased from the company Pharma Nostra Ltda (*Rio de Janeiro*, Brazil).

Intraperitoneal insulin tolerance test

The test was performed at the end of the experimental period. Food was removed six hours before the test and the first blood collection corresponded to time "0" Next, insulin (2 U/kg of body weight) was injected intraperitoneally and blood samples were collected from a tail incision after 5, 10, 15, 20, 25, and 30 minutes to measure

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blood glucose. The constant of glucose disappearance during insulin tolerance test (k_{ITT}) was given by the formula $0.693/t_{1/2}$. The $t_{1/2}$ of glucose was given by Least Squares Analysis of the blood glucose level during the linear glucose disappearance phase.

Epididymal fat weight

The animals were sacrificed and the epididymal adipose tissue was removed and weighed by an analytical balance (Bel Engineering Ltda, *Piracicaba*, SP) with an accuracy of 0.001 g for comparing the groups. Body fat weight was expressed as a percentage of the body weight.

Tissue extraction and Western Blot

Twenty-four hours after the last supplementation, the rats were anesthetized with ketamine (50 mg/kg, Syntec; *Cotia*, SP) and xylazine (20 mg/kg, Syntec; *Cotia*, SP). Next, the abdominal cavity was opened and either saline (group without insulin (-), 0.1 mL) or regular insulin (group with insulin (+), 0.1 mL, 10^{-6}) was injected into the inferior vena cava. After the insulin (Humulin R; Eli Lilly, *São Paulo*, SP) injection, fragments of the myocardium were collected and immediately placed in a specific extraction buffer (1% Triton-X 100, 100 mM Tris, pH 7.4 containing 100 mM of sodium pyrophosphate, 100 mM of sodium fluoride, 10 mM of Ethylenediamine-tetraacetic Acid (EDTA), 10 mM of sodium vanadate, 2 mM of Phenylmethanesulfonylfluoride (PMSF), and 0.1 mg of aprotinin/mL) and homogenized by a Polytron® homogenizer (Polytron MR 2100, Kinematica, Switzerland). At the end of the extraction, the animals were sacrificed by guillotine decapitation. Triton X-100 was added to all samples, which were then kept in ice for 40 minutes. The homogenized samples were centrifuged at 11000 rpm for 30 minutes by the centrifuge Eppendorf 5804R (Eppendorf AG, Hamburg, Germany). The Bradford method determined the protein concentration on the supernatant. The proteins were then denatured by boiling at 100 ºC in a Laemmli buffer system containing 100 mM of Dithiothreitol (DDT).

Once the protein concentration was determined, the samples were loaded in Sodium Dodecyl Sulfate - Polyacrylamide Gel (SDS-Page) and separated by electrophoresis. The proteins separated by SDS-PAGE were transferred to a nitrocellulose membrane in the device Mini Trans-Blot® Electrophoretic Transfer Cell (BIO-RAD, Hercules, United States) and immediately blocked by a blocking buffer (5% albumin; 10 mmol/L of Tris; 150 mmol/L of NaCl; 0.02% Tween 20) for two hours to minimize binding between the antibodies and nonspecific proteins. The membrane was incubated for 12 hours with the primary antibodies anti-pIR$^{Tir1162/1163}$ and anti-pIRS1^{Tir971} acquired from Cell Signaling Technology (Beverly, MA, United States) and anti-pAkt^{Ser473}, anti-TNFα, anti-pIKKα, anti-NF-κB, and β-actin acquired from Santa Cruz Biotechnology (Santa Cruz, CA, United States). After the primary antibody incubation, the membranes were rinsed again with a basal solution for three 5-minute sessions and incubated with the secondary antibody conjugated to peroxidase for chemiluminescence (Thermo Scientific, Rockford, IL, United States). Band intensity and area were determined by reading the autoradiographs developed by densitometry using a scanner (HP® G2710) and the software Scion Image (Scion Corporation®).

Statistical analysis

The results were expressed as means ± Standard Error of the Mean (SEM) and analyzed by one-way Analysis of Variance (Anova) followed by the Bonferroni *post hoc* test. The significance level was set at 5% ($p<0.05$). The software Statistical Package for the Social Sciences (SPSS) version 17.0 for Microsoft Windows performed the statistical analyses.

RESULTS

The body and epididymal adipose tissue weights of the obese animals without and with resveratrol supplementation were similar (Figures 1A and 1B), but significantly higher than those of the lean animals. The insulin tolerance test showed that the obese group had lower insulin sensitivity than the lean group (p<0.05). However, resveratrol supplementation increased the insulin tolerance of the supplemented obese group in comparison with the non-supplemented obese group (Figure 1C).

The insulin receptor (Figure 2A), IRS1 (Figure 2B), and Akt (Figure 2C) of the control group given insulin were significantly more phosphorylated than those of the lean group given saline. IR, IRS1 and Akt phosphorylation in the obese group was lower than that in the lean group (p<0.05). However, phosphorylation of these molecules was significantly higher in resveratrol-supplemented obese rats than in non-supplemented obese rats (p<0.05).

The TNFα and NFκB (subunit p65) protein levels and IKKα phosphorylation were analyzed. Obese animals presented a significant increase in TNFα (Figure 3A), IKKα phosphorylation (Figure 3B) and NFκB (Figure 3C) protein levels when compared with lean animals, but supplemented obese rats presented lower values than non-supplemented obese rats (p<0.05).

DISCUSSION

Obesity is an important factor in the development of cardiovascular diseases and insulin resistance, and a decisive risk for diabetes Mellitus type 2[2,3]. The IKK/NF-κB inflammatory pathway and TNFα have a critical role in the development of insulin resistance in pathophysiological conditions like obesity[14]. High-fat diet-induced obese rodents presented a significant increase in insulin resistance and expression of inflammatory cytokines, such as IL-1β, IL-6, TNFα, and NF-κB[13]. In states such as

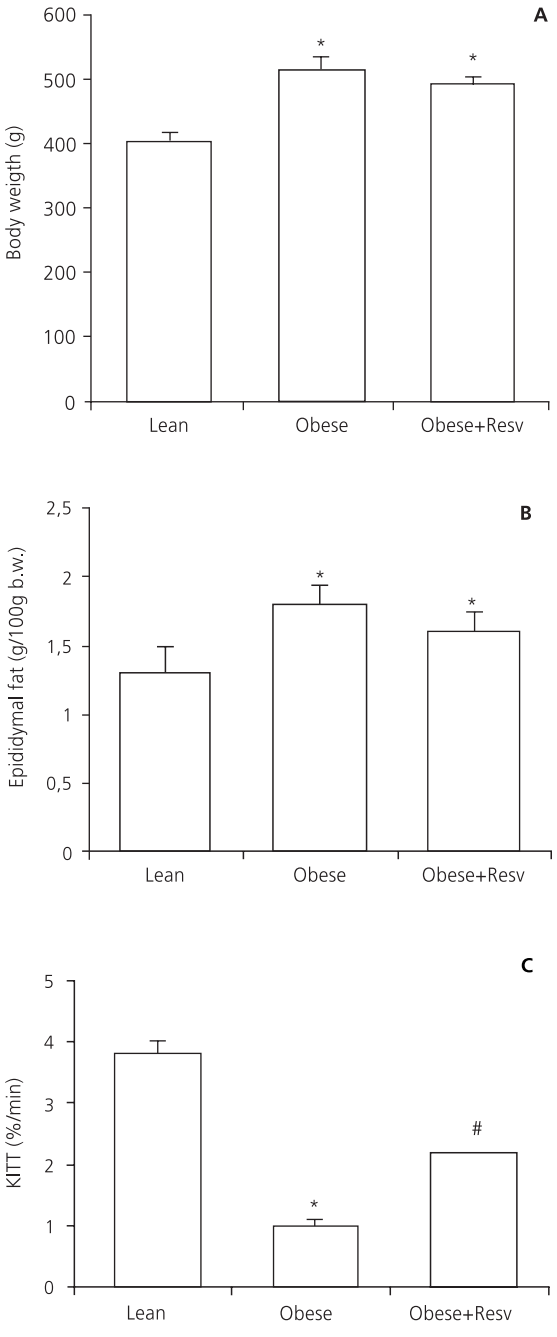

Figure 1. Analysis of body weight and epididymal fat, and rate of glucose disappearance (k_{ITT}) in the myocardium of lean rats, non-supplemented obese rats, and resveratrol-supplemented obese rats.

Note: Anova: *p<0.05 for non-supplemented obese rats and resveratrol-supplemented obese rats *versus* lean rats; #p<0.05 for resveratrol-supplemented obese rats *versus* obese rats. Body weight (A), epididymal adipose tissue weight (g/100g body weight) (B) and k_{ITT} (C). The results were expressed as arbitrary units. Bars represent means ± Standard Error of the Mean (SEM) of n=10 per group.

Source: *Universidade do Extremo Sul Catarinense* (Unesc). Laboratory of Physiology and Exercise Biochemistry. *Criciúma* (SC), Brazil, 2013.

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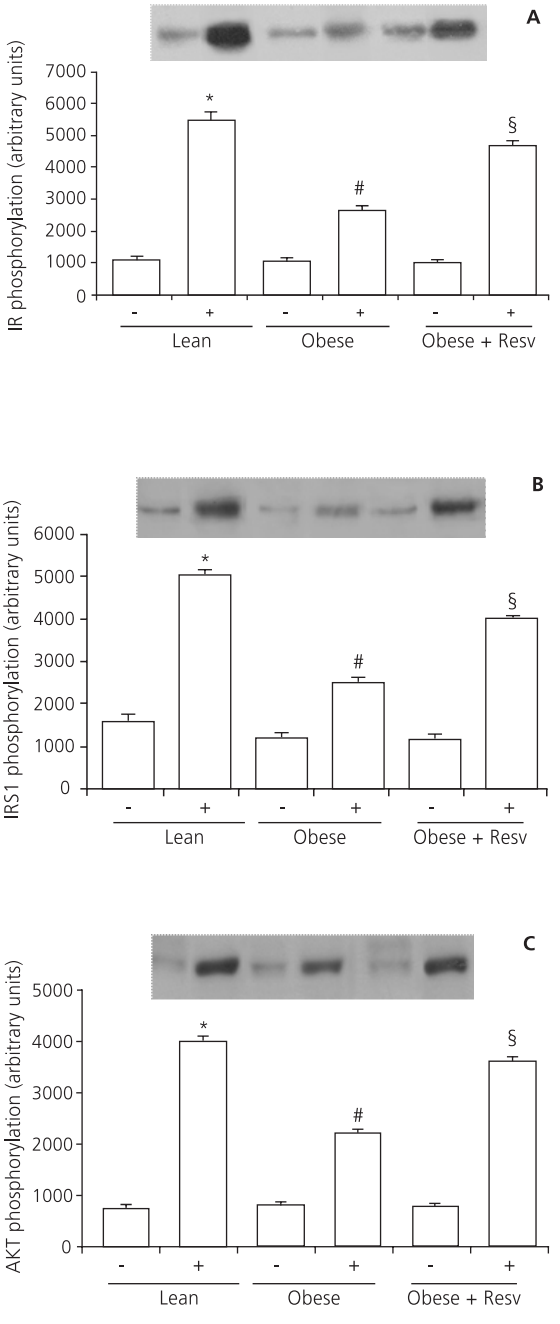

Figure 2. Insulin signaling pathway in the myocardium of lean rats, non-supplemented obese rats, and resveratrol-supplemented obese rats.

Note: Anova: $^{*}p<0.05$ for lean controls with insulin *versus* lean controls without insulin; $^{\#}p<0.05$ for obese rats with insulin *versus* lean controls with insulin; $^{\S}p<0.05$ for resveratrol-supplemented obese rats with insulin *versus* non-supplemented obese rats with insulin. IR (A), IRS1 (B), and Akt (C) phosphorylation. The results were expressed as arbitrary units. Bars represent means ± Standard Error of the Mean (SEM) of n=10 per group.

Source: *Universidade do Extremo Sul Catarinense*. Laboratory of Physiology and Exercise Biochemistry. *Criciúma* (SC), Brazil, 2013.

insulin resistance, cytokines such as TNFα activate IKKα and IKKβ by intermediate signaling pathways. This activation promotes the serine phosphorylation of IR and IRS1, reducing insulin signal transduction[22]. However, changes in inflammation levels and myocardial insulin signaling pathway require further investigation. Additionally, nutrients like resveratrol improve insulin sensitivity[19,23] and reduce inflammation and incidence of coronary diseases[16]. Thus, the study hypothesis was that resveratrol supplementation could benefit the myocardial insulin signaling pathway of obese rats. As expected, obese rats developed insulin resistance and presented higher levels of proinflammatory molecules in the myocardium, and resveratrol supplementation was capable of reversing these findings regardless of body weight and fat loss. Similar results were found in humans where a supplementation of 1g/day of resveratrol for 45 days improved insulin sensitivity, fasting glucose, and Homeostatic Model Assessment-Insulin Resistance (HOMA-IR) regardless of body weight[24].

The resveratrol has also been shown to benefit the insulin signaling pathway[21,23]. Resveratrol supplementation increased IRS1 and Akt phosphorylation in the liver and soleus muscle of insulin-resistant rats, and reduced blood glucose and insulin[21]. The present study found similar results, that is, resveratrol supplementation increased IR, IRS1, and Akt phosphorylation in the myocardium and consequently, insulin sensitivity, as shown by the rate of glucose disappearance. Concordantly, resveratrol supplementation reduced hyperglycemia in an animal obesity model[25].

Regulation of the insulin pathway by resveratrol can be attributed to its ability to activate the protein Sirtuin 1 (SIRT1)[26] by inhibiting phosphodiesterase 4 with consequent Adenosine Monophosphate-Activated Protein Kinase (AMPK) activation[27]. SIRT1 activation helps to control glucose homeostasis by various mechanisms, such as regulation of insulin secretion[28], protection of pancreatic β-cells[29], IR modulation (which improves insulin resistance), inflammation

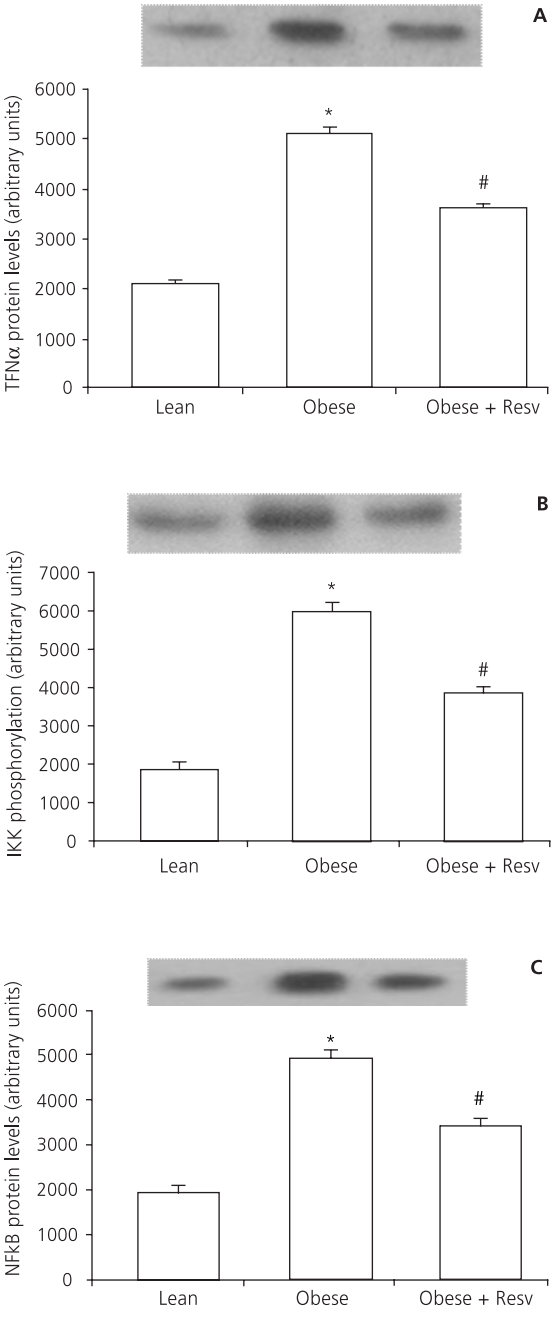

Figure 3. Protein and phosphorylation levels of enzymes involved in the proinflammatory signal transduction in the myocardium of lean rats, non-supplemented obese rats, and resveratrol-supplemented obese rats.

Note: Anova: $^{*}p<0.05$ for obese rats *versus* lean controls; $^{\#}p<0.05$ for resveratrol-supplemented obese rats *versus* non-supplemented obese rats. TNFα (A) and NFkB(p65) (B) levels and pIKKα (C) phosphorylation. The results were expressed as arbitrary units. Bars represent means ± Standard Error of the Mean (SEM) of n=10 per group.

Source: *Universidade do Extremo Sul Catarinense* (Unesc). Laboratory of Physiology and Exercise Biochemistry. *Criciúma* (SC), Brazil, 2013.

reduction, lipid mobilization, and adiponectin secretion[30]. The effects of 150 mg/day of resveratrol taken orally by obese men for 30 days were similar to those of calorie restriction, namely better insulin sensitivity and triglyceride levels, and activation of the AMPK/SIRT1 pathway in skeletal muscle[31].

The biochemical and molecular mechanism by which resveratrol reduces inflammation was not the focus of this study and deserves to be better clarified. However, this study clearly shows the effects of resveratrol on the levels of proinflammatory proteins. Moreover, Gonzales & Orlando[13] found that resveratrol acts on the NF-κB of adipocytes by inhibiting IKK, which prevents the translocation of NF-κB to the nucleus and consequently, reduces the transcription of inflammatory genes[13]. Other studies found that resveratrol reduces IKK phosphorylation in rats' liver[32] and expression of NF-κB and the cytokines IL-1β and IL-6 in fibroblasts[33]. In addition to its effect on the insulin pathway, SIRT1 can deacetylate and consequently, inhibit NF-κB, thereby reducing the transcription of proinflammatory genes[34]. SIRT1 activation by resveratrol also reduced the levels of proinflammatory molecules, such as JNK, IKK, and NF-κB[35].

Another explanation for resveratrol's ability to reduce inflammation may lie in its antioxidant nature[34]. Reactive oxygen species activate the molecules that regulate the inflammation pathway, including NF-κB, and promote the secretion of inflammatory mediators[36]. Furthermore, obese individuals have high levels of reactive oxygen species and impaired antioxidant defense system[37]. However, 20 mg/kg/day of resveratrol were capable of reversing the oxidative stress in the myocardium and aorta of obese rats[38]. Finally, the results are interesting because insulin's effects on the myocardium impacts heart survival[39]. These data evidence that resveratrol can be an effective non-pharmacological treatment to reduce inflammation and consequently, increase whole-body insulin sensitivity.

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Resveratrol treatment increases whole-body insulin sensitivity and the intracellular signaling of this hormone in the myocardium of obese rats, which apparently reduces the levels of proinflammatory cytokines.

CONTRIBUTORS

TF LUCIANO, SO MARQUES, BLS PIERI and DR SOUZA physiological and molecular analysis and article's drafting. FS LIRA analysis and data interpretation, article's drafting and critical revision of important intellectual content. CT SOUZA conception, design, analysis and data interpretation, article's drafting and critical revision of important intellectual content.

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Neck circumference as predictor of excess body fat and cardiovascular risk factors in adolescents

Perímetro do pescoço como preditor de excesso de gordura corporal e fatores de risco cardiovascular em adolescentes

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ABSTRACT

Objective

To verify whether neck circumference can predict cardiovascular risk factors and excess body fat in adolescents.

Methods

This cross-sectional study included male and female adolescents aged 10 to 14 years from *Viçosa, Minas Gerais*. The following data were collected: anthropometric measurements, blood pressure, percentage of body fat according to dual energy X-ray absorptiometry, and levels of fasting glucose, fasting insulin, triglycerides, total cholesterol, high-density lipoprotein, and low-density lipoprotein. The anthropometric measurements were used for calculating indices and assessing nutritional status. The receiver operating characteristic curve tested whether neck circumference could predict cardiovascular risk. We also investigated how neck circumference related to the study parameters. The significance level was set at 5% ($p<0.05$).

Results

A total of 260 adolescents were assessed of which 50.4% (n=131) were females, 20.4% (n=53) had excess body weight according to the body mass index-for-age index, and 42.7% (n=111) had excess body fat. Blood pressure (3.9%, n=10) and all biochemical parameters were affected, varying from 1.9% (n=5) for glucose to

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65% (n=169) for total cholesterol. Neck circumference correlated with body fat, waist circumference, hip circumference, weight, height, body mass index, waist-to-height ratio, homeostasis model of assessment - insulin resistance, fasting insulin, blood pressure, and high-density lipoprotein (<0.05). It predicted excess body fat and changes in fasting insulin and blood pressure in both sexes, blood glucose and high-density lipoprotein in females, and triglycerides in males (area under the curve >0.5; p<0.05, varying from 0.610 for high-density lipoprotein to 0.817 for blood pressure).

Conclusion

Neck circumference was capable of predicting excess fat and cardiovascular risk factors in adolescents.

Indexing terms: Adiposity. Adolescent. Cardiovascular diseases. Neck.Triage.

RESUMO

Objetivo

Verificar a capacidade do perímetro do pescoço, predizer fatores de risco cardiovascular e excesso de gordura corporal na triagem de adolescentes.

Métodos

Estudo transversal com adolescentes de 10 a 14 anos, de ambos os sexos, residentes em Viçosa, Minas Gerais. Foram realizadas avaliações de medidas antropométricas, pressão arterial, gordura corporal pelo Absortometria Radiológica de Dupla Energia, glicemia e insulinemia de jejum, triglicerídios, colesterol total e frações lipoproteína de alta densidade e lipoproteína de baixa densidade. As medidas antropométricas foram utilizadas para cálculo de índices e avaliação do estado nutricional. O perímetro do pescoço foi testado como preditor de risco cardiovascular através da Curva ROC e verificada sua relação com os parâmetros avaliados. Adotou-se significância de p<0,05.

Resultados

Foram avaliados 260 adolescentes: 50,4% (n=131) do sexo feminino, 20,4% (n=53) com excesso de peso pelo índice de massa corporal/Idade e 42,7% (n=111) com excesso de gordura corporal. Houve alterações em todos os parâmetros bioquímicos - com variação de 1,9% (n=5) para glicemia a 65% (n=169) para colesterol total - e na pressão arterial (3,9%, n=10). O perímetro do pescoço correlacionou-se com gordura corporal, perímetro da cintura, perímetro do quadril, peso, estatura, índice de massa corporal, relação cintura/estatura, homeostasis model of assessment-insulin resistance*, insulinemia, pressão arterial e lipoproteína de alta densidade (p<0,05), sendo capaz de predizer o excesso de gordura corporal e alterações na insulina de jejum e na pressão arterial para ambos os sexos; glicemia e lipoproteína de alta densidade para o sexo feminino e triglicerídeos para o masculino (*Area Under the Curve *>0,5; p<0,05, com variação entre 0,610 para lipoproteína de alta densidade e 0,817 para pressão arterial).*

Conclusão

O perímetro do pescoço foi capaz de predizer o excesso de gordura corporal e fatores de risco cardiovascular na população adolescente.

Termos de indexação: *Adiposidade. Adolescente. Doenças cardiovasculares. Pescoço. Triagem.*

INTRODUCTION

Adolescence is a period of physical, behavioral, and emotional changes that marks the transition between childhood and adulthood. During this phase, which chronologically lasts from ages 10 to 19 years, individuals are consolidating food habits, and so are more vulnerable both to nutritional deficiencies because of the high amounts of energy and nutrients needed to meet the intense growth that occurs during this period, and to obesity because of the excessive intake of energy-dense foods. Besides food, other factors such as smoking, alcohol

abuse, and inactivity contribute to adolescents' vulnerability to the risk factors for metabolic disorders and cardiovascular diseases[1,2].

According to the *Programa de Orçamento Familiares* (POF, Family Budget Survey) conducted by the *Instituto Brasileiro de Geografia e Estatística* (IBGE, Brazilian Institute of Geography and Statistics), between 2008 and 2009 roughly 20% of the adolescents living in metropolitan areas in Brazil were overweight[3]. Excess body weight, when due to the accumulation of body fat, is closely related to the incidence of obesity and many other diseases, so early detection is important[4].

Neck circumference has been investigated as a screening instrument for overweight individuals because it is easy to measure, inexpensive, noninvasive, and unlike waist circumference, it does not vary throughout the day. Moreover, neck circumference correlates with many fat-related anthropometric measurements and cardiovascular risk factors[5-8].

Given that anthropometric assessment is easy and practical and that early detection of excess body fat in adolescents is important, the objective of this study was to verify the extent to which neck circumference can predict cardiovascular risk factors and excess body fat in adolescent screenings.

METHODS

This epidemiological, cross-sectional study included male and female adolescents aged 10 to 14 years and 11 months selected by simple random sampling in all public and private schools in the rural and urban areas of the municipality of *Viçosa, Minas Gerais*, Brazil. The inclusion criteria were: not taking medication that affects the metabolism of lipids and carbohydrates or blood pressure, and not having been diagnosed with infections and/or acute inflammations and chronic Non-Communicable Diseases (NCD).

The sample size was determined by considering all the 10-to-14-year-old adolescents living in the municipality in 2010, which totaled 5,752[9], and a rate of excess body fat of 17.5% found by another study of the local adolescent population with similar ages[10]. The acceptable variability was 5.0% with a 95% confidence level, totaling 214 adolescents. Considering a sample loss of 20.0%, at least 257 volunteers would be needed for the sample, 129 of each gender. The tool StatCalc of the software Epi Info version 6.04 was used for the cross-sectional studies in the calculation.

Students were selected among those who signed the Informed Consent Form, respecting the proportion of students of each age in each school. When a participant refused to participate in any of the study stages or dropped out, another student was selected to replace him/her. Thirteen individuals were excluded from the study because of the following reasons: taking anticonvulsants (1); inappropriate fasting (2); blood could not be collected for technical reasons (1); history of myelomeningocele (1); nose cancer (1); taking growth hormone (1); hormonal changes (3); taking dietary supplements and/or vitamins (3).

The project was approved by the Human Research Ethics Committee of the *Universidade Federal de Viçosa* (UFV) under Protocol number 0140/2010. The adolescents and their guardians signed an Informed Consent Form created as recommended by Resolution 196/96 of the National Health Council.

Anthropometric and body composition assessment

Body weight was determined by an electronic digital scale with a maximum capacity of 150 kg and accuracy of 50 g. Height was determined by a portable stadiometer with a maximum length of 2.13 m and accuracy of 0.1 cm. All measurements were taken twice, and the average was used for the study. When the two height measurements differed by more than 0.5 cm, a new measurement was taken. Body Mass Index (BMI)-for-age and height-for-age were

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calculated to characterize the population, using the World Health Organization's (WHO) cut-off points (Z-scores) as reference[11].

Waist circumference was measured by a two-meter flexible, inelastic tape measure with an accuracy of 0.01 cm, making sure not to squeeze the soft tissues, at the midpoint between the last rib and the iliac crest[12]. The waist-to-height ratio was given by dividing the waist circumference in cm by the height in centimetre.

The hip circumference was measured at the gluteal region at the widest circumference between the waist and the knees[13]. The waist-to-hip ratio was then calculated by dividing the waist circumference in cm by the hip circumference in centimetre.

Neck circumference was measured at its midpoint, except when the individual had a pronounced Adam's apple, in which case the neck circumference was measured right below it. The adolescents were advised to stare at the horizon and stand up straight[14].

All anthropometric measurements were taken by the same individual who had been duly trained for the task.

The percentage of Body Fat (%BF) was determined by the device Dual Energy X-ray Absorptiometry (DEXA) (Lunar Prodigy Advance DXA System - analysis version: 13.31, GE Healthcare) at the Diagnostic Imaging sector of the Health Division of the UFV and analyzed according to adolescent-specific classification proposed by Lohman[15], who suggests 15% to 25% of body fat for females and 10% to 20% for males.

Biochemical assessment

Participants' blood (12 mL) was collected by trained professionals after a 12-hour fast by venipuncture using disposable syringes. The laboratory of clinical analyses of the Health Division of the UFV performed the biochemical analyses. The following were determined: total cholesterol, triglycerides, High Density Lipoprotein-cholesterol (HDL-c), Low Density Lipoprotein-cholesterol (LDL-c), fasting glucose, and fasting insulin.

The blood was centrifuged by the centrifuge Excelsa Model 206 BL for 10 minutes at 3,500 rpm right after collection but allowing enough time for the blood to coagulate. Total cholesterol, HDL-c, and triglycerides were automatically determined by the device Cobas Mira Plus (Roche®) using an enzymatic method. LDL-c was given by the Friedewald equation. Nobody's triglyceride level exceeded 400 mg/dL. Fasting glucose was automatically determined by the device Cobas Mira Plus (Roche®) using the glucose oxidase method. Fasting insulin was determined by electrochemiluminescence.

Serum lipids were assessed as recommended by the I Guidelines for Preventing Childhood and Adolescent Atherosclerosis[2]. Fasting glucose levels were classified as recommended by the *Sociedade Brasileira de Diabetes*[16] (Brazilian Diabetes Society) and fasting insulin as recommended by the *Sociedade Brasileira de Cardiologia*[2] (Brazilian Cardiology Society). High and borderline values were considered abnormal as follows: total cholesterol ≥150 mg/dL, LDL-c ≥100 mg/dL, HDL-c <45 mg/dL, triglycerides ≥100 mg/dL, fasting glucose ≥100 mg/dL, and fasting insulin ≥15 μU/mL.

Insulin resistance was given by the Homeostasis Model Assessment - Insulin Resistance Index (HOMA-IR) according to the fasting insulin and glucose levels as follows: HOMA-IR=fasting insulin (μU/mL)xfasting glucose (mmol/L)/22.5 and interpreted as recommended by the *Sociedade Brasileira de Cardiologia* [2].

Blood pressure

Blood pressure was measured by a digital blood pressure monitor recommended by the *Sociedade Brasileira de Cardiologia* and as recommended by the manufacturer and interpreted according to the VI Brazilian Guidelines on Hypertension. Both the systolic and

diastolic blood pressures were assessed for changes[17].

Blood pressure was classified according to height percentiles for both genders as follows: normal when blood pressure <90th percentile (<120/80 mmHg); borderline when 90th percentile <blood pressure <95th percentile; high when blood pressure >95th percentile. A blood pressure equal to or above 120/80 mm/Hg, even when <95th percentile, was considered borderline. Borderline and high blood pressures were considered abnormal.

Statistical analyses

The data were entered twice in the spreadsheet Excel 2010 and analyzed by the programs Epi Info 6.04, Sigma Stat for Windows 3.5 and MedCalc 12.

The Kolmogorov-Smirnov test identified the variables with normal distribution, determining which other tests should be used: Student's *t* test or Mann-Whitney test, and Pearson or Spearman correlations.

Receiver Operating Characteristic (ROC) curves were constructed to verify the ability of neck circumference to predict biochemical, body composition, and blood pressure changes in the study adolescents and to determine the respective cut-off points for females and males. The Areas Under the Curves (AUC) were calculated along with their respective 95% Confidence Intervals (95%CI). The null hypothesis was accepted when AUC ≤0.50. The ROC curve quantitatively describes the performance of a diagnostic test whose result can be treated as a continuous ordinal or categorical variable depending on how it compares with the gold standard[18].

The following were calculated: positive and negative predictive values, sensitivity, and specificity of neck circumference for predicting biochemical, body composition, and blood pressure changes associated with cardiovascular risk.

The significance level was set at 5% (p<0.05).

RESULTS

Subject characteristics

A total of 260 adolescents participated in the study. Their median age, weight, and BMI were, respectively: 12.4 (10.1-14.9) years; 43.3

Table 1. Descriptive characteristics of the sample of 260 students aged 10 to 14 years from public and private schools from *Viçosa* (MG), Brazil, 2011.

Characteristics	Female		Male		Total	
	%	n	%	n	%	n
Gender	50.4	131	49.6	129	100.0	260
BMI-for-age						
Underweight	0.8	1	6.2	8	3.4	9
Normal weight	81.7	107	70.5	91	76.2	198
Overweight	10.7	14	15.5	20	13.1	34
Obese	6.8	9	7.8	10	7.3	19
H-for-age						
Stunted	2.3	3	1.5	2	1.9	5
Normal height	97.7	28	98.5	127	98.1	255
%BF						
Low	9.2	12	19.4	25	14.2	37
Normal	36.6	48	49.6	64	43.1	112
Excessive	54.2	71	31.0	40	42.7	111

Note: H: Height; %BF: percentage of Body Fat; BMI: Body Mass Index.

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(25.1-92.8) kg; and 18.3 (12.5-33.8) kg/m^2. Their mean height were 153.6±10.1 cm. These parameters did not differ significantly between the genders (p>0.05).

The median neck circumferences for the general population, males, and females were, respectively: 30.2 (25.5-39.5) cm, 30.5 (25.7-39.5) cm, and 29.9 (25.5-34.5) cm. Males had greater neck circumferences (p<0.05).

Table 1 shows other characteristics of the study sample.

Clinical and biochemical assessments

Table 2 shows the following results: biochemical tests, insulin resistance, and blood pressure. Females had higher triglyceride levels, HOMA-IR, and diastolic blood pressure, while males had higher fasting insulin levels (p<0.05). The other study parameters did not vary significantly between the genders (p>0.05).

Relationship between neck circumference and cardiovascular risk variables

Neck circumference presented correlations that varied from 0.51 to 0.88 with fat-related parameters and fat distribution, such as waist and hip circumferences, percentage of body fat, weight, and BMI. It also correlated with waist-to-height ratio, HOMA-IR, fasting insulin, and blood pressure, with amplitudes varying from 0.29 to 0.62. The waist-to-hip ratio and HDL-c were also positively correlated with neck circumference.

Regarding the lipid profile, neck circumference correlated positively with triglycerides in females and negatively with HDL-c in both genders. For these parameters and stratum, neck circumference may be used (Table 3).

Predictive ability of neck circumference

Table 4 shows the AUC, sensitivity, specificity, positive predictive value, and negative predictive value of neck circumference for the study parameters with significant results. It also shows the neck circumferences associated with abnormal parameters (cut-off points).

The area under the curve varied from 0.616 for HDL-c to 0.807 for blood pressure. Sensitivity varied from 61.9% for HDL-c to 80.0% for blood pressure and fasting glucose. Specificity

Table 2. Measurements and rates of biochemical and blood pressure changes in students aged 10 to 14 years from public and private schools in *Viçosa* (MG), Brazil, 2011.

Parameters	Female	Changes		Male	Changes		Total	Changes	
		%	n		%	n		%	n
Total cholesterol (mg/dL)	158.3±31.3	71.8	94	165.4±26.7	58.1	75	161.9±29.2	65.0	169
HDL-c (mg/dL)	52 (24-100)	23.7	31	51 (32-117)	31.0	40	52 (24-117)	27.3	71
LDL-c (mg/dL)	93.2 (42.2-165.4)	41.9	55	93 (2.9-149.2)	34.1	44	93 (2.9-165.4)	38.1	99
Triglycerides (mg/dL)	66 (28-206)**	18.3	24	62 (7-194)**	8.5	11	64 (7-194)	13.5	35
Fasting glucose (mg/dL)	86 (67-114)	2.3	3	86 (70-195)	1.6	2	86 (67-195)	1.9	5
Fasting insulin (mcU/mL)	8.4 (1.1-45.7)*	17.6	23	9.9 (1.8-36.4)*	7.8	10	6.3 (1.1-45.7)	12.7	33
HOMA-IR	2.1 (0.4-7.2)*	17.6	23	1.4 (0.2-10.6)*	7.8	10	1.8 (0.2-10.6)	12.7	33
SBP (mmHg)	96.5 (72.5-124.5)	2.3	3†	96 (73.5-143)	5.4	7†	96.5 (72.5-143)	3.9	10†
DBP (mmHg)	60.9±6.3*			58.7±7.8*			59.8±7.1		

Note: **p<0.05; *p<0.001; Student's t test or Mann-Whitney test; †prevalence of blood pressure changes considering both systolic and diastolic blood pressures. Data with normal distribution were expressed as means ± standard deviations. Data with abnormal distribution were expressed as medians and their respective amplitudes. The following were considered abnormal: total cholesterol ≥150 mg/dL, LDL-c ≥100mg/dL, HDL-c <45 mg/dL, triglycerides ≥100 mg/dL, fasting glucose ≥100 mg/dL, and fasting insulin ≥15 mU/mL; blood pressure was considered abnormal when above the 90th height percentile.

HDL-c: High Density Lipoprotein-cholesterol; LDL: Low Density Lipoprotein-cholesterol; HOMA-IR: Homeostasis Model Assessment - Insulin Resistance; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

Table 3. Correlation between neck circumference and anthropometric and cardiovascular risk parameters of students aged 10 to 14 years from public and private schools in *Viçosa* (MG), Brazil, 2011.

Parameters	Female (r)	Male (r)	Total (r)
Body fat	0.67*	0.61*	0.51*
Waist circumference	0.67*	0.83*	0.74*
Hip circumference	0.78**	0.87*	0.75*
Weight	0.83**	0.92*	0.88*
Body mass index	0.73**	0.81*	0.75*
W-to-He ratio	0.43*	0.46*	0.41*
W-to-H ratio	-0.05	0.23**	0.14**
HOMA-IR	0.33*	0.50*	0.35*
Fasting insulin	0.36*	0.49*	0.36*
SBP	0.65**	0.63*	0.62*
DBP	0.43*	0.33*	0.29*
Total cholesterol	-0.19**	-0.29*	-0.27*
LDL-c	-0.08	-0.26**	-0.18**
HDL-c	-0.26**	-0.26**	-0.27*
Triglycerides	-0.01	0.20**	0.06

Note: Pearson or Spearman correlation. *p<0.001; **p<0.05.
W-to-He ratio: Waist-to-Height ratio; W-to-H ratio: Waist-to-Hip ratio; HOMA-IR: Homeostasis Model Assessment - Insulin Resistance; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; HDL-c: High Density Lipoprotein-cholesterol; LDL-c: Low Density Lipoprotein-cholesterol.

varied from 57.3% for fasting insulin to 78.4% for blood pressure.

In summary, the cut-off points of 28.8 cm for girls and 30.4 cm for boys indicate the possibility of parameter changes associated with cardiovascular risk.

DISCUSSION

The study adolescents were in consonance with the national reality[3]: 20.3% (n=53) had excess body weight, being overweight or obese according to their BMI-for-age. Nevertheless, a higher percentage was classified as having excess body fat (42.7%, n=111), showing that many normal-weight adolescents are already at risk for obesity-related metabolic disorders.

Changes in glucose metabolism, blood pressure, and lipid profile were also found by other studies on adolescents of the same age group[19-20].

Table 4. Ability of neck circumference to predict the cardiovascular risk of students aged 10 to 14 years from public and private schools in *Viçosa* (MG), Brazil, 2011, according to the receiver operating characteristic curve.

Parameters	AUC	95%CI	Sensit%	Specif%	PPV%	NPP%	COP
Body fat							
Total	0.676*	0.615-0.733	64.0	65.1	57.7	70.8	>30.3
Female	0.711*	0.625-0.786	67.6	66.7	70.6	63.5	>29.55
Male	0.728*	0.643-0.803	75.0	60.7	46.2	84.4	>30.4
Fasting glucose							
Total	0.682*	0.621-0.738	80.0	67.5	4.6	99.4	>31.1
Female	0.827*	0.751-0.887	100.0	75.8	8.8	100.0	>31.0
Fasting insulin							
Total	0.703*	0.643-0.757	72.7	57.3	19.8	93.5	>30.4
Female	0.659**	0.571-0.739	95.7	36.1	24.2	97.5	>28.8
Male	0.902*	0.837-0.947	100.0	74.0	24.4	100.0	>31.7
HDL-c							
Total	0.616**	0.554-0.676	61.9	59.3	36.4	80.6	>30.4
Female	0.645**	0.557-0.727	64.5	64.0	35.7	85.3	>30.4
Triglycerides							
Male	0.700**	0.613-0.777	54.6	86.4	27.3	95.3	>33.5
Blood pressure							
Total	0.807*	0.754-0.854	80.0	78.4	12.9	99.0	>31.7
Female	0.908*	0.844-0.951	100.0	69.5	7.1	100.0	>30.8
Male	0,747***	0.663-0.819	85.7	71.3	14.6	98.9	>31.7

Note: *p<0.001; **p<0.05.
AUC: Area Under the Curve; SD: Standard Deviation; 95%CI: Confidence Interval of 95%; Sensit: Sensitivity; Specif: Specificity; PPV: Positive Predictive Value; NPP: Negative Predictive Value; COP: Cut-Off Point; HDL: High Density Lipoprotein-cholesterol.

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Chaves *et al*.[19] corroborate the present findings in their study of a similar population: 21.0% were overweight or obese and 54.2%, 26.7%, 25.8%, and 20.0% presented changes in their total cholesterol, LDL-c, HDL-c, and triglyceride levels, respectively. They also found prevalences of hyperinsulinemia and hyperglycemia of 8.3% and 1.7%, respectively. In both studies, the worst results were for total cholesterol and the best, for fasting glucose.

The results reinforce the need of identifying this population early to develop an effective intervention. Such identification requires practical and rapid screening methods with good accuracy and sensitivity. Waist circumference has been used for this purpose and relates to cardiovascular risk factors both in Brazilian and other adolescents[21-24].

However, waist circumference varies throughout the day and its measurement may abash adolescents because of the body changes they experience during puberty. In this sense, neck circumference is an option and its use is being investigated in different ethnicities and age groups[8, 25-27].

In the present study, neck circumference was capable of predicting excess body fat for both genders (AUC >0.7) and correlated with the measurements and indices used for identifying fat deposits, such as hip circumference, waist-to-height ratio, and waist circumference. Neck circumference also correlated with weight and was associated with BMI, proving to be a useful instrument.

Hatipoglu *et al.*[6] assessed healthy and obese Turkish children and adolescents aged 6 to 18 years and also found neck circumference to correlate with BMI and waist circumference, considering it a good supplementary instrument for detecting overweight and obesity. Nafiu *et al.*[7] found that these variables, in addition to body weight, also correlated with neck circumference in a population of the same age bracket in the United States of America, stating that neck circumference can be a good predictor of excess weight.

Although neck circumference did not correlate with blood glucose level, it predicted blood glucose changes in females quite well. Meanwhile, hyperinsulinemia, even by itself, has been pointed out as a good indicator of insulin resistance in adolescents[24], and neck circumference has shown good sensitivity for predicting hyperinsulinemia in female and male adolescents. Given that neck circumference has also correlated with HOMA-IR, there is evidence that it may be useful for screening adolescents with high blood glucose.

Studies that investigated the relationship between neck circumference and parameters associated with impaired glucose metabolism in adolescents were not found, but Vallianou *et al.*[25], Laakso *et al.*[28], Ben-Noun & Laor[29] and Yang *et al.*[30] found neck circumference to be associated with insulin resistance indicators in adults.

Neck circumference also indicated blood pressure changes well, correlating with both systolic and diastolic blood pressure. High AUC (0.807) and sensitivity (80%) show that neck circumference could identify a large number of adolescents at risk.

Ben-Noun & Laor[5,29] found neck circumference to correlate with blood pressure in adult Israelis and an association between the changes that occurred in both parameters over time. Studies with adolescents were not found.

Even by itself, high blood pressure is a linear and continuous risk factor for cardiovascular diseases. In population-based studies, blood pressure is related with the risk of death and disease[17]. Faria *et al.*[20] found a 5.0% prevalence of high blood pressure in adolescents, and Pinto *et al.*[31] found that 5.6% and 9.9% of the adolescents aged 10 to 14 years from *Bahia*, Brazil, were hypertensive and prehypertensive, respectively.

Lauer & Clarck[32] found that blood pressure and excess adiposity during adolescence correlated with blood pressure during adulthood in a study that followed 2,445 individuals. This fact restates the importance of neck circumference:

not only it is associated with blood pressure and capable of predicting blood pressure changes, but it is also related to body fat.

While neck circumference was not associated with total cholesterol and LDL-c, it correlated with HDL-c and predicted low HDL-c in females. On the other hand, neck circumference correlated with triglycerides and predicted triglyceride changes only in males.

Gonçalves *et al.*[33] studied a population with similar ages and found significant prevalences of low HDL-c in boys (26.9%) and girls (30.6%) and high triglycerides in boys (18.6%) and girls (25.6%). Gontijo *et al.*[34] corroborated these findings in another study with adolescents aged 10 to 19 years. The high number of dyslipidemic adolescents reinforces the importance of identifying them for early intervention.

Ben-Noun & Laor[5] found neck circumference to be related to serum lipid levels in adults. Vallianou *et al.*[25] found neck circumference to correlate with HDL-c and triglyceride levels in adults, corroborating the present study.

The *Sociedade Brasileira de Cardiologia*[2] recommends that the identification and treatment of dyslipidemic children and adolescents should be done early to prevent atherosclerosis, among others. Simple and easy-to-use methods, such as measuring neck circumference, may help to identify these individuals.

The study adolescents already present changes in cardiovascular risk parameters, suggesting the importance of identifying and monitoring this population from the beginning of this life phase.

Protocols should be created for primary care and other units of the health care networks that use simple, accurately reproducible measurements, such as neck circumference, a convenient and accessible alternative. However, the diagnosis must be confirmed by more specific methods, ones that can better measure the study parameters.

The suggestion of specific cut-off points for the neck circumference of adolescents can be considered a strength of the present study, since cut-off points enable the use of this measurement. However, a study limitation is the absence of data for the last years of adolescence, preventing the determination of references for this entire life phase.

Finally, the prediction of changes was generally more sensitive than specific. Since the sensitivity of screening instruments is more important than specificity for the nutritional diagnosis, we reiterate that neck circumference is a good alternative for this end.

CONCLUSION

Neck circumference was capable of predicting excess body fat and cardiovascular risk factors in adolescents aged 10 to 14 years. It is easy and quick to measure, noninvasive, and inexpensive, and can be used as a screening tool in population-based studies.

Many changes have been found in the study parameters, demonstrating the importance of health care programs for adolescents that promote their health and prevent future diseases.

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CONTRIBUTORS

All authors participated in all phases of the article's research.

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Association between sociodemographics factors and dietary patterns during pregnancy

Associação entre fatores sociodemográficos e padrões de consumo alimentar durante a gestação

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ABSTRACT

Objective

To investigate the association between socio-demographic factors and dietary patterns in pregnancy.

Methods

Cross-sectional study with baseline data from a cohort of 421 postpartum women aged 18 and 45 years resident in *Rio de Janeiro,* Brazil. Dietary intake was evaluated with a validated food frequency questionnaire at 15 days following delivery, having as time frame the second and third pregnancy trimesters. Dietary patterns were identified using factor analysis for principal components analysis. The association between socio-demographic factors and the identified dietary patterns was assessed with multiple linear regression analysis.

Results

Two dietary patterns were identified: i) healthy: fruits; green vegetables; vegetables; fish; roots, corn and potato; milk and dairy and herbal tea mate, and negatively loadings for alcohol and coffee and ii) mixed: rice; bean;

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flour and pasta; breads; cake and cookies; soda and juice; sugar and sweets; fatty foods; meats; chicken; and eggs. The linear regression showed that the income (β=0.0002; 95%CI: 0.0002-0.0004) and schooling (β=0.0491; 95%CI: 0.0264-0.0718) were positively associated with healthy pattern, and parity (β=-0.1044; 95%CI: -0.1665- -0.0423) and skin color (β=-0.3102; 95%CI: -0.5256- -0.0947) were negatively associated. Skin color (β=0.1647; 95%CI: 0.0378- 0.2916) and marital status (β=0.1065; 95%CI: 0.0062- 0.2067) were positively associated with mixed pattern and income (β=-0.0001; 95%CI:-0.0002- -0.0001) and schooling (β=-0.0281; 95%CI: -0.0417- -0.0146) were negatively associated.

Conclusion

Socio-demographic factors such as income, schooling, skin color, marital status and parity were associated with dietary patterns in this sample of postpartum women residents in *Rio de Janeiro*.

Indexing terms: Demographic data. Factor analysis. Food consumption. Pregnant women. Socioeconomic factors.

RESUMO

Objetivo

Investigar a associação entre fatores sociodemográficos e padrões de consumo alimentar gestacional.

Métodos

Estudo transversal, com dados da linha de base de uma coorte com 421 puérperas entre 18 e 45 anos, residentes no Rio de Janeiro. O consumo alimentar foi avaliado com um questionário de frequência alimentar validado, aplicado aos 15 dias do pós-parto, e teve como referência o segundo e o terceiro trimestres gestacionais. Os padrões alimentares foram identificados a partir da análise fatorial por meio de análise de componentes principais. A associação entre os fatores sociodemográficos e os padrões alimentares foi avaliada com regressão linear múltipla.

Resultados

Foram identificados dois padrões alimentares: i) saudável: frutas; folhosos; hortaliças; peixe; raízes, milho e batata; leite e derivados e mate, e, negativamente para o consumo de álcool e café; e ii) misto: arroz; feijão; farinhas e macarrão; pães; bolo e biscoito; refrigerante e suco; açúcares e doces; alimentos gordurosos; carnes; frango e ovos. Na regressão linear, a renda (β=0,0002, IC95%: 0,0002-0,0004) e a escolaridade (β=0,0491, IC95%: 0,0264-0,0718) associaram-se positivamente ao padrão saudável, e a paridade (β=-0,1044, IC95%: -0,1665- -0,0423) e a cor da pele (β=-0,3102, IC95%: -0,5256- -0,0947) associaram-se negativamente. A cor da pele (β=0,1647, IC95%: 0,0378-0,2916) e o estado marital (β=0,1065, IC95%: 0,0062-0,2067) associaram positivamente ao padrão misto; e a renda (β=-0,0001, IC95%: -0,0002- -0,0001) e a escolaridade (β=-0,0281, IC95%: -0,0417- -0,0146) associaram-se negativamente.

Conclusão

Fatores sociodemográficos como a renda, a escolaridade, a cor da pele, o estado marital e a paridade influenciaram os padrões alimentares nessa amostra de puérperas residentes no Rio de Janeiro.

Termos de indexação: *Dados demográficos. Análise fatorial. Consumo de alimentos. Gestantes. Fatores socioeconômicos.*

INTRODUCTION

Dietary nutrient adequacy during pregnancy is usually assessed by estimating the intake of specific macro and micronutrients, foods, and food groups[1-4]. Although these studies are important, diet consists of a combination of meals, nutrients, and foods[5], and is determined by social, cultural[6,7], physiologic, genetic[8], and demographic[9] factors.

Studies on nutritional epidemiology have analyzed the diet of populations using their dietary patterns[6,10] and associating these patterns with sociodemographic determinants during pregnancy[9,11-13]. Principal Component Analysis (PCA) is one of the methods used for assessing

dietary patterns[14]. This analytical procedure allows assessing a diet within a multidimensional context of exposure[6,10] by reducing the number of dietary variables, which are grouped into factors composed of correlated foods. Analysis of dietary patterns assesses the global effect of diet on health and identifies population groups at the greatest risk of diet-related morbidities[15,16].

Northstone *et al*.[9] used a Food Frequency Questionnaire (FFQ) to assess the food intake of 12,053 pregnant women on the third trimester of pregnancy and found five distinct dietary patterns. These authors found a positive association between schooling and the pattern called "health conscious". Arkkola *et al*.[12] found that the mother's age and schooling were positively associated with "healthy" and "low-fat foods" patterns when they studied 3,730 Finnish women. To date, only one study about the dietary patterns of pregnant women was published in Brazil[17].

Food intake during pregnancy varies greatly[18]. The analysis of dietary patterns can be a guide for specific groups of women according to their demographic and socioeconomic determinants, promoting a healthier diet during pregnancy. Hence, the aim of the present study was to investigate if demographic and socioeconomic factors are associated with dietary patterns during pregnancy.

METHODS

Study design and population

This cross-sectional study used the baseline data of a prospective cohort of 479 women aged 18 to 45 years. The study was conducted from May 1999 to April 2001. The prospective cohort design included 15 months of recruitment and 9 months of follow-up, and collected data on the following occasions: 15 days after delivery (baseline), and 2, 6, and 9 months postpartum. The participants were recruited for the cohort during prenatal and newborn Bacillus Calmette-Guérin (BCG) immunization visits, performed at the Municipal Health Center Marcolino Candau, and immediately after delivery at the maternity hospital of the *Praça* XV, both located in the municipality of *Rio de Janeiro*, Brazil.

The present study analyzed only the baseline data. Forty-seven women aged less than 18 years and two with a daily total energy intake in excess of 6,000kcal were excluded. Of the 430 (100.0%) eligible women, 421 (97.9%) answered the FFQ.

Dependent variable

A total of 421 *postpartum* women answered the FFQ approximately 15 days after delivery. The FFQ, previously validated by Sichieri & Everhart[19], was administered to collect food intake data during the second and third trimesters of pregnancy[1]. This instrument was validated to investigate food intake during the six months prior to its administration[19].

The dietary patterns were obtained by grouping the 81 food items and beverages listed in the FFQ into 19 food groups: 1) rice; 2) bean; 3) breads; 4) flours and pasta; 5) roots, corn and potato (cassava, yam, corn, and potatoes); 6) meats (steak, oxtail, pork, and giblets); 7) chicken; 8) eggs; 9) fish; 10) green vegetables (lettuce, kale, cabbage, and chicory); 11) vegetables (okra, chayote, cucumber, onion, squash, zucchini, carrots, pea pods, beets, cauliflower, red/green/yellow peppers, and tomatoes); 12) fruits (orange, banana, papaya, apple, melon, avocado, pineapple, mango, grapes, guava, and pear); 13) milk and dairy products (whole milk, skim milk, yogurt, cheese, and cream cheese); 14) sugar and sweets; 15) cakes and cookies-crackers (cookies and savory biscuits); 16) soda and juices; 17) fatty foods (butter/margarine, bacon, mayonnaise, pizza, savory snacks, french fries, popcorn, patty, and sausage; 18) alcoholic beverages and coffee (wine, beer, and other alcoholic beverages); and 19) herbal mate tea. Some foods like rice, bean,

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breads, and herbal mate tea were not grouped because they were consumed frequently. Other foods such as chicken, eggs, and fish were placed in individual groups because they have a unique nutritional composition. Alcoholic beverages and coffee were kept in the same group because they were consumed only occasionally during pregnancy, and also because they should be avoided during this time.

The factor analysis for PCA determined the dietary patterns of the women during pregnancy. Commonalities greater than 0.30 determined whether the groups were correctly correlated. The following criteria established the number of factors (patterns): (1) eigenvalues >1.50 and (2) the Scree test plots. After varimax orthogonal rotation, factor loadings above 0.20 limited the intercorrelation between the dietary variables given by the factors[10,20]. The internal consistency of dietary pattern identified was given by Cronbach's alpha. Next, the factors were labeled according to the most prevalent foods[14-16].

Independent variables

The following sociodemographic and obstetric variables were selected as independent: family income (*reais*), schooling (years), skin color (white or brown/black), marital status (married/living together or single/other) and parity (number of deliveries). Pregnancy-related information was collected at baseline using a structured questionnaire.

Covariates

Information about total energy intake (calories), pre-pregnancy Body Mass Index (BMI) [pre-pregnancy weight (kg)/height^2 (meters), and age (years) were used as adjustment variables in data analysis.

Total energy intake was determined by a program developed by Sichieri[21] in the statistical package Statistical Analysis System (SAS) version 8.2. The usual food intake was converted into daily total energy intake by multiplying each food consumed in standardized portions[22] by the daily intake frequency: more than 3 times a day; 2 to 3 times a day; once a day; 5 to 6 times a week; 2 to 4 times a week; once a week; 1 to 3 times a month; never or hardly ever. The energy content of the foods was given by the nutrient composition database from *Escola Paulista de Medicina*[23]. If a food was not listed in the aforementioned database, the food composition table of the National Household Expenditure Study was used[24].

The pre-pregnancy BMI was obtained by pre-pregnancy weight reported by women and their height was measured by a stadiometer of the brand Holtain-Harpeden (Crymych, United Kingdom) with an accuracy of 0.1 cm. The women were measured barefoot.

Statistical analysis

The Student's *t* test and the Chi-square test compared the independent variables and covariates according to the forth quartile of identified dietary patterns. Bivariate linear regression analysis considered the dietary pattern scores as the outcome variable. Age and total energy intake were used as adjustment variables. Although the pre-pregnancy BMI of women with healthy and mixed dietary patterns were not different distributed, this covariate was used as an adjustment variable because its p-value was <0.20 in the bivariate linear regression analysis. The dependent variable of the final multiple linear regression model was the score of each dietary pattern, and the model was adjusted for age, total energy intake, and pre-pregnancy BMI. The significance level was set at $p<0.05$.

Ethical aspects

The study was approved by the Research Ethics Committee of the *Núcleo de Estudos em Saúde Coletiva* (NESC) of the *Universidade Federal*

do Rio de Janeiro (UFRJ) under Protocol number 041/98. All participants signed an Informed Consent Form before they joined the study. More information about the study design and population can be found elsewhere[4,25].

RESULTS

Two dietary patterns were identified and labeled healthy and mixed. Their eigenvalues were 2.24% and 2.22%, respectively. The accumulated variance was 23.48%. The healthy pattern explained 11.79% of the total variance and consisted of fruits; green vegetables; vegetables; fish; roots, corn and potato; milk and dairy products; and herbal mate tea; and inversely with alcohol and coffee intake. The mixed pattern explained 11.69% of the total variance and consisted of rice; bean; flours and pasta; breads; cake and cookies-crackers; soda and juices; sugar and sweets; fatty foods; meats; chicken, and eggs (Table 1).

Women who adhered more to the healthy pattern were older (28.4x24.7 years, $p<0.001$), had higher income (R$1.038,00xR$569,00 *reais*, $p<0.001$), and higher schooling (8.1x6 years, $p<0.001$) than those who adhered more the mixed pattern. White and married women or those living with a partner also preferred the healthy pattern as opposed to the brown/black women who were single/other (Table 2).

The bivariate linear regression model showed that income and schooling were positively associated with the healthy pattern. Brown or black skin color was positively associated with the mixed pattern and negatively associated with

Table 1. Distribution of factor loadings and communalities (h2) of the two dietary patterns identified in the gestational period[1] in a cohort with 421 postpartum women. *Rio de Janeiro*, Brazil, 1999-2001.

Foods and food groups	Dietary pattern		
	Factor loadings[2]		h_2
	Healthy	Mixed	
Fruits	0.537	0.175	0.71
Green vegetables	0.455	-0.073	0.72
Vegetables	0.439	0.039	0.73
Fish	0.261	0.034	0.60
Roots, corn, and potato	0.296	0.083	0.68
Milk and dairy products	0.443	-0.049	0.74
Alcoholic beverages and coffee	-0.210	0.096	0.59
Herbal mate tea	0.283	-0.070	0.64
Rice	-0.306	0.355	0.59
Bean	-0.201	0.332	0.55
Flours and pasta	0.029	0.260	0.59
Breads	-0.056	0.555	0.69
Cakes and cookies-crackers	0.101	0.266	0.60
Soda and juices	0.130	0.307	0.74
Sugar and sweets	-0.034	0.257	0.54
Fatty foods	0.075	0.516	0.66
Meats	0.291	0.328	0.66
Chicken	-0.029	0.250	0.70
Eggs	-0.095	0.271	0.62
Number of items	8	11	
Eigenvalues	2.24	2.22	
Final communalities	1.43	1.41	
% of variance explained	11.79	11.69	
% of cumulative variance explained	11.79	23.48	

Note: [1] Food intake refers to second and third gestational trimester; [2] Factor analysis for principal component analysis.

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Table 2. Mean values and proportions of selected variables from the dietary patterns identified in the gestational period[1] in a cohort with 421 postpartum women. *Rio de Janeiro*, Brazil, 1999-2001.

Variables	Dietary pattern				*p* value*
	Healthy		Mixed		
	Mean	SD	Mean	SD	
Age (years)	28.4	5.79	24.7	5.76	<0.001
Total energy intake (kcal)	2.867	653	3.874	666	<0.001
Pre-pregnancy BMI (kg/m²)	22.6	3.24	22.5	4.05	0.889
Income (*reais*)	1.038	995	569	414	<0.001
Schooling (years)	8.1	3.45	6.0	2.75	<0.001
	N	%	N	%	*p* value*
Parity					0.746
<1	22	38.6	29	41.4	
≥2	35	61.4	41	58.6	
Skin color					<0.001
White	38	54.3	26	24.5	
Brown/Black	32	45.7	80	75.5	
Marital status					0.029
Married or stable partnership	59	84.3	74	69.8	
Single/Other	11	15.7	32	30.2	

Note: *The *p* value refers to the Student's *t* test or Chi-square test. [1]Food intake refers to second and third gestational trimester.
SD: Standard Deviation; BMI: Body Mass Index.

Table 3. Bivariate linear regression and multiple linear regression of selected variables from the dietary patterns identified in the gestational period in a cohort with 421 postpartum women. *Rio de Janeiro*, Brazil, 1999-2001.

Variables	Healthy pattern					
	Bivariate linear regression			Multiple linear regression		
	β	*p* value*	95%CI	β	*p* value**	95%CI
Age (years)	0.0184	0.005	[0.0056] - [0.0312]	-	-	-
Total energy intake (kcal)	0.0003	<0.001	[0.0002] - [0.0004]	-	-	-
Pre-pregnancy BMI (kg/m²)†	-0.0068	0.514	[-0.0274] - [0.0137]	-	-	-
Income (*reais*)	0.0003	<0.001	[0.0002] - [0.0004]	0.0002	<0.001	[0.0001] - [0.0004]
Schooling (years)	0.0493	<0.001	[0.0256] - [0.0729]	0.0491	<0.001	[0.0264] - [0.0718]
Parity (*n*)	-0.0321	0.271	[-0.0893] - [-0.0252]	-0.1044	0.001	[-0.1665] - [-0.0423]
Skin color††	-0.2062	0.063	[-0.4238] - [0.0114]	-0.3102	0.005	[-0.5256] - [-0.0947]
Marital status†††	-0.1464	0.108	[-0.3249] - [-0.0321]	-0.1384	0.112	[-0.3094] - [0.0326]
Variables	Mixed pattern					
	Bivariate regression			Multiple regression		
	β	*p* value*	95%CI	β	*p* value**	95%CI
Age (years)	-0.0128	0.050	[-0.0256] - [-0.00001]	-	-	-
Total energy intake (kcal)	0.0008	<0.001	[0.0007] - [0.0008]	-	-	-
Pre-pregnancy BMI (kg/m²)†	-0.0160	0.124	[-0.0363] - [-0.0044]	-	-	-
Income (*reais*)	-0.0001	0.1363	[-0.0002] - [-0.00003]	-0.0001	<0.001	[-0.0002] - [-0.0001]
Schooling (years)	-0.0336	0.006	[-0.0572] - [-0.0099]	-0.0281	<0.001	[-0.0417] - [-0.0146]
Parity (*n*)	0.0230	0.415	[-0.0324] - [0.0784]	0.0328	0.083	[-0.0043] - [0.0698]
Skin color††	0.4242	<0.001	[0.2091] - [0.6393]	0.1647	0.011	[0.0378] - [0.2916]
Marital status†††	0.1213	0.182	[0.0570] - [0.2997]	0.1065	0.038	[0.0062] - [0.2067]

Note: **p* value refers to bivariate linear regression; ***p* value refers to multiple linear regression; The final multiple linear regression model was adjusted for age, total energy intake, and pre-pregnancy BMI. †Pre-pregnancy Body Mass Index (BMI): [Pre-pregnancy weight (kg)/height ² (meters)] was obtained by pre-pregnancy weight reported by women and their height was measured; ††White or Brown/Black; †††Married or stable partnership or single/other.

schooling. The multiple linear regression model found that income and schooling were positively associated with the healthy pattern and negatively associated with parity and skin color. Income and schooling were negatively associated with the mixed pattern, and marital status and skin color were positively associated with it. The multiple regression model was adjusted for age, total energy intake, and pre-pregnancy BMI (Table 3).

DISCUSSION

Two dietary patterns were identified, a healthy pattern that explained most of the dietary variance and was characterized by fruits; green vegetables; vegetables; roots, corn and potato; milk and dairy products; fish; and herbal mate tea; and inversely with alcoholic beverages and coffee; and a mixed pattern characterized by rice; bean; breads; cakes and cookies-crackers; sodas and juices; fatty foods; meats, chicken, and eggs. Older women with higher schooling, higher income, lower parity, married or living with a partner, and white were more likely to adhere to the healthy pattern. The results of the multiple regression analysis model showed that higher income and schooling were positively associated with the healthy pattern, and higher parity and brown or black skin color were negatively associated with it. Married women or those living with their partners and those with brown or black skin color were positively associated with the mixed pattern, while income and schooling were negatively associated with it. Women who adhered more to the mixed pattern were more likely to be younger and have higher parity.

Among the study limitations, it is important to emphasize that even though the broader study comprises a prospective cohort of postpartum women, the analyses were based exclusively on baseline data, therefore the study has a cross-sectional design. Other limitations include the potential memory bias associated with the FFQ; the arbitrary decisions taken by the researchers, such as food grouping; number of extracted factors; and naming of the retained factors[20]. However, these decisions are inherent to PCA, which is being widely used in epidemiological studies on the dietary patterns of pregnant women[9,11,12,26].

Women with higher schooling, higher income, lower parity, and white were more likely to adhere to the healthy dietary pattern, a finding corroborated by other studies. Northstone *et al.*[9] studied a cohort of pregnant women in the Southeast region of England and found a pattern that they called "health conscious", characterized by the intake of salads, fruits, rice, pasta, oat, breakfast cereals, fish, fruit juices, and whole bread. Low schooling and multiple parities were negatively associated with this pattern. Arkkola *et al.*[12] studied the dietary patterns of a cohort of pregnant Finnish women and found that higher schooling was associated with the healthy pattern. In a population-based, cross-sectional study of 1,026 women aged 20 to 60 years living in the Brazilian South region, Alves *et al.*[27] found that those with higher schooling and socioeconomic status adhered more frequently to the healthy pattern. The first Brazilian study to assess the dietary patterns of pregnant women included women attended in health care facilities located in the Brazilian South; this study found that high family income and schooling were positively associated with a healthy dietary pattern[17].

In general, higher socioeconomic status and age tend to be associated with healthier food choices[13,28]. These results are expected since these factors are related to access to health services and consequently, to health-related information, and additionally, higher income grants better access to healthier foods[29] since these are usually more expensive[30]. The study women had low income and schooling. Yet, it was possible to detect a positive association between income and schooling and healthier food choices. This is probably because women tend to prefer healthier foods when they are pregnant to promote better fetal development, even when these foods are nutrient poor[31].

The mixed pattern consisted of foods with high energy and lipid contents, but also included items like rice and beans, considered commom

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in the Brazilian diet[32,33]. The women who adhered to this pattern were married or lived with a partner, had brown or black skin, and had lower income and schooling. Thompson *et al.*[26] found that the women who adhered to the "junk and fusion pattern", consisting of foods similar to those of the mixed pattern of the present study, were from middle and low socioeconomic levels. Olinto *et al*.[32] studied 4,202 adults from a birth cohort from *Pelotas* (RS), a city in the Brazilian South region, and found that low schooling and income were associated with the common Brazilian pattern, which consisted of rice, beans, sugar, bread, coffee, butter/margarine.

In the present study, pregnant women with lower schooling and income and brown or black skin were more likely to prefer high-energy, refined carbohydrates, and high-fat foods, characteristic of the mixed pattern. Black women of low socioeconomic level usually do not begin prenatal care during the first trimester of pregnancy[34], that may compromise the information they receive about a healthy pregnancy and consequently, proper diet during pregnancy. The changes in Brazilian eating habits seen in the last years included the replacement of healthier foods by high-fat, high-carbohydrate foods, especially those with sugar, although many people still consume the traditional diet[35,36]. Most of these foods are inexpensive and available everywhere, good reasons for women of low income and schooling to adhere more of these foods during pregnancy.

In summary, this study has shown that sociodemographic factors such as income, schooling, skin color, marital status, and parity were associated with the dietary patterns of pregnant women. These sociodemographic factors influenced the dietary patterns of a sample of pregnant women from *Rio de Janeiro* (RJ), emphasizing that women with higher schooling and income preferred the healthy pattern.

CONTRIBUTORS

MBT CASTRO contributed to the data analysis, interpretation of data, and drafting of the manuscript; RAG SOUZA and AAF VILELA contributed in the interpretation of data, and drafting of the manuscript; and G KAC participated in the design and coordination of the study, interpretation of data, and drafting the manuscript. All authors read, revised, and approved the final manuscript.

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ORIGINAL | *ORIGINAL*

Effect of actions promoting healthy eating on students' lipid profile: A controlled trial

Efeito de ações de promoção da alimentação saudável sobre o perfil lipídico de estudantes: um estudo controlado

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ABSTRACT

Objective

To assess the effect of nutrition intervention actions on the lipid profile of children and adolescents enrolled in public elementary schools.

Methods

This nine-month, controlled, intervention study included 202 students aged 7 to 14 years attending two schools (intervention/control) located in a poor neighborhood of the municipality of *Salvador, Bahia*, Brazil. Actions were implemented in the intervention school to promote healthy eating habits, presented as "Ten steps to healthy eating". The effect of these actions was assessed by subjecting the students at baseline and end of the follow-up to biochemical, maturation, and anthropometric measurements and a produce intake survey. The dependent variables were the changes in the study biochemical parameters: total cholesterol, high density lipoprotein-cholesterol, low density lipoprotein-cholesterol, and triglycerides. Analysis of covariance assessed the changes that occurred over the study period.

Results

The mean total cholesterol, low-density lipoprotein-cholesterol, and triglycerides of the intervention students decreased 13.18 mg/dL (p=0.001), 7.41 mg/dL (p=0.038), and 12.37 mg/dL (p=0.029), respectively, compared with the control students.

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Conclusion

Actions of this nature have a positive impact on lipid profile. This study adds to those that use effective and viable public health strategies implementable at the primary care level.

Indexing terms: Food habits. Intervention study. Lipids. Students.

RESUMO

Objetivo

Avaliar o efeito das ações de intervenção nutricional sobre o perfil lipídico de crianças e adolescentes matriculados na rede pública de ensino fundamental.

Métodos

Trata-se de um estudo de intervenção, controlado, com duração de 9 meses, do qual participaram 202 estudantes, com idade entre 7 e 14 anos, matriculados em duas escolas (intervenção/controle) situadas em bairro pobre do município de Salvador, Bahia, Brasil. Foram previstas para a escola sob intervenção ações com vistas à adoção de hábitos alimentares saudáveis, traduzidos nos "Dez passos para uma alimentação saudável". Com o propósito de avaliar o efeito de tais ações, todos os alunos foram submetidos, no baseline *e final do* follow-up*, aos exames bioquímicos, maturacionais e antropométricos. Além disso, responderam a um inquérito de consumo de frutas, verduras e legumes Adotaram-se como variáveis dependentes as mudanças nos parâmetros bioquímicos (colesterol total, lipoproteína de alta densidade-colesterol, lipoproteína de baixa densidade-colesterol e triacilglicerol). Para avaliar as mudanças ocorridas ao longo do tempo, empregou-se análise de covariância.*

Resultados

Os estudantes sob intervenção apresentaram decremento de 13,18 mg/dL na média do colesterol total (p=0,001), de 7,41 mg/dL na média do lipoproteína de baixa densidade-colesterol (p=0,038) e de 12,37 mg/dL na média dos triacilglicerídeos (p=0,029) quando comparados àqueles que não foram submetidos à intervenção.

Conclusão

Ações dessa natureza têm impacto positivo na adequação do perfil lipídico. Este estudo soma-se àqueles que adotam estratégias eficazes e viáveis em saúde pública, que podem ser desenvolvidas no âmbito da atenção básica.

Termos de indexação: *Hábitos alimentares. Estudo de intervenção. Lipídeos. Estudantes.*

INTRODUCTION

The risk factors associated with the relative and absolute increase in the prevalence of chronic Non-Communicable Diseases (NCD) are also reaching children and already constitute an important cause of morbidity in this life stage[1]. Concern with the morbidity profile of people everywhere led the World Health Organization (WHO) to create a proposal called "Global Strategy on Diet, Physical Activity, and Health"[2]. The general aim of this proposal, also adopted by the Brazilian Ministry of Health, is to promote and protect health by implementing sustainable actions that support healthy lifestyles, relying on the participation of health professionals and pertinent sectors. Because of the importance of schools in the formation of healthy eating habits, the Interministerial Ordinance nº 1.010, published on May 8, 2006, instituted the guidelines for promoting healthy eating in schools[3]. Thus, the construction and assessment of intervention models made for schools meet the Brazilian Ministry of Health's expectation and are based on the evidence promulgated by the WHO that positive behavioral changes - especially those that aim to control and reduce the risks associated with poor food choices, physical inactivity, and use of alcohol and tobacco - result in strategies capable of reducing the rates of NCD-related morbidity and mortality[4].

The urgent need to stop the growing prevalences of NCD in Brazil justifies studies that attempt to develop effective and sustainable strategies for preventing and controlling these diseases, by focusing on their main risk factors[1,2]. Very few studies in Brazil were created with this purpose, especially youth-oriented studies. Hence, the present study aims to assess the effect of actions promoting healthy eating on the lipid profile of children and adolescents attending municipal elementary schools of a poor neighborhood located in the outskirts of *Salvador, Bahia*, Brazil.

METHODS

This is a nine-month controlled intervention study with male and female students aged 7 to 14 years, attending grades first to eighth of two medium-sized schools of a neighborhood of the *Distrito Sanitário do Subúrbio Ferroviário* (DSSF, District of the Railroad Outskirts) of *Salvador* (BA). This district is one of the most populous in the city and represents a typical example of the complexity of the social and sanitary problem that characterizes some city areas. Today this area is mostly occupied by people from low socioeconomic classes who suffer with the lack of appropriate infrastructure and government services[5].

The sample size was calculated as follows: an intervention subject-to-control subject ratio of one (1), a statistical power of 0.80, a 95% Confidence Interval (95%CI), and a mean Total Cholesterol (TC) difference of 0.2 mmol/L[6], which resulted in a sample size of 336 students. An extra 10% was added to account for losses due to student's refusal to participate in the study, relocation to other cities, and transfer to other schools. Therefore, the initial sample should consist of 372 students, 186 from the intervention school and 186 from the control school. The DSSF has a total of 71 public schools; of these, two were randomly selected for the study, one to be the control and the other, the intervention. All regularly enrolled students of both schools who agreed to participate in the study were included.

The study protocol was approved by the Research Ethics Committee of the *Universidade Federal da Bahia* under Protocol number 18/09. In compliance with ethical precepts, all underweight, overweight, and dyslipidemic students were referred to primary health care units for treatment and follow-up. All guardians signed an Informed Consent Form before the students were included in the study.

The data collected at baseline included biochemical, maturation, and anthropometric measurements and a survey about Fruit and Vegetable (FV) intake. Over the nine-month study period, lectures and workshops discussing the benefits of a healthy lifestyle to promote health were provided to the intervention students. To assess the effects of these actions, all students (intervention and control) were submitted to the same measurements and survey at the end of the study, nine months after the baseline data were collected. Anthropometric assessment consisted of weight and height measurements. Blood was collected to determine the lipid profile: CT, Low Density Lipoprotein-cholesterol (LCL-c), High Density Lipoprotein-cholesterol (HDL-c), and Triglycerides (TG). When possible, the participant's guardian was invited to answer a questionnaire about the family's socioeconomic status.

Blood collection for lipid profiling

Five milliliters of blood were collected after a 12-hour fast at school, in an appropriate environment. The blood samples were properly conditioned and transported to the Central Laboratory of the *Complexo Hospitalar Universitário Professor Edgard Santos*, where they were analyzed. Serum TC, HDL-c, and triglycerides were determined by enzymatic methods, and LDL-c was calculated by the Friedewald equation: LDL-c=CT-(HDL+TG/5) when TG exceeds 400 mg/dL. CT<150 mg/dL; LDL-c<100 mg/dL; HDL-c≥45 mg/dL; and TG <100 mg/dL were considered appropriate[7].

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Anthropometric status

Weight was determined by a microelectronic scale of the brand Marte, Model PP 200-50, with a capacity of 199.95 kg and accuracy of 50 g. Height was determined by the stadiometer Leicester Height Measure, with an accuracy of one millimeter. The anthropometric status was given by the WHO[8] reference tables of percentiles of Body Mass Index (BMI)-for-gender and BMI-for-age. BMI was given by dividing the weight in kilograms by the square of the height in meters. The classification followed the WHO[9] proposal. Overweight and obesity were grouped together for the analyses. Therefore, the BMI of individuals with excess weight were equal to or above the 85th percentile.

Maturation stage

Pubertal development was self-assessed based on male and female sexual characteristics. The age of menarche was also collected. For girls, Tanner Stage II marked the beginning of puberty, and menarche, postpuberty. For boys, Tanner Stage III of genital development marked the beginning of the pubertal growth spurt and Stage V, the end of puberty[10,11]. Hence, the students were grouped into three categories: prepubertal ($_{\text{category of reference}}$), pubertal, and postpubertal.

Food intake: fruits and vegetables

The participants' FV intake frequency was determined by the Food Frequency Questionnaire (FFQ). Item intake frequency was divided into four categories as follows: never consumes=0; 1 to 3 monthly=1; 1 to 2 weekly=2; 2 to 4 weekly=3; and ≥4 weekly=4. The intake frequencies of the food groups were summarized into a single value for each student. This value was given by the formula: ($\sum$ of the intake frequencies of all foods in the food group)/number of foods in the group *the maximum frequency provided by the study FFQ[12]. The resulting scores were stratified into two categories, having the 75th percentile as the cut-off point (percentile <*p*75% *versus* percentile ≥*p*75%$_{\text{category of reference}}$).

Collection of socioeconomic and demographic data

A structured questionnaire collected these data. The socioeconomic level of the family was given by the mother's education level, which was classified as follows: I ≤ fourth grade; II ≥ fifth grade $_{\text{(category of reference)}}$. The demographic variables were: gender (male $_{\text{(category of reference)}}$; female) and age group (<10 years $_{\text{(category of reference)}}$; and ≥10 years).

The intervention protocol covered three major axes

1. *The student*: This axis regarded actions to keep students within a healthy weight range. Six pertinent classes were provided to promote healthy eating and physical activity, each lasting fifty minutes, over the nine-month intervention. The subjects covered during each class were: a) the importance of a healthy diet and physical activity for health promotion; b) the food pyramid, introduction of the food groups, their nutrients, and their functions in the body; c) the importance of drinking water; d) promotion of physical activity at school; e) sugar: the villain in caries; and f) the ten steps to a healthy diet[13]. Next, short videos taken from the Internet were shown to the students, commented, and discussed.

2. *The teacher and cooks*: The intervention for the school staff involved training the teachers and cooks. Three one-hour workshops on healthy eating were provided. They focused on the food preparation techniques and good food handling practices needed for preparing healthy and safe school meals and encouraged the use of locally produced and minimally processed fresh foods;

3. *The family*: Two one-hour workshops about healthy eating were provided to the

families. Their objective was to inform and motivate students and their families to adopt healthy eating habits.

The subjects covered in the workshops for all categories were: a) food groups, their nutrients, and their respective functions in the body, in addition to their representations in the food pyramid; and b) the ten steps for promoting a healthy diet at school[13]. Problematization followed, with a discussion about healthy eating and food preparation techniques as health-protecting factors.

All activities (lectures and workshops) planned for the intervention protocol were performed by a dietician who collaborated with the study.

Data analysis

The questionnaires were reviewed, checking the answer and the code of each question and correcting errors possibly caused by coding. The database was constructed in the software Epi-Info version 6.0, which was then checked for discrepancies, conflicting simple variable frequencies, and answer coherence.

The population was characterized by descriptive analysis using proportion for categorized data and mean ± standard deviation for the continuous variables.

Analysis of Covariance (Ancova) assessed the influence of the intervention program on the lipid profile and anthropometric changes. The dependent variables were the changes that occurred in TC, HDL-c, LDL-c, and triglycerides during the study period. The main independent variable was the intervention itself (yes/no). The biochemical parameters were assessed at baseline and end of the intervention. The estimates were adjusted as recommended by the literature[14-20] and the study dataset. Baseline age, gender, maturation stage, and BMI were the adjustment variables in Ancova. Two-tailed tests were also used and the significance level was set to 5%. The data were treated by the Statistical Package Social Sciences (SPSS) version 13.0.

RESULTS

Characteristics of the study population at baseline

When the study began, 718 students were enrolled in both schools and 531 were attending classes. Of the 272 intervention students, 227 underwent blood collection and anthropometric assessment (Figure 1). Of the 259 control students, 259 underwent anthropometric assessment, and 155 underwent blood collection. At the end of the follow-up, 142 and 192 intervention students underwent anthropometric assessment and blood collection, respectively; and 137 and 60 control students underwent anthropometric assessment and blood collection, respectively. Most losses were due to dropping out of school and refusal to participate in the second stage of the study. Hence, 202 students were effectively studied to assess the effect of actions promoting healthy eating and physical activity on the lipid profile. Of these, 53.1% were females, most aged less than 10 years (69.9%); 11.9% were malnourished; 78.7% were normal weight; and 11.1% had excess weight, being 6.9% overweight and 4.2% obese. Most (66.6%) students had high TC, 45.9% had high LDL-c, 47.1% had low HDL-c, and 26.8% had high triglycerides. Many (75.1%) had inadequate FV intake (data not shown).

The sociodemographic, anthropometric, biochemical, and FV intake characteristics of the two groups at baseline were similar (Table 1). After the nine-month intervention, the intervention group was consuming significantly more FV than the control group ($p<0.001$).

Furthermore, at the end of the study, the mean TC, LDL-c, and triglycerides of the intervention students decreased by 13.18 mg/dL

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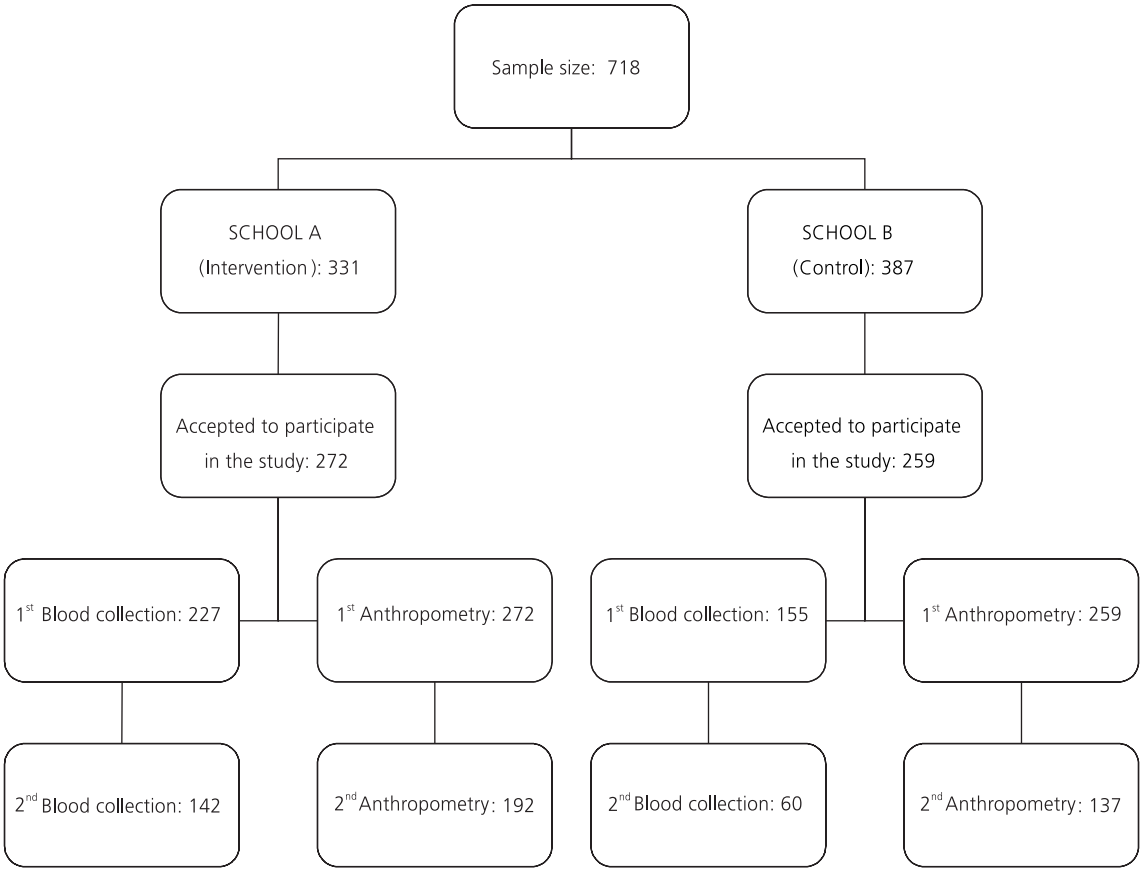

Figure 1. Flowchart of study group participation over the study period. *Salvador* (BA), Brazil, 2011.

(*p*=0.001), 7.41 mg/dL (*p*=0.038), and 12.37 mg/dL (*p*=0.029), respectively. These results were adjusted for age, gender, maturation stage, and BMI. Models including the variable mother's education level as indicator of socioeconomic status were tested. However, since the regression parameters did not change and the sample size was small, it was decided to be kept the parsimonious model (Table 2).

DISCUSSION

This study was planned to assess how the actions of a program designed to encourage healthy eating impacted the lipid profile of children and adolescents enrolled in municipal schools of *Salvador* (BA). This is a study developed in an epidemiological landscape characterized by a high prevalence of dyslipidemia, excess weight, and low FV intake. This scenario, similar to that of the Brazilian and other youth in the last decades[4,21,22], indicates the need of creating and implementing effective and integrated strategies for reducing cardiovascular risk factors[2]. The results found herein are in agreement with those that demonstrate that actions promoting healthy eating and/or regular physical activity have a positive impact on the lipid profile of children and adolescents[6,23]. Unquestionably, a strong ally of the study results is the biological plausibility of the existing associations. Dyslipidemia may be credited to physical inactivity and inappropriate food patterns, that is, patterns with a prevalence of energy-dense foods, such as foods high in fats and simple carbohydrates, to the detriment of

Table 1. Sociodemographic, lipid profile, and fruit and vegetable intake data of the groups at baseline and end of the intervention. *Salvador* (BA), Brazil, 2011.

Variables	Baseline			Follow-up		
	Intervention (n=142)	Control (n=60)	*p* value	Intervention (n=142)	Control (n=60)	*p* value
Age (years)-mean (±SD)	8.3 (2.2)	8.0 (2.0)	0.207 ¥	9.3 (2.0)	9.6 (2.0)	0.266 ¥
Gender (%)						
Male	50.2	41.9	0.111¥¥			
Female	48.8	58.1				
Mother's education level (%)						
I ≤ fourth grade	24.7	18.9	0.297¥¥			
II ≥ fifth grade	75.3	81.1				
Pubertal stage (%)						
Prepubertal	73.5	74.4	0.866¥¥			
Pubertal	26.5	25.6				
FV intake frequency						
Percentile <75th	73.1	75.9	0.635¥¥	67.9	88.7	0.001¥¥
Percentile ≥75th	26.9	24.1		32.0	11.3	
Lipid profile (mean (±SD)						
Total cholesterol	165.6 (30.5)	161.9 (27.6)	0.223 ¥	150.1 (26.0)	159.8 (31.2)	0.025 ¥
HDL-c	46.6 (9.8)	45.2 (8.1)	0.145 ¥	47.2 (12.0)	49.0 (9.3)	0.305 ¥
LDL-c	100.8 (26.8)	100.0 (24.0)	0.748 ¥	86.5 (23.3)	94.1 (26.2)	0.042 ¥
Triglycerides	87.7 (34.1)	84.4 (49.8)	0.441 ¥	78.4 (31.5)	83.0 (31.8)	0.344 ¥
BMI	15.8 (2.3)	15.5 (2.6)	0.220¥	16.3 (2.6)	16.2 (2.8)	0.639 ¥

Note: ¥Student's *t* test; ¥¥χ^2 Pearson's Chi-square test.

FV: Fruits and Vegetables; HDL-c: High Density Lipoprotein-cholesterol; LDL-c: Low Density Lipoprotein-cholesterol; BMI: Body Mass Index; SD: Standard Deviation.

high-fiber foods, such as fruits and vegetables, which contain fewer calories and better nutritional quality[24]. At the end of the nine-month follow-up, the intervention students were consuming more FV than the control students (p<0.001), a finding corroborated by similar studies[13,25]. Dietary fiber content is positively correlated with the intake of whole grains, fruits, and vegetables[26,27]. Fibers increase satiety and reduce appetite, TC synthesis, and LDL-c synthesis[20,28]. Another important benefit is their action on the gastrointestinal tract, given that they reduce gastrointestinal transit time, helping to eliminate cholesterol[29]. Intervention studies have consistently reported that fiber intake benefits the lipid profile[20,24,28,30] and other health indicators[13-20].

The study findings are particularly important because of the challenge associated with convincing youth to adopt a healthy diet. The type of intervention performed by the present study mainly encourages higher FV intake and the restriction of foods and meals high in sugars, saturated fats, and *trans* fats. Such intervention may be an alternative for preventing childhood dyslipidemia and associated factors. This life stage is critinstruction and planning must be incorporated into food and nutrition education actions, one cannot ignore that the construction is local, that is, it is based on a specific reality as stated by the "Reference Landmark for Food and Nutrition Education"[31].

Study limitations

Even though the number of study dropouts is considered high for a nine-month intervention when compared with studies using similar

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Table 2. Analysis of covariance for the influence of the intervention program on the lipid profile of the intervention students. *Salvador* (BA), Brazil, 2011.

Variables	Estimates*	Standard error	*p*
Total cholesterol			
Intercept	32.68	15.54	0.037
Control	Reference		
Intervention	-13.18	4.04	0.001
LDL-c			
Intercept	2.16	13.6	0.846
Control	Reference		
Intervention	-7.41	3.54	0.038
HDL-c			
Intercept	17.64	6.43	0.007
Control	Reference		
Intervention	-3.28	1.67	0.052
Triglycerides			
Intercept	56.49	21.57	0.010
Control	Reference		
Intervention	-12.37	5.61	0.029

Note: *Regression coefficients adjusted for age, gender, maturation stage, and body mass index at baseline.
HDL-c: High Density Lipoprotein-cholesterol; LDL-c: Low Density Lipoprotein-cholesterol.

methods[13,15] and may have reduced the study power and accuracy, these losses were not unbalanced. That is, the characteristics of the dropouts and completers were similar, indicating the random character of the losses (data not shown).

The non-inclusion of the students' levels of physical activity should also be mentioned. There is evidence suggesting an association between physical inactivity and dyslipidemia[32-34]. The lack of consistency of the collected physical activity data encouraged excluding this variable from the analysis. Due to logistics, the intake of foods high in saturated fats and/or sugars was not assessed. A higher intake of carbohydrates has been associated with low HDL-c and high LDL-c and triglycerides[35]. Nevertheless, FV intake is one of the food intake indicators used globally to monitor NCD risk factors[35,36].

The possible confounding effect of socioeconomic status was minimized by the socioeconomic homogeneity of the sample, that is, all participants were from poor families. A wide range of program components was used in the study intervention protocol. Therefore, it is not possible to distinguish which components contributed most to the benefits promoted by the study intervention.

Despite these limitations, one cannot ignore the methodological rigor and the analytical techniques used for controlling potential confounders, reinforcing the findings and the knowledge about the positive influence of nutritional counseling on the lipid profile of children and adolescents.

CONCLUSION

The results show that actions promoting healthy eating improve lipid levels. Once again this finding evidences that the study intervention model may prevent and/or treat cardiovascular risk factors in adolescents. Moreover, these results suggest that the combination of school and home actions can positively impact the health status of this population. The multi-professional approach required by such strategies is also recognized, given that the behavior and lifestyle of individuals and social groups are largely determined by their physical, socioeconomic, and cultural environments.

CONTRIBUTORS

RCR SILVA and LA SILVA helped to conceive the study, collect data, analyze and interpret the results, and review the manuscript. MCT CANGUSSU helped to interpret the results and review the manuscript.

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Household food availability in *Pelotas*, Brazil: An approach to assess the obesogenic environment[1]

Disponibilidade domiciliar de alimentos em Pelotas (RS): uma abordagem do ambiente obesogênico

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ABSTRACT

Objective

To identify household food availability according to socioeconomic and demographic factors.

Methods

A cross-sectional, population-based study was carried out in the city of *Pelotas*, Southern Brazil to determine household food availability in the 30 days that preceded the interview. Availability was considered high when food was "always" or "usually" available at home. The independent variables were: age and education level of the household head, number of household members, presence of children or adolescents, National Wealth Score, and family income.

Results

Data were collected from 1,555 households. A high availability of fruits and vegetables (80%) was more prevalent than that of soft drinks, processed meats, and sweets (40%). Whole grains and frozen foods were never available in half of the households. High-sugar and high-fat foods were positively related and fruits and whole grains were negatively related to the presence of children or adolescents in the household. National Wealth Score, family income, and age and education level of the household head were associated with household food availability.

[1] Article based on the dissertation of ALG SOARES intitled "Disponibilidade domiciliar de alimentos uma abordagem do ambiente obesogênico". Universidade Federal de Pelotas; 2012.

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Conclusion

Socioeconomic factors and demographic characteristics were associated with household food availability. High household availability of fruits and vegetables, together with sweets, processed meats, and soft drinks suggests the complex eating practices of a household, impairing classifying the environment as obesogenic.

Indexing terms: Cross-sectional studies. Food. Socioeconomic factors.

RESUMO

Objetivo

Avaliar a disponibilidade domiciliar de alimentos de acordo com fatores socioeconômicos e demográficos.

Métodos

Estudo transversal, de base populacional, realizado na cidade de Pelotas, Rio Grande do Sul, em 2012. A disponibilidade domiciliar de alimentos foi medida a partir da frequência da presença do alimento nos 30 dias precedentes à entrevista. Definiu-se alta disponibilidade como a presença sempre ou quase sempre do alimento no domicílio. As variáveis independentes foram: idade e escolaridade do chefe da família, número de moradores, presença de crianças e/ou adolescentes, indicador econômico nacional e renda familiar.

Resultados

Foram obtidas informações de 1 555 domicílios; cerca de 80% deles apresentaram alta disponibilidade de frutas, legumes e verduras, e 40% de refrigerantes, embutidos e guloseimas. Os cereais integrais e alimentos congelados nunca estiveram disponíveis em 50% dos domicílios. Alimentos ricos em açúcares e gorduras estiveram diretamente relacionados à presença de crianças e/ou adolescentes, enquanto frutas e cereais integrais apresentaram relação inversa. Indicador econômico nacional, renda familiar, idade e escolaridade do chefe da família estiveram significativamente associados à disponibilidade alimentar.

Conclusão

Além de fatores socioeconômicos, características demográficas também estiveram associadas à disponibilidade domiciliar de alimentos. A alta disponibilidade de frutas, legumes e verduras concomitante à de guloseimas, embutidos e refrigerantes demonstra a complexidade da prática alimentar no domicílio, o que dificulta a classificação do ambiente como obesogênico.

Termos de indexação: *Estudo transversais. Alimentos. Fatores socioeconômicos.*

INTRODUCTION

Over the last decades, Brazil has experienced a process of food and nutrition transition, where the population replaced foods high in complex carbohydrates and fibers by energy-dense foods, that is, foods with high sugar and fat contents, especially saturated fat[1,2]. The participation of minimally processed foods also decreased and that of ultra-processed foods increased[3]. The Western diet, characterized by energy-dense foods, those high in lipids and simple carbohydrates, together with low physical activity are the main risk factors for excess weight[1,2].

In addition to behavioral, genetic, psychological, and cultural aspects, environmental aspects are also involved in the etiology of chronic diseases, such as obesity[4], and there is a growing scientific interest in environmental factors[5-7], especially because of their direct or indirect influence on food choices[6,8]. An obesogenic environment is a location where opportunity and environmental conditions promote or favor obesity[6]. The obesogenic environment may be macro, such as education networks, the food industry, government, and society, or micro, such as schools, workplaces, neighborhoods, and homes, and allows the assessment of its different dimensions[6,7].

Food choices are influenced by economic, social, cultural, demographic, and environmental conditions[9,10]. The home is yet a microenvironment

poorly approached in the literature, and among its many factors, it has food access and availability[6,8,11,12]. In Brazil the home environment has been investigated periodically by the *Pesquisa de Orçamentos Familiares* (POF, Family Budget Survey)[9], which determined the relative participation of foods and food groups in the total number of calories available at home. The last decades have seen a considerable reduction in the relative participation of foods such as rice, beans, and other legumes and an increase in the participation of cookies, soda, processed meats, and ready-to-heat meals. The same study shows that the participation of fruits and vegetables at home remained relatively stable during this period[13]. Although POF assesses the purchasing patterns of Brazilian families, it does not assess how often these foods are available at homes.

The foods available at home provide important information about the eating process, especially of households from different socioeconomic levels and compositions. The home food availability has been directly or inversely associated with the intake of many foods and food groups[8,12,14,15]. The presence of energy-dense, nutrient-poor foods at home characterizes the home as an obesogenic environment[2,6]. However, little is known about the simultaneous presence of these foods and of low-energy, high-fiber foods. Thus, this study aims to determine the availability of high-fat or high-sugar foods, fruits, vegetables, and whole grains at homes, and describe it according to socioeconomic and sociodemographic factors.

METHODS

This population-based, cross-sectional study was conducted in the city of *Pelotas*, located in the Brazilian South region, from February to June 2012, and is part of a larger project called "*Diagnóstico de saúde em adolescentes, adultos e idosos da cidade de Pelotas-RS*", (Health status of adolescents, adults, and older adults from the city of *Pelotas*, RS).

A pre-pilot study to estimate the prevalence of food availability, in a sample similar to the sample we intended to study, was performed to help determine the study, sample size. The following parameters and estimates were then used: 95.0% confidence level, prevalence of fruit availability of 85.4% (the highest prevalence of food availability found in the pre-pilot study), and sampling error of three percentage points. Another ten percent was added to the calculated sample size to account for losses and participation refusals, and the number was then multiplied by two because of the study design, resulting in a minimum sample size of 1,160 households.

The households were sampled in two stages. Based on *Censo Demográfico* 2010 (2010 Census) of *Instituto Brasileiro de Geografia e Estatística* (IBGE, Brazilian Insititute of Geography and Statistics) a total of 495 census sectors of the city's urban area were ordered by numbers, representing all areas of the city. Then, 130 census sectors were systematically selected. The households were systematically selected in each sector, and the number of selected households was proportional to sector size. A mean of 13 households were selected per sector, totaling 1,722 households.

Before the interview, all homes were visited by the field supervisors to deliver a letter of presentation. Later, a semi-structured questionnaire was administered by trained interviewers, preferably to the household head or the individual in charge of the home. The household head was either the person who self-reported as such or the person indicated by the homemaker as being the head. If the questionnaire could not be administered to either of these individuals, it was administered to another household member.

Home food availability was determined by a structured questionnaire, a translated and adapted version of the one used in the Eating Among Teens Project (EAT Project - University of Minnesota, Minneapolis - United States of America)[16], which investigates socio-environmental factors related to diet and body weight. The time

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period that the original questionnaire investigates was reduced from one year to thirty days, as this reflects the purchasing habits of the household and reduces memory bias. Food availability was assessed by the following question, "In the last 30 days, did you have [food] at home?" Each question had an answer key in the form of a 5-point Likert scale[17]: never, occasionally, sometimes, usually, or always. This instrument was submitted to a validation study in a sub-study with a sample of 100 households, similar to that included in the present study. A food availability diary based on POF's Household Purchases Form (*Caderneta de Aquisição Coletiva*) was used and considered the reference method. The participants were advised to record in the diary all foods purchased over 30 days, which was then used for assessing availability. This validation study is currently being analyzed.

Home food availability was initially classified into three categories (never/occasionally, sometimes, usually/always). Next, high availability was dismembered into either "always" or "usually" available at home. The study foods and/or food groups were: fruits, vegetables, whole grains (whole bread, whole rice, or oat), soda, processed meats (mortadella, salami, sausage, hotdog, or ham), frozen foods (French fries, pizza, or nuggets), packaged savory snacks (potato chips, corn chips, bacon chips, straw potatoes, pretzels, etc.; some examples include Ruffles®, Cheetos®, Fandangos®, Pastelina®, Fritex® or others), and sweets (chocolates, candies, and sweets). These foods were based on the original questionnaire adapted to the Brazilian context, to which some foods listed in the literature as risk factors for chronic Non-Communicable Diseases (NCD) were added, such as soda, processed meats, frozen foods, packaged savory snacks, and sweets, and foods listed as protective against NCD (fruits, vegetables, and whole grains)[4]. Less energy-dense foods were distributed randomly in the questionnaire to avoid automatic answers or those considered socially appropriate. The participants were also asked where they purchased their fruits and vegetables with the following question, "Where do you usually buy [food]?" The answer options were: farmer's market, fruit vendor, grocery story, supermarket/hypermarket. We also asked if the place was located near or far from home.

The study independent variables were: age and education level of the household head (none to third grade; fourth grade to incomplete elementary school; complete elementary school to incomplete high school; complete high school to incomplete higher education; complete higher education); number of household members at the time of the interview; presence of children or adolescents (individuals under 20 years of age); *Indicador Econômico Nacional* (IEN - National Wealth Score)[18] in quintiles; and family income in minimum salaries (R$622,00 in 2012, which corresponded to roughly US$307,00 per month in July 2012). The variable education level was classified according to the categories used by the Brazilian Economic Classification Criterion developed by the *Associação Brasileira de Estudos Populacionais* (ABEP, Brazilian Association of Market Research Companies).

The questionnaire was programmed in the software Pendragon 6.1 (Pendragon® Software Corporation) enabling the use of netbooks during the interviews. The data were transferred weekly to a central computer. Meetings with the interviewers were also held weekly, in addition to database checking for possible inconsistencies. Some questions were readministered by the field supervisors to 10% of the sample to control data quality. The chosen question was the one about where the fruits were purchased, which had a kappa of 0.63.

The data were treated by the software Stata version 12.1 (Stata Corp, College Station, USA) considering the sampling design with the command "svy". The continuous variables with normal distribution were expressed as means ± standard deviation, and those with asymmetric distribution, as median and Interquartile Range (IQR). The categorical variables were expressed as proportions with their respective 95%CI. Poisson regression estimated the prevalence ratios and tested heterogeneity and linearity. The significance level was set at 5%.

The study was approved by the Research Ethics Committee of *Universidade Federal de Pelotas* (UFPel) School of Medicine under Protocol number 77/11. Before joining the study, all participants signed an Informed Consent Form.

RESULTS

Of the 1,722 eligible households, information was collected from 1,555, totaling 9.7% of loss and refusal. Table 1 shows the

Table 1. Description of the sample according to socioeconomic and demographic characteristics (n=1,555). *Pelotas* (RS), Brazil, 2012.

Variables	n	Frequency (%)	95%CI
Gender of household head			
Male	872	56.1	53.1 - 59.1
Female	683	43.9	40.9 - 46.9
Age of household head			
<30 years	180	11.6	9.6 - 13.6
30-39 years	264	17.0	14.4 - 19.5
40-49 years	336	21.6	19.3 - 23.9
50-59 years	319	20.5	18.4 - 22.6
≥60 years	456	29.3	26.6 - 32.1
Education level of the household head			
None to 3rd grade	205	13.2	10.9 - 15.5
4th grade to incomplete elementary school	426	27.4	24.0 - 30.8
Complete elementary school or incomplete high school	256	16.5	14.4 - 18.5
Complete high school or incomplete higher education	411	26.4	23.8 - 29.0
Complete higher education	257	16.5	13.2 - 19.8
Number of household members			
1	279	17.9	15.8 - 20.1
2	422	27.1	24.6 - 29.6
3	402	25.9	23.6 - 28.1
4 or more	452	29.1	26.5 - 28.1
Presence of children and/or adolescents			
No	804	51.7	48.7 - 54.7
Yes	751	48.3	45.3 - 51.3
National Wealth Score			
1° quintile (med.: 1.7; IQR: 1.0 MS)	312	20.1	17.2 - 23.0
2° quintile (med.: 2.0; IQR: 1.5 MS)	310	20.0	17.9 - 22.0
3° quintile (med.: 2.7; IQR: 1.6 MS)	311	20.0	17.8 - 22.3
4° quintile (med.: 3.7; IQR: 2.6 MS)	310	20.0	17.5 - 22.4
5° quintile (med.: 7.4; IQR: 8.7 MS)	309	19.9	16.1 - 23.7
Fruit purchase location			
Farmer's market	257	16.7	13.9 - 19.5
Fruit vendor	311	20.2	17.5 - 22.9
Grocery	187	12.1	9.9 - 14.4
Supermarket	785	51.0	47.6 - 54.3
Vegetable purchase location			
Farmer's market	273	17.9	15.2 - 20.7
Vegetable vendor	279	18.3	15.9 - 20.7
Grocery	188	12.4	10.0 - 14.6
Supermarket	782	51.4	48.1 - 54.3

Note: *Missing total - maximum value 33.

Med: Median; IQR: Interquartile Range; MS: Minimum Salaries; 95%CI: 95% Confidence Interval.

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demographic and socioeconomic characteristics of the sample. Most household heads were males and the mean age was 49±15.9 years; half were 50 years old or older, and 43.0% had at least a high school diploma. Almost 18.0% of the households consisted of only one person; about 50.0% had children and/or adolescents. The median family income was 1.7 Minimum Salaries (MS) per month in the first IEN quintile (IQR=1.0), and 7.4 MS per month in the fifth quintile (IQR=8.7). More than half of the households bought fruits and vegetables in supermarkets, usually close to home.

Figure 1 shows the reported availability of foods and food groups in the study homes in the 30-day period before the interview divided into three categories. Three distinct food group availability patterns were evident. Fruits and vegetables had similar prevalences and were reported as being usually or always available in roughly 80% of the households. Processed meats, soda, and sweets were usually or always available in about 40% of the households. The availability of whole grains, packaged savory snacks, and frozen foods was similar: they were occasionally or never available in 50% of the households.

Table 2 shows the frequencies of foods and food groups that were usually or always available in the study homes according to the household's demographic and socioeconomic factors. The age of the household head related positively with a high availability of fruits, vegetables, and whole grains, and inversely with a high availability of processed meats, packaged savory snacks, and frozen foods. The education level of the household head was also directly related to high food availability, except for vegetables and soda. Number of household members was inversely related to a high availability of whole grains and directly related to a high availability of fruits, vegetables, and processed meats. High availability of packaged savory snacks, soda, and sweets also tended to increase with number of household members.

The probability of a home having a high availability of fruits and vegetables was, respectively, 11.0% (Prevalence Ratio - PR=1.11; 95%CI=1.05-1.17) and 14.3% (PR=1.14; 95%CI=1.09-1.20) greater in households who purchased them in farmer's markets than in those who purchased these items in other vendors. IEN and education level of the household head did

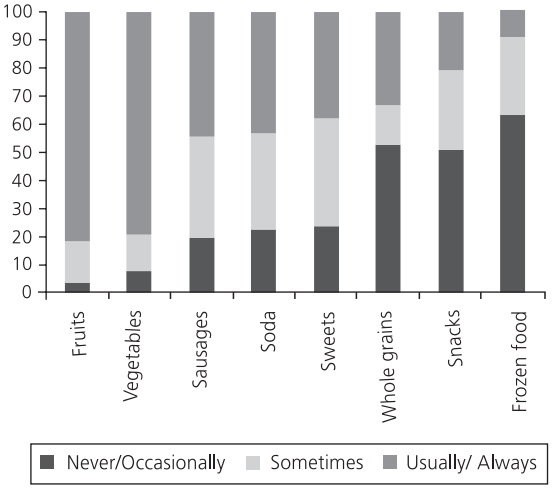

Figure 1. Household food availability during the 30-day period before the interview. *Pelotas* (RS), Brazil, 2012.

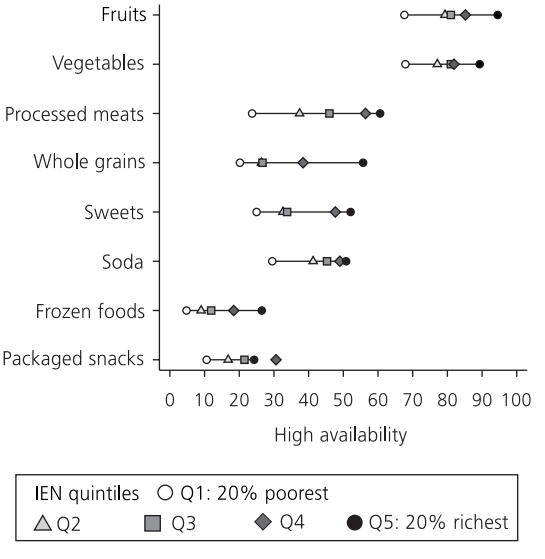

Figure 2. High household food availability variation according to National Wealth Score. *Pelotas* (RS), Brazil, 2012.

Table 2. High household food availability according to socioeconomic and demographic characteristics (n=1,555). *Pelotas* (RS), Brazil, 2012.

Variables		Fruits	Veggies	Sausages	Soda	Sweets	W grains	Snacks	F foods
Age of household head		*p*<0.001*	*p*<0.001*	*p*<0.001*	*p*=0.821	*p*=0.194	*p*<0.001*	*p*<0.001*	*p*=0.002*
	%	66.7	67.8	52.2	44.4	38.3	23.3	28.9	18.3
<30 years	95%CI	(59.2;74.2)	(60.6;75.0)	(44.2;60.3)	(36.1;52.8)	(32.3;44.4)	(16.6;30.1)	(22.1;35.7)	(12.6;24.1)
	%	73.9	72.7%	52.3	42.4	40.1	21.6	26.5	16.3
30 - 39 years	95%CI	(68.3;79.4)	(67.2;78.3)	(46.2;58.3)	(26.3;48.5)	(33.6;46.6)	(16.2;27.0)	(21.4;31.6)	(11.9;20.6)
	%	81.8	76.2	46.7	45.8	36.3	27.1	21.4	15.5
40 - 49 years	95%CI	(78.0;85.7)	(71.6;80.8)	(40.7;52.7)	(40.3;51.4)	(30.8;41.8)	(22.0;32.1)	(16.7;26.2)	(11.1;19.8)
	%	85.3	85.3	45.5	43.2	43.3	40.4	20.4	15.1
50 - 59 years	95%CI	(81.2;89.3)	(81.4;89.1)	(40.3;50.6)	(37.7;48.8)	(37.3;49.2)	(34.8;46.1)	(15.5;25.2)	(11.0;19.1)
	%	89.0	86.4	35.7	41.2	35.1	44.1	14.3	9.6
≥60 years	95%CI	(85.9;92.1)	(83.2;89.6)	(30.9;40.6)	(35.8;46.6)	(29.8;40.3)	(38.6;49.5)	(10.9;17.6)	(6.7;12.5)
Education level of household head		*p*<0.001*	*p*=0.288	*p*<0.001*	*p*=0.159	*p*<0.001*	*p*<0.001	*p*=0.008	*p*<0.001*
	%	75.1	73.7	31.7	36.1	29.8	23.4	13.7	6.3
1	95%CI	(68.3;81.9)	(66.8;80.5)	(24.5;38.9)	(29.0;43.2)	(22.7;36.8)	(16.6;30.2)	(8.8;18.5)	(2.7;10.0)
	%	77.9	80.5	41.1	43.4	33.1	23.2	18.8	8.2
2	95%CI	(73.7;82.2)	(77.2;83.8)	(36.3;45.8)	(38.4;48.5)	(28.6;37.6)	(18.9;27.5)	(15.2;22.3)	(5.5;10.9)
	%	81.2	80.9	42.2	46.9	35.9	27.3	22.3	9.8
3	95%CI	(76.3;86.1)	(76.2;85.5)	(35.6;48.7)	(40.7;53.0)	(30.0;41.8)	(22.1;32.5)	(17.3;27.2)	(6.0;13.5)
	%	83.2	80.0	51.1	45.3	41.1	39.2	25.8	19.9
4	95%CI	(79.4;87.0)	(76.0;84.1)	(46.0;56.2)	(40.4;50.1)	(35.9;46.3)	(34.2;44.1)	(21.2;30.3)	(16.1;23.8)
	%	90.3	80.2	54.1	41.6	51.4	55.2	20.6	25.3
5	95%CI	(86.3;94.3)	(75.4;84.9)	(48.6;59.6)	(34.5;48.8)	(45.0;57.7)	(47.9;62.6)	(15.1;26.1)	(19.1;31.4)
Number of household members		*p*=0.014	*p*<0.001	*p*<0.001	*p*<0.001*	*p*<0.001*	*p*<0.001	*p*<0.001*	*p*=0.125
	%	76.0	66.3	25.8	32.6	30.1	38.4	10.4	12.2
1	95%CI	(71.1;80.9)	(60.4;72.2)	(20.0;31.5)	(25.4;39.8)	(24.3;35.9)	(32.1;44.6)	(6.4;14.4)	(7.3;17.1)
	%	82.5	81.5	44.3	42.4	38.4	39.6	17.1	11.6
2	95%CI	(78.4;86.5)	(77.4;85.6)	(39.2;49.4)	(37.1;47.7)	(33.2;43.5)	(33.9;45.2)	(13.7;20.4)	(8.6;14.6)
	%	85.6	83.8	49.3	45.3	40.5	28.9	24.6	16.4
3	95%CI	(82.0;89.1)	(80.0;87.6)	(43.7;54.8)	(40.7;49.8)	(35.4;45.7)	(23.6;34.1)	(19.7;29.5)	(12.8;20.0)
	%	80.5	81.9	53.1	48.7	41.1	28.8	27.4	15.7
4 or +	95%CI	(76.6;84.4)	(78.2;85.5)	(48.3;57.8)	(43.7;53.6)	(36.4;45.9)	(23.9;33.6)	(23.9;31.0)	(12.2;19.2)

Note: *Linear trend; 95%CI: 95% Confidence Interval.

Education level of the household head: 1: None to 3rd grade; 2: 4th grade to incomplete elementary school; 3: Complete elementary school to incomplete high school; 4: Complete high school to incomplete higher education; 5: Complete higher education.

Veggies: Vegetables; Sausages: Processed meats; W grains: Whole grains; Snacks: Packaged savory snacks; F foods: Frozen foods.

not influence purchasing location (data not shown).

The availability of nearly all foods was greater in homes in the higher IEN quintile, except for packaged savory snacks (Figure 2). Fruits and vegetables were the food groups with the highest frequency of high availability, being roughly 70.0% and 90.0% in the first and fifth quintiles, respectively. Packaged savory snacks were the foods with the smallest availability variation between the first and fifth IEN quintiles, with a variation of 14.0 percentage points. On the other hand, frozen foods were highly available in only 4.8% of the households in the first IEN quintile and in 26.5% of the households in the fifth IEN quintile, a fivefold increase. High availability of processed meats and whole grains varied greatly between IEN quintiles, with a difference of 35.0

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Table 3. High household food availability according to the presence of children and/or adolescents. *Pelotas* (RS), Brazil, 2012.

Foods	Households with children	Households without children	Prevalence ratio	95%CI
Fruits	79.4%	83.6%	0.95	0.91 - 0.99
Vegetables	78.2%	80.7%	0.97	0.92 - 1.02
Sausages	51.5%	38.6%	1.34	1.20 - 1.49
Soda	46.3%	40.3%	1.15	1.01 - 1.30
Sweets	40.2%	36.4%	1.10	0.97 - 1.25
Whole grains	24.0%	42.3%	0.57	0.48 - 0.66
Packaged savory snacks	27.6%	14.6%	1.89	1.53 - 2.35
Frozen foods	17.0%	11.4%	1.49	1.12 - 1.98

Note: 95%CI: 95% Confidence Interval.

percentage points between the first and fifth quintiles. The high availability of foods considered risk factors for NCD, excluding frozen foods, was directly related to the high availability of fruits and vegetables (data not shown).

Table 3 shows the frequency of high food availability stratified by the presence or absence of children and/or adolescents and the prevalence ratios, considering the absence of children as reference. High availability of fruits and whole grains was inversely related to the presence of children and/or adolescents; for example, the availability of whole grains was 43% lower in households with children and/or adolescents. On the other hand, high availability of processed meats, soda, packaged savory snacks, and frozen foods was positively related to the presence of children and/or adolescents; the availability of packaged savory snacks was 90% greater in households with at least one person aged less than 20 years than in households with only adults and/or older adults.

DISCUSSION

Investigating home food availability provides information about the initial phase of the eating process, which involves choice and acquisition. This study described food availability, one of the home environment dimensions that can contribute to obesity and other diseases. Most households had a high availability of fruits and vegetables, and in many of these households, the availability of processed meats, soda, and sweets was also high.

The high availability of fruits and vegetables at least shows that almost all study households buy them frequently, but this does not seem to confirm the consumption of these products, which in Brazil is much lower than the consumption recommended by the World Health Organization (WHO) and evidenced by studies[19,20]. The high availability of these foods may result from the widespread advertising of their importance to health. In Brazil, there are no published studies about the frequency of home availability of fruits and vegetables, but in other countries with distinct socioeconomic characteristics, such as Australia and the USA, the frequency of availability exceeded 90%[8,21]. Some authors[14,15] have highlighted the importance of having fruits and vegetables frequently available at home, demonstrating that even when preference for these foods is low, their availability may favor intake[22].

Although whole grains were never available in almost half the households, they were highly available in roughly 55% of the higher IEN households and in those whose heads had higher education. The ability to buy these foods is related to their higher price compared with refined grains and other high-fat, high-sugar foods[5,23,24]. Higher education level may be related to knowing about the benefits of consuming high-micronutrient,

high-fiber foods and the importance that buying these foods has on the family and social spheres.

Soda, processed meats, and sweets had very similar high availability prevalences: they were usually or always present in about 40% of the households; this finding is similar to that found in high-income countries[8,21]. This may indicate diet westernization, a fact that is occurring in many parts of the world[1]. The high frequency of availability of these foods, packaged savory snacks, and frozen foods was positively associated with the education level of the household head (except for soda) and IEN. In Brazil the relative participation of these foods is directly related to family income[9]. Since these foods are more energy-dense, even small amounts contribute more to total energy than other less energy-dense foods. In high-income countries the availability of these foods is higher in lower-income households[8].

In agreement with the literature[24], the education level of the household head and IEN were positively related to the availability of foods that protect against NCD, but they were also directly related to a higher availability of risky foods. There is scientific evidence that the presence of soda, sweets, cookies, and packaged savory snacks at home is not only positively associated with their intake, but also inversely related to the intake of fruits and vegetables[25]. Hence, the availability of high-fat or high-sugar foods at home may encourage their intake and discourage the intake of less energy-dense foods with higher micronutrient and fiber contents.

The relationship between the age of the household head and the foods available at home possibly indicates that people become more careful with their diets as they age, either to prevent or control NCD[19]. The lower home availability of processed meats, packaged savory snacks, and frozen foods in households whose heads were aged 50 years or more may also be justified by their eating habits, established at a time when ultra-processed foods were less common[3,19]. However, the household food buyer was not interviewed to confirm this hypothesis. Information about the relationship between age of the household head and/or food buyer and the food groups available at home was not found in the relevant literature.

Household composition was also associated with the food groups available at home. High-sugar and high-fat foods were positively related and fruits and whole grains were inversely related to the presence of children and/or adolescents in the household. These associations were opposite to those found regarding the household head's age because of the smaller probability of finding children and/or adolescents in households where the head and other members are older. Studies on the influence of children and/or adolescents on food purchases have found that these individuals tend to have a greater influence on the purchase of products of which they are the primary consumers[26,27]. Therefore, these groups could encourage the purchase of high-fat and high-sugar foods, which are generally more palatable and advertised than other foods[5,23,24].

Despite the small number of households who purchased produce at farmer's markets, the frequency of availability of these items was about 10% higher in such households. A Brazilian study[28] found that farmer's markets tend to be located in central areas with higher purchasing power, in addition to a positive relationship between regular produce intake and the density of farmer's markets in a given location. The education level of the study household head and the income of households who purchased produce in farmer's markets were similar to those who purchased in other places. Although these socioeconomic factors are related to fruit and vegetable availability[19,29], purchase location may also provide important information.

This population-based study enabled approaching the home microenvironment and gathering qualitative information about home food availability, especially foods that protect against or are risk factors for NCD. Although

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relying on the interviewee's perception, the frequency of availability of the study food groups probably reveals part of the purchasing habits of the study households over a 30-day period and provides important information about the food preferences of the household and its individual members. Nevertheless, the availability assessed herein reflects neither the food diversity nor the food intake frequency because the instrument was restricted to food groups. Studies that actually assess the relationship between the household availability of these foods and/or food groups and their intake are needed.

The literature shows that low household availability of foods that protect against obesity predicts lower consumption of such foods, while high availability of risky foods encourages their consumption[24]. On the other hand, high availability of protective foods combined with limited availability of risky foods suggests a higher intake of protective foods[15]. Therefore, anti-obesity and obesity-promoting foods may be present in the same household, showing the complexity of dietary issues and the difficulty of classifying an environment as obesogenic. We highlight the need of studies that attempt to clarify the relationship between the great diversity of foods in the home environment and food choices/intake, the home's obesogenic level, and the extent to which the intake of risky foods reduces that of protective foods. Even though these factors vary, a detailed account of the foods a given population has at home provides important elements for the creation of public policies that encourage or restrict the purchase of certain foods.

CONTRIBUTORS

ALG SOARES helped to plan the study, review the literature, analyze the results, and write the manuscript. GVA FRANÇA helped to plan the study, analyze the data, and write and review the manuscript. H GONÇALVES helped to plan the study, analyze the data, and review the manuscript.

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School Gardens in the *Distrito Federal*, Brazil[1]

Hortas escolares no Distrito Federal, Brasil

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ABSTRACT

Objective

The aim of the present study was to identify experiences with gardens in public schools in the *Distrito Federal*, Brazil, and to analyze factors involved in their use to promote healthy eating habits.

Methods

This is an analytical cross-sectional study with data collection in two phases: (1) telephone contact with all public schools in the *Distrito Federal*; (2) interviews conducted with a sample of schools with a garden (n=105).

Results

Of the 582 schools in the *Distrito Federal*, 453 (77.8%) participated in phase 1 and 37.7% of these had a garden. Rural schools had a higher prevalence of gardens (p=0.003). Among the schools which had no garden, 75.2% (n=212) had interest in creating one. The main reason for the deactivation of gardens was a lack of manpower to maintain them. The main reason for creating a garden was to supplement school food (56.2%). The garden was used as an educational space to promote healthy eating habits by 60.8% of the schools.

Conclusion

An expressive percentage of schools with gardens (37.7%) was identified in the *Distrito Federal*. A number of factors were associated with the presence of a garden, including the location and size of the school, as well as the level of education. A significant percentage of schools reported using the garden as a space to promote healthy eating habits. This result must be refined by assessing the use and impact of gardens as a tool to promote healthy eating habits in the school community.

Indexing terms: Food and nutrition education. Health promotion. Schools.

[1] Article based on the dissertation of the R BERNARDON intitled "*Horta escolar no Distrito Federal: instrumento de promoção da alimentação saudável*". Universidade de Brasília; 2011.

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RESUMO

Objetivo

Identificar experiências com hortas em escolas públicas do Distrito Federal, Brasil, analisando determinantes no seu uso voltado à promoção da alimentação saudável.

Métodos

Estudo transversal analítico, com coleta de dados em duas fases: (1) por telefone com todas as escolas públicas do Distrito Federal; (2) entrevista presencial com amostra das escolas que possuíam horta (n=105).

Resultados

Das 582 escolas do Distrito Federal, 453 (77,8%) participaram da fase 1 e dessas, 37,7% possuíam horta. Escolas rurais apresentaram maior prevalência de horta (p=0,003). Das escolas sem horta, 75,2% tinham interesse na sua implantação. O principal motivo para desativação da horta foi falta de mão-de-obra para manutenção. Quanto às escolas com horta, a intenção de complementar a alimentação escolar foi o principal motivo de sua implantação (56,2%). A horta era utilizada como espaço educativo para promoção da alimentação saudável por 60,8% das escolas.

Conclusão

Foi identificado no Distrito Federal um percentual expressivo de escolas com horta (37,7%). Alguns fatores relacionados à localização, porte e nível de ensino da escola associaram-se à presença da horta. Verificou-se inicialmente, um elevado percentual de escolas que relataram utilizar a horta como espaço de promoção da alimentação saudável. Faz-se necessário aprofundar este resultado por meio de avaliação do uso e impacto da horta como instrumento de promoção da alimentação saudável na comunidade escolar.

Termos de indexação: *Educação alimentar e nutricional. Promoção da saúde. Instituições acadêmicas.*

INTRODUCTION

Brazilian food consumption data indicate excessive intake of foods with a high sugar, fat and sodium content, as well as a reduction in the consumption of protective foods, such as fruit and vegetables[1]. This has also been observed among children and adolescents in schools. A study in *Rio de Janeiro* (RJ) assessed children from the 8th grade of a public school and confirmed a high consumption of candy, soft drinks, fried and salted food, with a low consumption of fruit and vegetables[2]. A study in *Piracicaba* (SP) assessed the eating habits of adolescents from 10 to 17 years of age and reported that 84% of them exhibited an energy intake above the recommended levels (37% lipids)[3]. Similarly, a reduction was confirmed in the rates of malnutrition and deficiency diseases, with increases recorded in the prevalence of overweight or obese adolescents. This epidemiological situation demands new strategies focused on health promotion[4,5].

The promotion of healthy eating habits in the school environment presupposes the development of educational activities that help and motivate the adoption of healthy eating habits[6]. School gardens offer potential integration for several health determinants (eating habits, physical activity and social interaction) in a single activity and can be used as a nutritional education instrument and an important pedagogical resource for the school[7-9].

The aim of the present study, conducted in the *Distrito Federal* (DF) where Brazil's capital city is located, was to assess experiences with public school gardens and to identify the determinants of their use as a strategy to promote healthy eating habits. The authors of the present study hope to contribute to the knowledge and assessment of factors that could guide the management of different government spheres, facilitating the planning, stimulation and guidance of this type of activity.

METHODS

This is a cross-sectional analytical study of public schools in the 25 administrative regions of the DF, Brazil. The factors assessed were associated with the presence or absence of a garden in these schools. The data were collected between August 2008 and July 2009. The research was divided into two phases: phase 1 involved mapping the gardens in the DF, based on the available public schools; phase 2 involved characterizing the use of the gardens, based on the schools that had a garden. This information was obtained from the phase 1 data.

The study population in phase 1 was constituted of an initial figure of 582 public schools, registered with the *Instituto Nacional de Estudos e Pesquisas Educacionais* (INEP) and the *Secretaria de Educação do Distrito Federal* in January 2008. Due to the impossibility of telephone contact with a number of these schools, this total number was reduced to 576 schools. Of these schools, 15 (2.6%) were excluded because they had already participated in the pilot phase and 93 (16.6%) others were excluded based on the exclusion criteria, which will be clarified shortly. Therefore, the present study began with a total of 453 schools (77.8% of the initial figure).

Considering that in phase 1, 171 (37.7%) schools reported having a garden, a representative sample of these schools was selected for phase 2 (n=105), based on simple random sampling, establishing a maximum sampling error of 6.0%. The sample calculations took into consideration the administrative regions of the DF.

The 15 schools that were involved in the pilot study were selected randomly and four of them contained a garden. Important observations were made regarding the instruments in an attempt to ensure a better applicability of the same.

As well as participation in the pilot study, the following exclusion criteria were applied in phase 1: three unsuccessful attempts to make telephone contact at different times on different days; altered telephone number and refusal to participate in the study. In phase 2, two further criteria were considered: address not found; absence of a garden or an inactive garden.

Two instruments were developed for data collection. The phase 1 instrument was applied based on telephone contact with a coordinator or manager of the school's pedagogical projects and involved a semi-structured questionnaire, with variables organized in two blocks: (i) identification and characterization of the school and (ii) presence of a school garden. The first block contained questions about the location of the school, the teaching methods, the operating shifts, the presence or absence of a garden, among others, and was used for all schools. If there was no garden in the school, the second block of questions were applied by the interviewer, seeking the following information: the presence of a garden at some stage in the school's past or present; interest in implementing a garden and garden implementation projects. Schools without a garden took no further part in the study after this phase. After finishing the first block of questions, a visit was requested to schools with a garden. This visit was requested in order to apply the phase 2 instrument.

Phase 2 was carried out in person using a semi-structured questionnaire divided into four discussion points: (i) implementation, maintenance and cultivation of the garden; (ii) complementing school nourishment; (iii) participation of the school community, and (iv) the garden as an instrument that promotes healthy eating habits. The interviews were preferably conducted with the staff member who was responsible for the garden or who created the garden project.

Data were double entered in Statistical Package for the Social Sciences (SPSS) software, version 17.0. The answers to the open questions were transcribed textually and categorized in common themes. Statistical analysis was performed using descriptive statistics, the

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Student's *t* test and Pearson's Chi-squared test. In addition, a logistical regression model was designed, composed of variables of practical significance for the present study. Controlled regression was applied to the presence of a garden in relation to the location of the school, the level of education, the operating shifts, the quantity of students, teachers, staff and groups, and the presence of a commercial snack bar. The results were considered statistically significant if $p<0.05$.

Pre-requisites were defined for the construction of a garden and the presence of a non-cemented space and a green area of at least 1.20 m x 2 m[8,10].

The present study was approved by the Research Ethics Committee of the Health Sciences Faculty in the *Universidade de Brasília* (UnB) under Protocol number 006/2005 on May 17, 2005. All participants signed an Informed Consent Form.

RESULTS

Phase 1: Characterization of schools in relation to the presence or absence of a garden

The 453 schools that participated in phase 1 operated a morning schedule, whereas 95.6% also operated in the evening and 25.6% also operated at night. In total, 93.4% of the schools were located in urban areas. Rural schools were present in nine of the 25 regions (data not shown in the tables). Of the 453 schools, 37.7% had a garden. The presence of a garden was more significant in rural schools than in urban schools (63.3% versus 35.9%; $p=0.003$) (Table 1).

Schools that were involved in pre-school and crèche activities more commonly contained a garden, which is contrary to the results found in high schools ($p=0.004$) (Table 1).

Among the 282 schools without a garden, 57.1% reported having a garden at some time in the past and 75.2% expressed an interest in implementing a garden in the future. When questioned about the existence of a project to implement a garden, 26.9% of urban schools and 45.5% of rural schools confirmed that they had one in place (Table 1).

The majority of urban schools (87.4%) and rural schools (81.8%) possessed at least one pre-requisite for the construction of a garden (66.4% of urban schools had one requisite and 20.2% had two). Only 12.8% of the schools had no requisites at all (Table 2). Having one of the pre-requisites could be a determining factor in the implementation of a garden since only 3.1% of the schools that already had a garden had no pre-requisite available at the time of the research ($p<0.001$). In addition, only 6.1% of the schools interested in creating a garden did not have pre-requisites ($p<0.001$).

Upon comparison of schools with a garden and schools that had one in the past, there was a greater prevalence of gardens in schools with less students ($p<0.001$), less teachers ($p=0.012$), less staff ($p=0.005$) and less groups ($p=0.046$) (Table 3).

The main reason for abandoning a garden was the lack of staff to maintain it, which constituted 42.9% of the responses (n=69) (data not shown in the tables).

Table 4 displays the variables that exerted an influence on the presence of a garden. The chance of the school having a garden was 2.35 times greater in rural areas. Schools with more students were less likely to have a garden. If a school increased its student numbers by 100, the chances of having a garden fell by 6% (1 - 0.94).

Phase 2: Characterization of the schools with gardens

The main reasons for creating a garden were the following: Intention to complement nourishment (56.2%); take advantage of the space to work with students (46.7%) and; use

Table 1. Characterization of public schools in relation to the school garden, location and education levels. *Distrito Federal*, Brazil, 2008-2009.

Characteristics	Presence of a school garden at the time of the research						p^a
	Yes		No		Total		
	n	%	n	%	n	%	
Location							
Urban Area	152	35.9	271	64.1	423	100.0	0.003
Rural Area	19	63.3	11	36.7	30	100.0	
Total	171	37.7	282	62.3	453	100.0	
School Level							
Pre-school	60	42.3	82	57.7	142	100.0	0.181
Crèche	7	43.8	9	56.2	16	100.0	0.614
Elementary School	136	37.5	227	62.5	363	100.0	0.803
High School	13	21.3	48	78.7	61	100.0	0.004
Others	42	36.8	72	63.2	114	100.0	0.818
Presence of a school garden prior to the research[b]							
Location							
Urban Area	152	56.1	119	43.9	271	100.0	
Rural Area	9	81.8	2	18.2	11	100.0	0.091
Total	161	57.1	121	42.9	282	100.0	
School Level							
Pre-school	49	59.8	33	40.2	82	100.0	0.563
Crèche	5	55.6	4	44.4	9	100.0	0.925
Elementary School	136	59.9	91	40.1	227	100.0	0.052
High School	25	52.1	23	47.9	48	100.0	0.441
Others	41	56.9	31	43.1	72	100.0	0.977
Interest in creating a garden[b]							
Location							
Urban Area	202	74.5	69	25.5	271	100.0	
Rural Area	10	90.9	1	0.9	11	100.0	0.218
Total	212	75.2	70	24.8	282	100.0	
School Level							
Pre-school	65	79.3	17	20.7	82	100.0	0.309
Crèche	6	66.7	3	33.3	9	100.0	0.548
Elementary School	188	82.8	39	17.2	227	100.0	<0.001
High School	33	68.7	15	31.3	48	100.0	0.258
Others	48	66.7	24	33.3	72	100.0	0.053
Existence of plans to create a garden[b]							
Location							
Urban Area	73	26.9	198	73.1	271	100.0	
Rural Area	5	45.5	6	54.5	11	100.0	0.178
Total	78	27.7	204	72.3	282	100.0	
School Level							
Pre-school	28	34.1	54	65.9	82	100.0	0.119
Crèche	2	22.2	7	77.8	9	100.0	0.711
Elementary School	74	32.6	153	67.4	227	100.0	<0.001
High School	11	22.9	37	77.1	48	100.0	0.420
Others	19	26.4	53	73.6	72	100.0	0.780

Note: [a]Chi-squared test. [b]Data referring to schools without a garden at the time of the research.

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the space for food nutrition education (14.3%). The main supporters of school gardens were teachers (30.5%) and management (23.8%). Once installed, 89.5% (n=94) reported appointing a person to look after the garden, usually teachers (45.7%), cleaning staff (33.0%) or students (23.4%).

Table 2. Distribution of public schools that do not have a garden according to the presence of requisites for creation. *Distrito Federal*, Brazil, 2008-2009.

Non-cemented space[a]	Green area of 1.20 m x 2 m[a]						p[b]
	Yes		No		Total		
Yes	57	20.2	91	32.3	148	52.5	
No	98	34.8	36	36.0	134	47.5	<0.001
Total	155	55.0	127	45.0	282	100.0	

Note: [a]Criteria for the existence of the garden. [b]Chi-squared test.

Table 3. Characterization of public schools in terms of the variables related to the garden, according to the number of students, teachers, staff and groups. *Distrito Federal*, Brazil, 2008-2009.

Characteristics	Presence of a school garden at the time of the research				p[a]
	Yes		No		
	M	SD	M	SD	
Number					
Students	745.0	530.6	1,036.0	791.1	<0.001
Teachers	35.2	25.8	43.1	33.1	0.005
Staff	51.4	31.0	63.4	61.5	0.020
Groups	25.9	16.9	29.4	17.0	0.033
	Presence of a school garden prior to the research[b]				
Number					
Students	1,020.1	732.1	1,057.1	866.0	0.698
Teachers	42.8	29.3	43.5	37.5	0.875
Staff	61.8	34.4	65.7	85.8	0.608
Groups	29.4	15.4	29.4	18.9	0.973
	Presence of a school garden				
Number					
Students	745.0	530.6	1,020.1	732.1	<0.001
Teachers	35.2	25.8	42.8	29.4	0.012
Staff	51.4	31.0	61.8	34.4	0.005
Groups	25.9	16.9	29.4	15.4	0.046
	Interest in creating a garden[b]				
Number					
Students	984.2	771.1	1,192.9	834.7	0.067
Teachers	40.9	32.3	49.9	34.5	0.049
Staff	66.1	68.0	55.0	32.4	0.206
Groups	28.8	16.6	31.3	18.0	0.309
	Existence of plans to create a garden[b]				
Number					
Students	1,030.8	880.1	1,038.0	756.6	0.945
Teachers	40.8	30.7	44.0	33.9	0.478
Staff	61.4	37.1	64.2	68.8	0.742
Groups	28.9	16.5	29.6	17.1	0.780

Note: [a]Student's *t* test. [b]Schools with no garden at the time of the research.
M: Mean; SD: Standard Deviation.

Table 4. Multivariate logistical regression of the variables associated with the presence of a school garden. *Distrito Federal*, Brazil, 2008-2009.

Variables	Exp(β)[a]	CI (95%) for Exp(β)		*p*[b]	Influence
		Inferior	Superior		
Location: rural	2,350	1,082	5,104	0.031	Positive
Quantity of students (in units of 100)	0,940	0,922	0,959	<0.001	Negative

Note: [a]Exponential of β - expresses the interpretation of the odds ratio. [b]Calculated with base in the contribution given by the variable to the model.

When designing the gardens, 36.9% (n=38) of the schools received technical instructions and 26.6% were trained in how to maintain it. There was a greater probability of the school receiving technical instructions about the garden when its implementation was approved in order to create an educational area (*p*=0.01).

In total, 35.2% (n=37) of the schools possessed specific didactic material to maintain the garden, usually material from government institutes providing technical agricultural assistance (51.3%). Furthermore, 68.7% of the schools stated that they had their own resources to finance the garden. However, staff (26.3%) and the community itself (24.2%) were also mentioned as contributors. When the reason for the creation of the garden was to work with students, there was a greater chance that the garden was funded by the school itself (*p*=0.002).

The main benefits reported in relation to school gardens were their contribution to healthier eating habits in the school (74.3%), improved pedagogical aspects (25.7%) and environmental awareness and interaction (21.8%).

The most commonly cultivated crops were the following: condiment plants (96.1%); greens (94.1%); medicinal plants (78.4%), fruit plants (61.8%) and cereals, roots and tubers (35.3%). Most of the schools (86.3%) reported using the food grown in their gardens within the school. The greatest frequency of use reported was weekly (72.4% of these schools) and 74.6% stated that they complemented school food two or three times a week.

In total, 32.4% of the schools reported some type of change in the preparation of school food after the implementation of a school garden (*p*=0.015), highlighting the enrichment involved in the introduction of new types of food and an improvement in acceptance, smell and taste.

In 59.0% of schools with a garden, the respondents reported using it as an educational area to promote healthy eating habits on a weekly (38.7%) or daily (32.3%) basis. The main activities indicated were classes and dynamic activities about healthy eating habits (69.4%), cultivating a garden (35.5%), culinary preparations and trying the food that was cultivated (33.9%). According to all respondents, the teachers carried out these activities. When the teachers participated in planting and cultivating the garden, there was a greater tendency for them to be used as an educational area to promote healthy eating habits on a daily or weekly basis (*p*=0.042).

In total, 32.4% of the schools mentioned having an area set aside for culinary activities with food from the garden, including the canteen (32.4%), classrooms (29.4%) and the kitchen (26.5%). In addition, 75.0% of the schools used the garden while discussing certain subjects, such as: science (91.8%); mathematics (57.5%); Portuguese (54.8%) and geography (32.9%). When the use of the garden as an educational area to promote healthy eating habits was correlated with its further use in association with other subjects, there was a greater probability of the teachers using the space for mathematics (*p*=0.002) and Portuguese (*p*=0.003).

According to reports, management (33%) was the school community that was least involved

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in activities related to planting and cultivating the garden. Staff (80%), students (78%) and teachers (66%) were the most involved groups. The main positive aspects of student participation in planting and cultivating the garden were the following: environmental awareness and interaction (37%); healthier eating habits at school (33%); improved pedagogical aspects (24%) and human development (22%). When students participated in planting and cultivating the garden, a collaboration was found between this strategy and the teaching/learning process ($p<0.001$). For 82% of the respondents, the garden collaborated with the teaching/learning process (67%).

The main difficulties regarding the implementation and maintenance of the garden were a lack of funding (45.0% and 42.0%, respectively) and a lack of manpower (34.0% and 48.0%, respectively). Due to these obstacles, 31.0% of the schools (n=32) reported abandoning the garden at some stage. There was a greater chance of the garden being abandoned ($p=0.04$) when a lack of adequate maintenance conditions were mentioned as a difficulty. In addition, when the difficulty was not a lack of time to care for the garden, the probability of the school not abandoning it was higher ($p=0.04$). Despite the abovementioned difficulties, 30.7% of the gardens remain productive and in place for the last six years or more.

DISCUSSION

School gardens are seen as a possible method of promoting the healthy development of young people and integration with activities that stimulate healthy eating habits, as proposed by the initiative of *Escolas Promotoras de Saúde* (Health Promoting Schools)[11-14].

The use of school gardens is not a novelty in Brazil. The *Portaria Interministerial* (Interministerial Ordinance) nº 1.010/2006, which instituted directives to promote healthy eating habits in schools, defined the stimulation of gardens as one of its priorities[15]. Furthermore, since 2005, gardens are stimulated by the *Fundo Nacional de Desenvolvimento da Educação* (FNDE) of the *Ministério da Educacão* (MEC), in partnership with the United Nations Food and Agriculture Organization (FAO), using projects that aim to incorporate healthy eating habits and environmental sustainability as generators of pedagogical practices[14].

However, there are still relatively few institutions appropriating this strategy in Brazil and investigations of the use of this type of space with students are scarce, which is a limitation of the present study in terms of possible data comparisons.

It is believed that urban schools in particular, do not have adequate space to develop a garden[16]. The present study shows that there is a tendency for more rural schools to have a garden, perhaps due to the availability of space or the fact that agricultural practices are more common in these areas. In fact, it also shows the existence of socio-cultural conflicts in relation to agricultural practices in urban environments[17]. However, most schools, urban and rural, possess the pre-requisites[8,10] to cultivate a garden and in theory, could implement one. Most of the participants also stated that they were interested in this type of activity.

Contrary to the findings of the present study, a study in California found that more urban schools had gardens than rural schools: the gardens were built on the ground (69%) and in a hanging garden fashion (60%), which is contrary to the data referring to the availability of adequate space[18]. Many spaces can be used for this type of activity, including small free spaces and squares near the school or near walls and fences[16].

Schools with lower educational levels and fewer students were more likely to have a garden. Particularly in the case of smaller schools, almost a third of Australian schools that participated in a study by Somerset & Bossard[19] reported using the garden extensively as a teaching instrument, whereas larger schools used their gardens in a more limited manner.

Although not the main reason for creating a garden, the space has been used to promote food and nutritional education by 60.8% of schools in the DF. This finding is similar to that reported in an Australian study[7], which highlighted the possibility of practical learning, the development of skills and a new teaching instrument, the initial aim of which was simply to create a garden. The possibility of providing nutritional education came about as a result of these activities. This confirms that the conscious use of gardens to promote healthy eating habits seems to be secondary.

Somerset & Bossard[19] reported that the initial reasons for creating a garden did not mention health directly but referred to learning about fruit, vegetables and food production. The same authors qualified these objectives as intrinsic motivational factors, associated with long-term sustained behavioral changes. These factors could be associated with high levels of utilization and a more lasting interest in the activity, since the gardens in question had been in existence for a number of years and particularly considering the appearance of gardens in the absence of any governmental instruction.

The second reason mentioned for creating a garden in the DF was to work with students, without necessarily linking this work with the possibility of food and nutritional education. The present study does not enable a detailed understanding of the respondents in terms of this possibility of working with students. Nevertheless, this option mostly referred to the educator's concern for the learner. When this was the reason for creating a garden, there was a greater chance of the school financing the project themselves.

Complementing school food was a guiding justification for creating a garden in the DF and healthier school food is cited as the main benefit of creating a garden. Significant results were found in relation to the production of condiments and vegetables for this purpose.

Similar to *Portaria Interministerial* (Interministerial Ordinance) nº 1.010[15], government material related to the promotion of healthy eating habits and destined for education professionals[16] considers an improvement in the nutritional quality of school food as one of the main reasons for creating this strategy. Based on the reports detailing the frequency of use of vegetables produced in the garden to complement school meals, it is clear that the volume of production is not sufficient for daily needs, although this aspect was not assessed in the present study. However, the main reason for using a garden goes beyond the possible provision of vegetables for school meals. This strategy is included as a food and nutrition education activity in the *Programa Nacional de Alimentação Escolar* (PNAE, National School Feeding Program) to encourage the consumption and appreciation of fresh, local food with good nutritional value. The availability of these foods, in terms of the volume provided, has been established in law number 11.947/2009, which stimulates the acquisition of food from familiar agriculture[20], as well as seeking to answer the abovementioned questions.

In a number of Australian schools, the food produced in the school garden exceeds the needs of the school and is also used in households[7]. North American studies have also reported experiences of gardens complementing school food, although those interviewed stated that the garden had not been very effective in supporting the school feeding program[18,21]. Although the use of gardens to complement school feeding programs was highlighted in the present study, the efficiency of this activity was not assessed.

Managers and teachers recognize that gardens reinforce healthy eating habits, although they identify poor coordination between the food program, the garden and the feeding of students[21]. It is believed that improvements in communication between the food service team, teachers, administrators and others involved in the garden, could help to identify strategies that would make the garden more effective in supporting the school feeding program and more adequately promote healthy eating habits.

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In the *Distrito Federal*, there was significant use of mathematics and Portuguese when dealing with healthy eating habits, although other subjects were also cited. A study performed with school directors in California, USA[18] showed that most schools that had a garden used them for teaching (85%), particularly in relation to science (95%), environmental studies (70%) and nutrition (66%). This indicates that the gardens have been used to teach certain disciplines that are central to the standard curriculum in the USA[18].

Several pedagogical activities have been carried out using school gardens, providing students with opportunities to get to know and try different types of food *in natura*. Although this aspect was not assessed in the present study, other studies have shown that these activities tend to encourage a preference for the consumption of fruit and vegetables[22,23].

In the *Distrito Federal*, when the main reason for creating a school garden was to provide a space for food and nutritional education, the probability of the school seeking technical instruction was higher. Teacher training processes and activities developed in the classroom have the potential to stimulate healthy eating habits among schoolchildren[24,25]. Therefore, food and nutrition training programs must focus on the teacher in order to increase the possibility of successfully achieving the objectives of the garden project[26].

Difficulties were identified in relation to the sustainability of school gardens, particularly in terms of a lack of manpower and financial resources. These problems were also reported in the USA, in association with a lack of time on behalf of teachers and overburdened garden coordinators. These are the main challenges that need to be overcome in order to ensure the sustainability of school gardens[18,19].

The lack of manpower is a direct consequence of the lack of time available to the people responsible for looking after school gardens. The fact that teachers are the people most involved, in the care and maintenance of these areas, reinforces the importance of the time factor in terms of ensuring the sustainability of the garden, as well as the fact that it can be a barrier when reduced. Therefore, there is a need for strategies that constantly involve volunteers and community members in the cultivation and maintenance of school gardens in order to prevent schoolteachers from becoming overburdened[18].

According to teachers that participated in a study involving food and nutritional training, the lack of time to develop educational activities in the classroom is one of the main barriers that must be overcome. Most teachers believe that it is necessary to include a new subject in the school curriculum in order to accommodate this theme[26]. However, this is not the root of the issue. The appearance of the theme on a school curriculum confers legitimacy on food and nutritional education activities and reinforces the need for teachers to include this content[16]. Inter-disciplinary and transversal approaches, such as those standardized by the National Curricular Parameters, enable schools to work with several aspects of food and nutrition continuously, combined with the daily practices of students, and to overcome barriers between didactic disciplines. Thus, it is possible to develop the subject with the same relevance as other more conventional areas of the school curriculum[27].

From the point of view of a transversal and interdisciplinary dissemination of the themes of healthy eating and nutrition, it is necessary to train educators in this area. Traditional teacher training in Brazil does not include this dimension[27,28]. This training could even represent a strategy of positive reinforcement for the sustainability of the garden, since the knowledge of the educators is paramount to the effectiveness of the projects implemented in schools. Training and commitment on behalf of educators tend to generate development and growth in the school community, thereby enriching the cognitive performance and participation of the learners from the social point of view of community members[25]. In addition, teachers agree that there is a need for further exploration of curricular resources related to the garden and its connection with traditional areas of the school curriculum[21].

CONCLUSION

In the *Distrito Federal*, an expressive percentage of the existence of school gardens was recorded, in line with the growing national movement encouraging this strategy.

The use of a garden as an instrument to promote healthy eating habits was most notable when the aim of the project was to complement school food. This possibility was highlighted as an initial objective of creating a garden and a strategy to promote healthy eating habits from the point of view of incentives, experimentation, consumption and value awarded to food produced in the school.

The results of the present study are indicative of the potential of gardens as an instrument to promote healthy eating habits since it deals with spaces that have entertaining features that can be applied in a transversal and multidisciplinary manner. However, the effectiveness of these actions was not assessed in the present study, since this was an initial investigative study. Further research focused on the use and impact of gardens as instruments to promote healthy eating habits among the school community is essential.

The involvement of this community, especially the teacher, is an essential component in ensuring the sustainability of the life cycle of the garden and its integration as a teaching resource. In addition, an understanding of certain characteristics of the present study, such as the location and size of schools and the different levels of education in schools, is important in the planning of strategies to extend and maintain existing gardens.

CONTRIBUTORS

All authors contributed to the conception and development of the study, data analysis, wording and revision of the final version.

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Iron intake and its association with iron-deficiency anemia in agricultural workers' families from the *Zona da Mata* of *Pernambuco*, Brazil[1]

Consumo de ferro e sua associação com a anemia ferropriva nas famílias de trabalhadores rurais da Zona da Mata de Pernambuco, Brasil

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ABSTRACT

Objective

To verify the association between dietary iron intake and the occurrence of iron-deficiency anemia in agricultural workers' families from the municipality of *Gameleira* in the state of *Pernambuco*, Brazil.

Methods

The study population consisted of 46 harvesters' families, consisting of 225 individuals. The food intake of each individual was recorded on three different days by directly weighing the foods consumed. Hemoglobin was determined by fingerstick (HemoCue). This research used the probability of adequacy method to assess iron intake and the paired *t* test for comparing groups. The Spearman Mann-Whitney test estimated associations between the dietary variables and anemia.

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Results

The prevalence of anemia was high in all ages groups and highest (67.6%) in children aged <5 years with a mean hemoglobin of 10.37 g/dL (±1.30 g/dL). Children aged <5 years had low percentage of iron intake adequacy (53.1%). Most of them consumed diets with low iron bioavailability (47.5%). Associations between the occurrence of anemia and dietary variables were significant for total iron (heme and nonheme), its bioavailabilities, and general meat intake.

Conclusion

Inadequate dietary iron intake and inadequate intake of factors that facilitate iron absorption can be considered decisive for the occurrence of iron-deficiency anemia. Food insecurity occurs between family members, with some members being favored over others with regard to the intake of good dietary iron sources.

Indexing terms: Iron deficiency anemia. Family. Food consumption. Iron deficiency. Iron dietary.

RESUMO

Objetivo

Verificar a associação entre o consumo de ferro dietético e a ocorrência da anemia ferropriva em famílias de trabalhadores rurais do município de Gameleira, Pernambuco.

Métodos

A população foi composta por 46 famílias de trabalhadores de cana-de-açúcar, totalizando 225 indivíduos. Para cada indivíduo, foram realizados três inquéritos alimentares pelo método de registro alimentar por pesagem direta dos alimentos e dosagem de hemoglobina por meio do equipamento Hemocue. Utilizou-se o método da adequação aparente para avaliar a ingestão de ferro, e o teste t pareado na comparação entre grupos de indivíduos. Para estimar associações entre variáveis dietéticas e anemia, foi utilizado o teste de Mann-Whitney.

Resultados

A prevalência de anemia foi elevada em todas as faixas etárias, sendo maior (67,6%) no grupo de crianças com menos de 5 anos de idade, com média de hemoglobina de 10,37 g/dL (±1,30 g/dL). Na análise da adequação aparente, as crianças menores de 5 anos apresentaram baixo percentual de adequação (53,1%). A maioria delas apresentou um percentual elevado de dieta com baixa biodisponibilidade de ferro (47,5%). As associações entre a ocorrência de anemia e as variáveis dietéticas mostraram-se estatisticamente significantes para ferro total (heme e não heme), suas biodisponibilidades e consumo de carnes em geral.

Conclusão

A inadequação do consumo de ferro dietético e dos fatores facilitadores da sua absorção pode ser considerada determinante para a ocorrência da anemia ferropriva. As famílias vivenciam insegurança alimentar intrafamiliar, com discriminação do consumo de alimentos fontes de ferro entre seus membros.

Termos de indexação: *Anemia ferropriva. Família. Consumo de alimentos. Deficiência de ferro. Ferro na dieta.*

INTRODUCTION

Iron-deficiency anemia is one of the most prevalent nutritional deficiencies that translates as an important indicator of malnutrition and poor health, affecting one out of every four individuals, that is, 24.8% of the world population. Although the most affected groups are children, women of childbearing age, and low-income families, all individuals regardless of social stratum are susceptible to this deficiency[1,2].

Food and nutrition security regards ensuring and facilitating food access to the population and making sure that individuals have healthy food habits[3] in order to promote health and general wellbeing. Thus, planned strategies are needed in the regions with the greatest social and economic inequalities because their inhabitants are even more prone to nutrition disorders.

In this context, special attention should be given to populations that may be at high risk of nutritional deficiencies, such as the agricultural

workers' families from the municipality of *Gameleira* in *Pernambuco*, one of the municipalities with the lowest Human Development Index (HDI) in the Brazilian Northeast. These families live in marginalized areas and are usually paid low production-based salaries for harvesting sugarcane[4]. Hence, the general situation of this population gets worse off season, when they face financial instability and higher food and nutrition insecurity.

A successful fight against nutritional deficiencies is closely related to the ability to intervene on its determinants[5]. In the understanding of iron-deficiency anemia as a nutritional deficiency of multifactorial etiology, it is important to consider dietary factors as one of its main determinants. Roughly 90% of anemia cases involve iron deficiency: either the iron intake is low, or its bioavailability is low[1]. However, the number of population-based studies on iron-deficiency anemia that investigate inadequate iron intake as the determinant of anemia during different life phases is still small.

In this sense, it is important to verify the association between dietary iron intake and the presence of anemia in families of sugarcane harvesters to determine the severity of the problem and the life phases where the nutritional risk is greatest, and to provide information for the creation and implementation of effective food and nutrition security strategies.

METHODS

This is an observational, analytical, cross-sectional study of a limited population of neighboring residents of cane sugar mills. The sample consists of 46 families of sugarcane harvesters from the rural area of the municipality of *Gameleira*, in the State of *Pernambuco* in the Brazilian Northeast. These families represent a population composed of 225 individuals where 40 are less than 5 years of age; 50 are 5 to 11 years of age; 15 are 12 to 14 years of age; 50 are females aged ≥15 years; 5 are pregnant women aged ≥15 years; and 65 are males aged ≥15 years.

The study lasted from February to April 2007, a period between sugarcane harvests. Data were collected by a team of dieticians consisting of six researchers and a field supervisor previously trained by the Department of Nutrition of the *Universidade Federal de Pernambuco* (UFPE).

Individual food intake was determined by directly weighing the foods consumed by an individual during the day for three nonconsecutive days, including a weekend day. For this purpose, a researcher would stay at an individual's home during the entire day, weighing or measuring and recording the solid and liquid foods consumed.

The solid foods consumed by each family member during each meal were weighed in all homes. Each food/preparation was weighed individually before being consumed using the utensils in which the foods were served and zeroing the scale before the addition of each food. A portable electronic scale with a capacity of 5 kg and accuracy of 1 g was used for weighing the solid foods. The liquid foods were measured by 100 mL and 500 mL graduated cylinders with 1 mL and 10 mL increments, respectively. The foods not consumed by each individual were weighed/measured and subtracted from the initial weight.

The food weights were entered into and analyzed by the software DietPro 5.1i Profissional (*Agromídia* Software, *Minas Gerais*, Brazil). This software analyzes macro- and micronutrients. The breast milk consumed by some children was determined by the software Virtual Nutri (Department of Nutrition, School of Public Health, *Universidade de São Paulo, São Paulo*, Brazil), according to breastfeeding frequency and volume according to the child's age.

Dietary iron intake was assessed according to the food intake of each family member, quantifying total iron, heme iron, and nonheme iron consumed daily separately. Then the mean intake was calculated from the three study days. Heme iron was given by foods of animal origin

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(meats in general, including organ meats) and nonheme iron by foods of plant origin (grains, legumes, and vegetables). For the foods of plant origin, 100% of the iron was considered nonheme; for those of animal origin, 60% of the iron was considered nonheme[6].

The method used for assessing individual dietary iron bioavailability was developed by Monsen & Balintfy[6] and Monsen *et al.*[7], who consider the general meat and ascorbic acid intakes and characterize dietary iron as of low, medium, or high bioavailability. Vitolo & Borlolini[8] presented the data for this method considering cooked meat amounts, a method repeated by the present study. Diets having low iron bioavailability were those with less than 23 g of meat and less than 75 mg of vitamin C; diets with medium iron bioavailability were those with 23 g to 70 g of meat and less than 25 mg of vitamin C; diets with high iron bioavailability were those with more than 70 g of meat and more than 25 mg of vitamin C.

The algorithm of Monsen & Balintfly[6] algorithm was used for calculating the percentage of nonheme iron bioavailable in the diet. This algorithm considers Stimulating Factors (SF) for iron absorption, specifically meats and vitamin C present in meals. One SF=1 mg of ascorbic acid or 1 g of cooked meat.

The absorption of dietary nonheme iron may vary from 3% (no SF) to 8% (SF≥75) and when the SF sum <75, the percentage of absorption corresponds to 3+8.93 log ((SF+100)/100). Twenty-three percent of the heme iron was estimated to be bioavailable, given that it is not affected by other dietary nutrients. In the present study, the absorption percentage of the heme and nonheme iron of each daily food record was calculated for the complete diet. The study also used as reference an individual iron reserve of 500 mg since the iron reserves of the study individuals are unknown[6].

Hemoglobin level was determined on the first home visit by fingerstick, read by the device Hemocue (HemoCue Inc., Laguna Hills, United States of America). The cut-off points for iron-deficiency anemia used were those provided by the World Health Organization (WHO) according to gender and age[1] as follows: Hb<11 g/dL for children aged 6 to 59 months and pregnant women; Hb<11.5 g/dL for children aged 5 to 11 years; Hb<12 g/dL for adolescents aged 12 to 14 years and women aged ≥15 years; and Hb<13 g/dL for men aged ≥15 years.

The database was constructed in the software Epi Info version 6.04 (Centers for Disease Control and Prevention-CDC, Atlanta, United States of America) and Statistical Package for the Social Sciences (SPSS) version 13.0, which also performed the statistical analyses. The significance level α for all tests was set at 5%.

The Mann-Whitney test investigated possible associations between the dependent variable iron-deficiency anemia and the independent variables total iron, including its subtypes and bioavailability, vitamin C, and meats in the diets of all individuals. The Mann-Whitney test was used because the sample data was asymmetrically distributed.

Intakes of iron and its subgroups (mg) were first checked by adjusting the normal distribution curve of these nutrients for each age group using the nonparametric Kolmogorov-Smirnov test. The study used the mean total iron intake, mean heme iron intake, and mean nonheme iron intake given that the distribution of this mineral was symmetric in all life phases.

The apparent adequacy method assessed whether the iron intakes met the individuals' requirements: the intakes were analyzed according to life phase and some life phases were represented by fewer than 30 individuals[9]. This is a statistical approach that compares the difference between habitual intake and Estimated Average Requirement (EAR), and considers the varying requirements and intrapersonal daily variation. The method refers to a Z-score that indicates the probability of dietary adequacy.

The requirement variability was estimated by considering a Variation Coefficient (VC) of 10% for the nutrient iron. Intrapersonal variation was

given by food intake studies of American populations[9], since Brazilian studies do not include this information.

For children aged one to three years, the present study used the intrapersonal variation for children aged four to eight years, since the required datum for children under four years of age was not available in the literature. Breastfed children under one year of age were excluded from the food intake analysis because there is not intrapersonal variation for the apparent adequacy method and because this age group has very specific nutritional requirements.

The Z-score area was given by the normal distribution table, which indicated the probability of adequate iron intake. The reliability level was set at $p \geq 0.70$.

The Z-scores verified the difference between the apparent adequacy of dietary iron intake of each age group. Two groups were compared at a time: men ≥15 years x women ≥15 years; men ≥15 years x children <5 years; men ≥15 years x children/adolescents 5-14 years; women ≥15 years x children <5 years; women ≥15 years x children/adolescents 5-14 years; children <5 years x children/adolescents 5-14 years. Children and adolescents were analyzed together because the number of adolescents was not enough for the said analysis in the study families.

In families with more than one individual per group, the mean Z-score was used. Given the heterogeneous composition of the families, some families were excluded from some analyses because they did not have individuals from one of the paired groups.

The Z-score differences between the groups in each family were calculated. Considering a two-tailed distribution, the paired Student's *t* test compared the Z-scores of the groups of all families to investigate whether significant differences occurred.

The present study was approved by the Research Ethics Committee of UFPE under Protocol (*Certificado de Apresentação para Apreciação Ética* - CAAE) number 1460.0.172.000-05 and met the regulations for human research given by Resolution nº 196/96 from the National Health Council. Individuals diagnosed as anemic received ferrous sulfate supplements for six months and were advised to visit a health care facility.

RESULTS

The groups most affected by iron-deficiency anemia were children aged <5 years and pregnant women, with rates of 67.6% (95% Confidence Interval - 95%CI=51.6-83.6) and 60% (95%CI=9.6-110.3), respectively. On the other hand, men aged ≥15 years are the least affected, with a rate of 20.3% (95%CI=13.0-27.6). Additionally, the pregnant women had the lowest percentage (20.0%) of apparent iron intake adequacy, followed by children aged <5 years (53.1%). Men aged ≥15 years presented adequate iron intake and the highest mean iron intake (21.66±7.87 mg) (Table 1).

The data in Table 2 shows that anemia was inversely associated with total iron, iron subtypes (heme and nonheme iron), its bioavailabilities, and meat intake. Despite the significant association between anemia and vitamin C, the association was directly proportional to vitamin C intake.

The apparent iron intakes of the study groups differed significantly for most paired groups, except for women aged ≥15 years and children/adolescents aged 5 to 14 years (p=0.86). Men aged ≥15 years consumed significantly more iron than the other groups, and the difference was even greater when they were compared with the iron intake of children aged <5 years (t=7.24; p<0.001). Generally, the apparent iron intakes of the children aged <5 years is always worse than the apparent iron intakes of all other groups (Table 3).

Figure 1 shows that most of the total iron consumed by all groups is nonheme. The mean nonheme iron intake of children aged <5 years is 23 times their mean heme iron intake, the greatest

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Table 1. Anemia rate, mean hemoglobin, mean iron intake, and apparent adequacy of iron intake of sugarcane harvesters' families by age group. *Gameleira* (PE), Brazil, 2007.

Age group	N	Anemia		Hb (g/dL)		Iron (mg)		Apparent adequacy (%)
		%	95%CI	M	SD	M	SD	
<5 years	40	67.6	(51.6-83.6)	10.37	1.30	5.03	3.78	53.1[b]
5 a 11 years	50	44.0	(39.5-48.5)	11.57	1.37	9.40	3.19	82.0
12 a 14 years	15	53.3	(30.4-76.2)	11.95	1.10	12.39	3.84	86.7
≥15 years (women)	50	38.8	(33.2-44.4)	12.28	1.18	14.57	5.65	84.0
≥15years (pregnant[a])	05	60.0	(9.6-110.3)	11.26	1.19	16.55	10.78	20.0
≥15 years (men)	65	20.3	(13.0-27.6)	13.98	1.24	21.66	7.87	100.0

Note: [a]All pregnant women were aged 15 years or more; [b]The apparent adequacy was not calculated for children under 12 months of age. 95%CI: 95% Confidence Interval; M: Mean; SD: Standard Deviation.

Table 2. Distribution of dietary heme iron, nonheme iron, total iron, respective bioavailabilities, vitamin C, and meats according to anemia in sugarcane harvesters' families. *Gameleira* (PE), Brazil, 2007.

Variables	Anemia		*p*
	Yes	No	
Heme iron	0.68 (0.35-1.22)	1.00 (0.58-1.39)	0.009
Nonheme iron	9.97 (6.59-13.54)	12.93 (8.80-17.91)	0.001
Total iron	10.95 (7.34-14.97)	14.04 (9.35-19.55)	0.001
Heme iron bioavailability	0.16 (0.08-0.28)	0.23 (0.13-0.32)	0.009
Nonheme iron bioavailability	0.78 (0.51-1.08)	1.03 (0.69-1.43)	0.001
Vitamin C	107.16 (43.86-203.69)	64.59(27.80-132.13)	0.015
Meats	87.83 (42.68-162.04)	119.0 (69.75-189.33)	0.009

Note: Dietary variables expressed as medians and 25 and 75 percentiles; *p* according to the Mann-Whitney test.

Table 3. Difference between the apparent iron intakes of members of different age groups of sugarcane harvesters' families. *Gameleira* (PE), Brazil, 2007.

Age group	Z_1	Z_2	$(Z_1-Z_2) \pm SD$	*t* test	*p* value
Men (≥15 years)[1]	3.15	1.55	1.60 ± 1.72	6.32	<0.001
Women (≥15 years)[2]					
Men (≥15 years)[1]	3.17	0.77	2.40 ± 1.72	7.24	<0.001
Children (<5 years)[2]					
Men (≥15 years)[1]	3.11	1.29	1.82 ± 1.65	6.33	<0.001
Children/Adolescents (5-14 years)[2]					
Women (≥15 years)[1]	1.86	0.77	1.09 ± 1.81	3.13	0.02112
Children (<5 years)[2]					
Women (≥15 years)[1]	1.35	1.30	0.05 ± 1.65	0.19	0.86254
Children/Adolescents (5-14 years)[2]					
Children (<5 years)[1]	0.83	1.58	-0.75 ± 0.83	-3.70	0.00201
Children/Adolescents (5-14 years)[2]					

Note: [1]Group one Z_1; [2]Group two Z_2.
Z: Mean apparent iron intake; SD: Standard Deviation.

intake difference of all study groups. The mean heme, nonheme, and total iron intakes increase gradually with age, peaking in men aged ≥15 years.

Most children aged <5 years (47.5%) consume diets with low iron bioavailability, and only 2.5% of these children consume diets with high iron bioavailability. Meanwhile, only a few

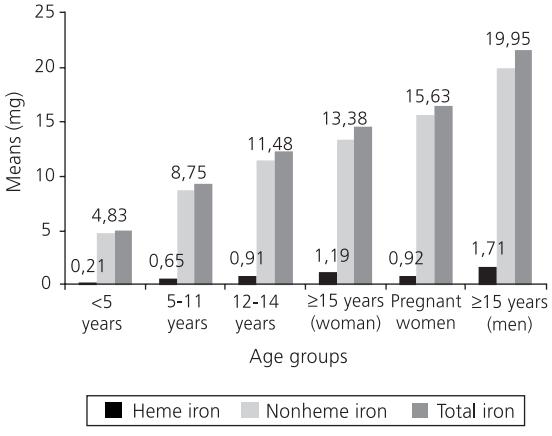

Figure 1. Mean dietary heme iron, nonheme iron, and total iron intakes of sugarcane harvesters' families by age group. *Gameleira* (PE), Brazil, 2007.

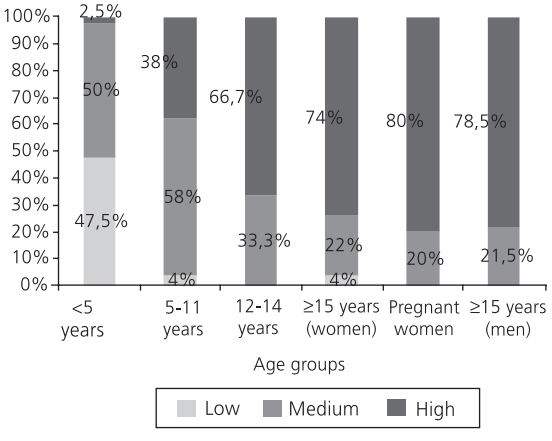

Figure 2. Iron bioavailability in the diets of sugarcane harvesters' families. *Gameleira* (PE), Brazil, 2007.

(4.0%) children aged 5 to 11 years and women aged ≥15 years consume diets with low iron bioavailability, and 38.0% of the said children consume diets with high iron bioavailability. None of the adolescents aged 12 to 14 years, pregnant women, and men aged ≥15 years consume diets with low iron bioavailability (Figure 2).

DISCUSSION

The present study found high prevalences of anemia in members of sugarcane harvesters' families of all age groups from the municipality of *Gameleira* (PE), indicating a moderate public health problem in women (38.8%) and men (20.3%). However, the situation is severe in preschool children (aged <5 years), schoolchildren (aged 5 to 14 years), and pregnant women, with rates of 67.6%, 46.2%, and 60%, respectively. These rates are much higher than the mean global rates: 30.2% in women; 12.7% in men; 47.4% in preschool children; 25.4% in schoolchildren; and 41.8% in pregnant women[1].

As the rates of iron-deficiency anemia found by the present study show, children aged <5 years are the most susceptible age group, with a rate similar to that found in Africa[1] and higher than those found by other Brazilian studies for children of the same age group[10-12].

The prevalence of anemia in children is relatively well studied. The Brazilian literature contains three systematic reviews on the prevalence of anemia and its determinants[13-15]. Fifty-three percent of the children aged <5 years are anemic[13]. However, Vieira & Ferreira[15] point out different mean prevalences of anemia in children according to some epidemiologic landscapes: population-based studies (40.1%), schools or daycare centers (52.0%), health services (60.2%), and socioeconomically vulnerable populations (63.5%). These authors also emphasize that in socioeconomically vulnerable populations, which include indigenous communities, rural settlements, slums, and *Pastoral da Criança* (Children's Pastoral) users, anemia is concerning because the children in these populations are almost three times more likely to be anemic than those in the general population. Children of sugarcane harvesters' families from *Gameleira* (PE) present a rate of anemia similar to those found in those vulnerable populations, hence evidencing a socioeconomic context of vulnerability to this condition.

The rate of anemia in women (38.8%) found by the present study was higher than that for women of childbearing age of the state of *Pernambuco* (16.4%)[16] and of Brazil (29.4%), according to the *Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher* (PNDS, National

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Child and Woman Demographic and Health Survey)[12]. However, the PNDS of the Brazilian Northeast region found a prevalence of anemia in women of 39.1%, similar to that of the present study.

Studies of anemia in pregnant women have found great variations in the prevalences of anemia that stem mainly from different socioeconomic contexts, gestational week, and age[17-19]. Since the number of pregnant women in the study sample is small, it is not possible to make comparisons.

There is literature consensus that children aged <5 years and pregnant women are the most vulnerable groups to nutritional deficiencies, especially iron-deficiency anemia, because of their higher energy and nutritional requirements[1]. In infants, there is also the influence of the exhaustion of the iron reserves between the fourth and sixth months of life, usually accompanied by early weaning and incorrect supplementary feeding[5,9]. Therefore, special attention should be given to the diet of these groups, and proper food intake should be encouraged by other family members, but what has been found by the present study is that these groups have the worst apparent iron intake adequacy and in the case of children, a high exposure to diets with low iron bioavailability.

There are only a few studies on the prevalence of anemia in other population groups[20-22]. Studies of anemia in children and adolescents aged 6 to 18 years enrolled in public schools found prevalences of 3.6% in 2005 in *Recife* (PE) to 39.3% in 2008 in *Maringá* (PR)[21, 22]. A study done in *Pelotas* (RS) found a prevalence of anemia in adults of 20.6%[20].

Serum hemoglobin is the most sensitive and widely used indicator of iron-deficiency anemia in a population. Its determination is inexpensive and the estimates are appropriate. The means found for the study sample are higher than the cut-off points provided by the WHO[1], except for children aged <5 years and adolescents aged 12 to 14 years whose means are closer to the respective cut-off points. Mild anemia is the most prevalent in all age groups (results not shown). However, this fact cannot be underestimated since the presence of iron-deficiency anemia is a late stage of severe iron deficiency, leading to functional impairments[7].

Iron is found in foods in the form of heme and nonheme, and both have specific absorption percentages. The absorption of nonheme iron depends on intrinsic dietary factors, such as ascorbic acid and meats in general[6,23,24].

Vitamin C keeps iron in the ferrous state and forms a more soluble compound, the chelate iron ascorbate[23]. In meats, some amino acids such as cysteine, histidine, and lysine, and some peptides affect iron absorption because these free amino acids in the intestine form soluble chelates with nonheme iron, increasing its bioavailability[24]. However, vitamin C only promotes iron absorption when consumed together with dietary iron sources[2,9].

Therefore, the intake of meats and vitamin C is very important for this population since most of the iron it consumes is nonheme, present in foods of plant origin such as legumes, tubers, and grains. Beans, a food item considered part of a healthy diet, was the main dietary source of nonheme iron for all study age groups (results not shown). The *Pesquisa de Orçamentos Familiares* (POF, Household Budget Survey) of 2008/2009[25] found that adults with lower income have a high intake of beans and the intake is even higher in rural areas. However, bean intake has been decreasing in Brazil.

The low intake of foods high in heme iron may be explained by the poor diet of this population, where meats are consumed habitually by less than 70% of the study population and by less than 40% of the study children aged <5 years (results not shown). These foods high in heme iron are the ones that increase food expenses the most[25]. Hence, the high local prices of these items compared with other food items impair access to them and their acquisition, resulting in inadequate intake. Heme iron intake is important for the

prevention of iron-deficiency anemia because it is well absorbed by the body (15% to 35%) and nearly not affected by other food constituents[6]. Additionally, children aged <5 years are less likely to consume a diet with high iron bioavailability because they consume fewer foods with high iron content than other family members.

The importance of consuming foods high in iron for the occurrence of anemia in the study population was also evidenced by the direct moderate correlation between the hemoglobin level and dietary iron intake, including its bioavailability (results not shown). Such associations are corroborated by Ai-Assaf[26] and Rodríguez *et al.*[27], reinforcing the proposition that inadequate iron intake and low bioavailability are the main determinants of anemia and confirming the validity of food surveys for detecting individuals at risk of anemia.

Although families have access to the same dietary sources of iron, the distribution of these foods within the family is unequal since the different iron requirement of each family member is not met, especially the requirements of women and children. This fact is evident when we compare the apparent iron intake of different age groups, noting a significant difference regarding the adequacy of men's intake as opposed to the adequacy of women's, children's, and adolescents' intakes. Women and schoolchildren have similarly inadequate intakes. Between preschool children and schoolchildren, the former are less likely to meet their iron requirement. Therefore, in addition to the physiological factors that place children and women at risk of anemia, there are still issues of food distribution within the family that prevent meeting the nutritional requirements of some groups.

Romanelli[28] states that men are favored in this issue because women tend to leave the best part of the food preparations to their spouses when they take their meals to work. Moreover, discrimination within the family favoring men is also possibly due to the fact that they are the main providers[29]. Sudo *et al.*[30] and Andrieu & Caillavet[31] also claim that adult males and male partners are favored in their iron intake requirements in detriment of other family members.

One of the limitations of this study is the small number of families, which resulted in a small number of individuals of certain groups. This was solved by combining some groups (children aged 5 to 11 years and adolescents aged 12 to 14 years) when analyzing the differences between their Z-scores. Another limitation regards not determining individual iron reserves, such as ferritin, to better estimate iron absorption. Iron absorption inhibitors present in foods of plant origin were also not considered.

It is important to point out that in the northeastern *Zona da Mata* where the municipality of *Gameleira* (PE) is located, the dominant presence of sugarcane monoculture opens a small and temporary space for subsistence agriculture in marginal areas not appropriate for sugarcane. Hence, given the economic structure of inadequate dynamism and small product diversity, salaried sugarcane harvesters' families living in this region have little access to food diversity, contributing even more to their nutrition disorders. This situation aggravates between sugarcane harvests, when family income decreases dramatically and these families survive, in most cases, with benefits provided by welfare programs and loans from relatives, friends, and retired family members[4].

In summary, given the high prevalence of anemia and the inadequate intake of high-iron foods among sugarcane harvesters' families from the Brazilian Northeast, especially among children and women, there is an immediate need of adding nutritional surveillance to the permanent dietary, nutritional, and health care provided to this population in order to control and monitor this nutritional deficiency and implement effective food and nutrition security strategies.

CONTRIBUTORS

DS CAVALCANTI and MM OSÓRIO helped to conceive the study, analyze and interpret the data, write

and review the manuscript. PN VASCONCELOS helped to write and review the manuscript. VM MUNIZ and NF SANTOS helped to analyze the data, write and review the manuscript.

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Nutritional adequacy of meals offered and consumed by soldiers of the Brazilian Army

Adequação nutricional de oferta e consumo de refeições por soldados brasileiros

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ABSTRACT

Objective

The purpose of this research is to evaluate the nutritional adequacy of meals served and consumed by soldiers in a construction unit (army and civil employees) of the Brazilian Army Construction.

Methods

Body mass index, fat percentage (bioimpedance) and the physical activity level were evaluated. Furthermore, the nutritional evaluation of meals offered and consumed by soldiers was evaluated, in relation to the macronutrients, sodium, fibers and total energetic value.

Results

Through the results, we verified that 76% of the soldiers were eutrophic, and that the population's energetic requirement was approximately 3.600 kcal. We verified that the energetic consumption of this population was below the required value (3.200 kcal) and with inadequacy regarding the distribution of macronutrients: percentage of carbohydrates above the recommended one, percentage of lipid below the minimum value recommended and percentage of proteins within the recommendation. Moreover, the amount of fibers was in accordance to the standards; however, there was an excessive amount of sodium, which may put this population in danger.

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Conclusion

We concluded that it is necessary to improve the quality of the meals offered in relation to the nutritional aspect, by promoting the adequacy to the soldiers' needs. Other types of quality were not studied, but they are important when evaluating acceptability of meals.

Indexing terms: Food composition. Food consumption. Military personnel. Nutrition assessment.

RESUMO

Objetivo

O objetivo do presente trabalho foi avaliar a adequação nutricional de refeições oferecidas e consumidas por soldados do Exército Brasileiro em uma unidade de construção.

Métodos

Para avaliar a demanda energética e de nutrientes para o grupo estudado, foram avaliados o índice de massa corporal, o percentual de gordura (bioimpedância) e o nível de atividade física. Ademais, avaliaram-se nutricionalmente (macronutrientes, sódio, fibras e valor energético total) as refeições ofertadas aos soldados e por eles consumidas.

Resultados

Verificou-se por meio dos resultados que 76% dos soldados estavam eutróficos e que a demanda energética média da população estudada foi de 3600 kcal, porém o consumo energético (3200 kcal) estava abaixo do valor necessário e com inadequação em relação à distribuição de macronutrientes: percentual de carboidratos acima do recomendado; percentual de lipídios abaixo do recomendado. O percentual de proteínas estava de acordo com a recomendação. Verificou-se, também, que havia consumo adequado em relação à quantidade de fibras, porém com excesso de sódio, o que pode representar um risco à população estudada.

Conclusão

É necessário melhorar a qualidade das refeições ofertadas em relação ao aspecto nutricional a fim de se promover adequação às necessidades dos soldados. Outros tipos de qualidade - sensorial, higiênico-sanitária, regulamentar, entre outras -, não foram avaliados, mas são importantes para se verificar a aceitabilidade das refeições.

Termos de indexação: *Composição de alimentos. Consumo de alimentos. Militares. Avaliação nutricional.*

INTRODUCTION

In the Armed Forces, the military has to obey a series of disciplinary norms and hierarchical principles that they will follow for their entire professional life. In this process, the soldier represents the lowest patent. Usually, in course of his work the demand of energy expenditure is very high, for example during trainings for war, jobs in defense of the native country in its boundaries, engineering missions and construction[1].

For soldiers, the nutritional adequacy of meals is one of the most important conditions for physical and mental support, mainly in the sustenance of the exhausting work that is required throughout the day. Balanced food intake must provide daily energy and nutrients required for the optimal body functioning[2,3] and is related to various factors from preparation of food until intake. Among the factors related to intake are cultural and religious habits, social status, familiar memory and guarantee of survival[4], factors directly related to nutritional and food security. This type of security predicts regular access to food in quality and quantity without compromising access to other essential needs. It is based on food practices that promote health, respecting cultural diversity, and on a sustainable environment[3].

Proper nutritional meals are important for soldiers in order to increase or maintain their performance at work[5], requiring specific caloric and nutrient contributions that may vary by

gender, age and body composition[6]. There is a disparity between nutrients routinely consumed by the public and the recommended dietary intake for good health. This gap also exists in the intakes of military personnel[7]. In many military missions that require great physical effort, such as training for war, works at borders, and missions, the demand for nutrients and energy is increased and all these factors are not always observed in the meals destined for this population.

When the dietary intake is not enough in order to fulfill the nutritional demand, loss of lean body mass may occur, resulting in the decrease of strength, which itself may promote the development of diseases arising from the deficiency of nutrients[8].

The knowledge concerning the energy requirements and nutritional demand is important in order to determine the nutritional composition of meals offered to soldiers to maintain health and prevent diseases, whilst ensuring the quality of their work[9].

Therefore, the purpose of this research is to evaluate the nutritional adequacy of meals served and consumed by soldiers in a construction unit (army and civil employees) of the Brazilian Army.

METHODS

This is an exploratory study, which is also transversal and subdivided in five steps: determination of the physical composition of soldiers; evaluation of energy expenditure of soldiers; evaluation of adequacy of nutrients offered; evaluation of adequacy of nutrients consumption and statistical analysis of data. This research was approved by the Committee of Ethics in Research Involving Human Beings of the *Universidade de Brasília* (UnB) (Record 0183.0.012.000-08).

The study population was composed of masculine soldiers, since women are not incorporated in this patent for the Brazilian Army[1]. The sample of the soldiers that took part in this study was calculated based on soldiers' population that had their meals at their work stations - a construction unit (army and civil employees) of the Brazilian Army located in the Brazilian Northeast, a place far from the commerce and housing zones. In this place, there is a meal production unit that serves five daily meals for military: breakfast, morning snack, lunch, dinner and late evening snack.

For the calculation of the sampling plan, a statistical study of simple random sampling was carried out based on the soldiers' population (n=396) at a significance level of (α) 5%[10]. The size of the sample was 92 individuals.

Determination of the physical composition

In order to determine and evaluate the physical composition, the following data was used: weight, height, date of birth and percentage of body fat.

For the diagnosis of the nutritional state of this population, the calculation of Body Mass Index (BMI) was used, and its classification according to the criteria adopted by the World Health Organization (WHO)[11]. The measurement of the body fat percentage was done, since this is a population with intense physical activity (average daily physical activity of 12 hours) as well as for the fact that the BMI is an index that does not differ between muscular mass (lean mass), adipose tissue and bone mass. The used method was bioimpedance; a non-invasive method that evaluates the body composition based on natural conduction of low intensity electrical current. The result expressed in resistance and reactance is transformed in to adipose tissue percentage through specific equations[12].

In order to measure the weight and height, the protocol of Jeliffe's[13] was used, through a Tech Line® scales with 150 kg capacity with accuracy of 100 g and a Tech Line® stature meter, with accuracy of half a centimeter.

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In order to obtain tetra-pole electrical Bioimpedance Analysis (BIA), TBW® equipment and measurement procedures were used as per Rossi's & Tirapegui's protocol[12]. The evaluation was carried out before the beginning of the daily work activities. The soldiers were oriented to be eight hour fasting and not to consume any alcoholic beverage in the previous night.

Evaluation of the energy expenditure

The Physical Activity Level (PAL) was evaluated in accordance with the WHO protocol[12]. The analysis of the physical activity level of the population according to the duration of the daily activities is important as to enable estimation of the total energy expenditure, taking into account the age, gender and body weight of the individuals.

The participants were inquired as for the duration of their daily activities (beyond the physical activities), such as sleep hours, working hours, leisure time, commuting, (kind of activity and duration)[14]. PAL was determined by the duration of the performed daily activities reported by the sample, in order to determine the energetic expenditure. For the remaining time with routine activities that were not reported, a factor of 1.4 was used in accordance with the FAO/WHO table[14]; multiplying it by Basal Metabolic Rate (BMR) and by the number of hours of that period. The sum of the partial activities was divided by 24 hours in order to obtain the PAL per day. The estimated value of PAL was used for each individual in a multiple regression model[15]. This obtained data was used for determining the individual's energy requirements[15] through calculation of the Estimated Energy Requirement (EER). In order to calculate EER for men, the following formula was used: EER=662 - 9.53xage (years)+PALx(15.91xweight [kg]+539.6xheight [m]).

Evaluation of the adequacy of the offer and of the nutrients consumption

In order to determine the supply of nutrients, the Technical Preparation Files (TPF) were initially developed for each component of the offered meals (breakfast, morning snack, lunch, dinner and late evening snack) during three consecutive days according to the model proposed by Camargo & Botelho[16]. Therefore, all steps of pre-preparation and preparation were monitored by checking the preparation techniques and ingredients used for each preparation, which enables to determine the amount of each ingredient used, for later calculation of the nutritional composition of the preparation.

The evaluated meals were made in the Army unit by employees of the foodservice. However, the distribution manner is differentiated: breakfast is served in the refectory; morning snack is distributed for each soldier in each stretch of the work; lunch is served in disposable bowls, transported and distributed to soldiers; meals, during the evening, are distributed in the refectory and soldiers serve themselves[17].

For the calculation of the nutritional composition of the offered meals the 2008 Dietwin® software was used, containing the Brazilian Table of Food Composition[18]. For the food that is not included in the data base of the aforementioned table, the ingredient label was used as a reference.

After the preparation of TPF, the empty disposable bowl was weighed, and while it was filled with each preparation by the foodservice's employees for the calculation of the offer, without interference of the team of researchers. Afterwards it was numbered and forwarded to each soldier that took part in the sample. After the meal, the metal bowls were collected and weighed for determination of the remaining portion.

For the determination of the remaining portion, the waste weight was collected in the

metal pans, by excluding the non-eatable material (bones, peels, seeds).

In order to evaluate the offer and intake of dinner, the methodology proposed by Sávio *et al.*[19] was used. In this method, all preparations are priory weighed using their utensils and, researchers directly observe each individual while serving each preparation. Therefore, the meals were served in the refectory by self-service mode during the evening. Thus, the preparations served with its respective portion were recorded in order to determine the ratio of each preparation put in the plates. Afterwards, the meal of each individual (made plate) was weighed. The participant soldiers were informed that if they wanted to repeat the meal, they should inform the team so that a new plate was weighed.

Once the weighing of the final plate was done, a numbered label was put under the plate for each participant.

From the data of the individual weight of the metal bowl or the plate and the respective remaining portion, the remaining portion index was obtained. The Ingestion Remaining Portion Index (IR) was calculated in accordance with the model proposed by Abreu *et al.*[20], by dividing the weight of the rejected meal by the weight of the distributed meal, multiplying by 100. For the preparations of breakfast, morning snack and late evening snack, there were no remaining portion.

In order to identify if the offer and the energy consumption were appropriate, the EER[15] was compared to the average estimated energy value of meals served per individual and also to the consumed energy value.

The evaluation of the adequacy of nutrients offered (total carbohydrates - 45% to 65%, proteins - 10% to 35%, lipids - 20% to 35%) was determined by comparison to the ingestion recommendations[21]. For the evaluation of the adequacy of fibers offered, the data was compared to the Brazilian recommendations of the Ministry of Health (25 g/day)[22]. The amounts of sodium of the offered meal were compared to the maximum amount of ingestion, determined by the Institute of Medicine (2.300 mg/day)[15].

Statistical analysis

The statistical analyses of the descriptive data (frequency, average, percentage, standard deviation) were done for characterization of the sample, by using MS Excel®.

In order to do a comparison between BMI and fat percentage, Pearson's Linear Correlation Coefficient (*r*) was used, which is the measure used to evaluate the linear correlation strength between two random variables. The coefficient varies from -1 to 1; -1 perfect negative linear correlation, that is, as one variable increases the other one decreases[23]. This comparison was performed in order to check if BMI classification was reliable, since soldiers, because of intense physical activity, can present weight excess from muscle weight.

In order to compare IR, the normality test Kolgomorov-Simirnova was conducted on sample. Afterwards, Student's *t* test was applied to determine difference from lunch and dinner waste.

RESULTS AND DISCUSSION

Characterization of the population and evaluation of the physical composition

In Table 1, the average age and anthropometrical data of the studied population is shown. The average age of soldiers was 20±1.8 years old; the majority of them was 20 years old or younger. In accordance with the classification of BMI[11], we verified that 76.5% of the soldiers are eutrophic, 4.0% of the soldiers showed low weight and 19.5% showed overweight. This approaches the Brazilian average, which is 23.0% of obesity prevalence in individuals of the male gender between 18 and 24 years old[24].

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Table 1. Characterization of the study population. Brazilian Army soldiers, Brazil, 2011.

Parameters	Average	Minimum	Maximum	Standard Deviation
Age	20.04	18.00	26.00	1.80
Weight	68.74	49.60	103.40	10.70
Height	1.72	1.60	1.91	0.06
BMI	23.10	16.20	32.30	3.00
Fat %	13.76	3.70	30.80	5.14

Note: BMI: Body Mass Index.

Studies confirm that only the use of BMI in order to evaluate the individual's nutritional state does not reflect the reality, therefore it is not possible to determine the body composition[25]. Thus, we can highlight that the average fat percentage measured in this population by the bioimpedance method was 13.76±5.14%. The fat percentage recommended for the male gender at this age is up to 16.00% of the total body fat. Possibly, the low average fat percentage found among soldiers is a reflection of the enhanced physical activity level practiced.

Nevertheless, 32% of the individuals showed fat percentage higher than the recommendation for their age (16%). Correlating to the BMI data and fat percentage, we can observe that among the individuals that are overweight (BMI>25.0), 73% showed fat percentage above the recommended value, which was already expected. The other 27% obtained a fat percentage below 16, which indicates that these individuals show great muscular mass and they should not be classified the same as the other individuals that are overweight. Therefore, considering the association between BMI and fat percentage, only 14% of the evaluated individuals could be classified with an inadequate weight because they showed at the same time high fat percentage.

Studies[25,26] corroborate the obtained result, by showing the occurrence of overweighed individuals (according to BMI) associated with low body fat percentages due to higher muscular mass concentration.

Although 27% of the individuals classified by BMI were overweight and they had fat percentage in the recommended value, we verified that there is a correlation between weight and fat percentage (r=0.69), indicating that heavier soldiers have greater fat percentage. We also observed that individuals that showed BMI classification for obesity showed high fat percentage as well. Thus, the evaluation for this group through BMI determination is a good parameter for the nutritional state analysis.

Evaluation of soldiers' energy expenditure

Considering the anthropometrical characteristics and the physical activity level of the studied population, we can conclude that EER estimated for the population is approximately 3.636 ± 359 kcal. In the study carried out by Montain & Young[27] which was done with American soldiers at the same physical activity level and equivalent age, a similar need of energy (3.600 kcal) was found.

Evaluation of the offer and of the nutrients consumption

Table 2 shows the menu for three days with average weight of the portions that were offered to the soldiers throughout the day. The served breakfast was composed of coffee with milk, bread, margarine, some type of spread for the bread and, occasionally, a fruit. At snack time, artificial juice (cold drink) and bread with varied filling were offered. Lunch and dinner were composed of one type of meat (main course), one

Table 2. Three-day Daily Menu with average weighed of offered portions. Brazil, 2011.

	1st day		2nd day		3rd day	
Menu	Preparations	Average portion (g)	Preparations	Average portion (g)	Preparations	Average portion (g)
Breakfast	White bread	61	White bread	64	White bread	64
	Bologna sausage	40	Sausage	68	Toast	34
	Margarine	5	Watermelon	80	Banana	123
	Coffee	123	Banana	123	Coffee	123
	Whole milk	247	Coffee	123	Whole milk	247
			Whole milk	247		
Snack	Toast with margarine and oregano	50	White bread	30	Sweet bread	88
			Sweet bread	44	White bread	30
	Sweet bread	166	Bologna sausage	20	Sausage with sauce	68
	Artificial soursop juice	200	Artificial mango juice	300	Artificial soursop juice	200
Lunch	Chicken with vegetables	164	Meat with vegetables	141	Meat with pumpkin	141
	Macaroni with garlic and oil	110	Macaroni with garlic and oil	85	Macaroni	89
	Olives					
	Brown beans with sausage	138	Mashed potatoes	63	White rice	288
	Rice (white rice, grapes, carrot and peas)	350	White rice	331	Brown beans	159
Dinner	Chicken with vegetables	103	Brown beans	172	Beef *stroganoff*	105
	White rice	355	Meat with vegetables	110	White rice	314
	Brown beans with sausage	72	White rice	368	Brown beans	93
			Brown beans with sausage	70		

garnish, white rice and brown beans (since this is a Brazilian consumption habit) and, sporadically, raw salad.

By analyzing the three-day menu (Table 2), we can observe little variety in the meals. The repetition of dishes offered at lunch and dinner is common in the studied unit. Therefore, the food volume prepared in the morning considers these two meals. The food storage of food ready for consumption and the food that was not prepared yet is improperly done, in locations with inappropriate temperature. This results in major loss of raw material and the possibility of spreading microorganisms in the prepared meals, which makes the consumption of this food dangerous both at lunch and dinner[28].

We can observe that the offer of cooked vegetables is prioritized in the menu and there is little offer of raw vegetables and fruits due to the limitations of supply and storage logistics. The insufficient offer of differentiated food is a factor that can influence food intake, because the acceptance of certain food given the frequent consumption decreases. In Brazil, the Health Department recommends in its Food Guide[22] the daily consumption of three portions of fruits and three portions of vegetables, which corresponds to 400 g/day of these foods. The Food Guide emphasizes the importance of varying the consumption of these fruits and vegetables in meals throughout the week aiming at variety of bioactive nutrients and substances and also avoiding rejection of food due to frequent intake.

In accordance with the Brazilian recommendations, the studied population does not receive proper meals in terms of amount and variety of fruits and vegetables. The average consumption of these foods was of 193 g/day, less than half the amount recommended. The juices offered were artificial, not contributing to the increase of fruit intake, but contributing to higher sugar consumption. The low consumption of fruits and vegetables may influence the consumption of fibers, vitamins and minerals.

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However, this is a standard observed in the Brazilian population that shows low consumption of fruits and vegetables[29].

We can observe by Table 3 that the meal weight offered during lunch is higher than the one offered for dinner. This possibly occurs because, in Brazil, lunch is the period when people have the habit to eat more, around 40% of total food ingestion[30]. In the case of this population, the consumption of lunch represents 48% of the daily total energetic value, which is then emphasized as the main meal. At dinner, there is a reduction in the offer and in the consumption of food. This fact is possibly due to the different service modality (self-service) and through the repetition of the same composition as lunch, which may cause rejection and jeopardize the acceptance.

In accordance to Mezomo[31], when the result of the remaining portion index is higher than 10% in healthy population, we assume that menus are inappropriate because of being badly planned and/or badly executed, causing great financial damage to the meal production unit. We verified by Table 4 that the percentage of the remaining portion both at lunch and dinner is higher than the recommendation, which possibly indicates low acceptance of the offered meals. Probably the remaining portions are larger at lunch for the type of service, because individuals serve themselves at dinner, putting on their plate only what they want to consume. The remaining portion percentage at dinner is also high. The statistical analysis comparing IR demonstrates that this difference of remaining portions at lunch and dinner is significant ($p<0.05$).

The estimate of nutrients ingestion is shown for the studied population in Table 4. Here we can verify the averages of offer and nutrients consumption calculated from the offered/consumed meals throughout three monitoring days. The data of energy value, proteins, carbohydrates, lipids, fractions of alimentary fiber and sodium are shown.

We verified that the average energy value of meals offered throughout the day was approximately 3.636 ± 183 kcal; the value is similar to the one found in EER recommendation for this population. However, total energy value consumed is below the recommended amount. The energy consumption is important not only for the maintenance of the body weight, but for maintenance of health. Therefore, the low energy ingestion can result in loss of muscular mass, increase of fatigue and, consequently, compromising the work productivity[32].

Table 3. Average and standard deviation of weight (g) of the offered meals, consumed amount and remaining portion regarding lunch and dinner in the three-day evaluation. Brazil, 2011.

Parameters	Lunch		Dinner	
	Average	SD	Average	SD
Offer (g)	728	159	418	111
Consumption (g)	521	160	326	90
Remaining portions (g)	216	177	93	80
Remaining portions (%)	29,8	23,3	22	20

Note: SD: Standard Deviation.

Table 4. Average of nutritional composition of the meals offered/consumed by soldiers. Brazil, 2011.

Nutritional Information	Offer		Consumption		Recommendation
	Average	SD	Average	SD	
Energy value (kcal)	3.636	183	3.197	413	3.600
Carbohydrates (%)	70	0,5	77	1,5	45 to 65
Proteins (%)	15	0,5	15	1	10 to 35
Total fat (%)	15	1	8	0,5	20 to 35
Alimentary fiber (g)	40	3,2	31	1,5	25
Sodium (mg)	10.448	1.810	8.626	2.384	2.300

Note: SD: Standard Deviation.

Although there was appropriate prevalence of offer of calories, carbohydrates, proteins, lipids and fibers in accordance with Dietary Reference Intake's (DRI) recommendations[21], the obtained results showed insufficiency for all studied variables related to the goals of nutrients ingestion by the WHO for the prevention of chronic diseases and the promotion of healthy nourishment[22].

As for the energy distribution between macronutrients, we verified that the average calorie contribution of carbohydrates was approximately 77%, proteins were 15% and lipid was 8%. That is, carbohydrate percentage is above the recommended amount (DRI); lipids are below the minimum recommended amount and proteins are within the limit. Thus, as the consumption reflected total energy value lower than the needs, the diet is unbalanced. This means that this population can show loss of weight and muscular mass in medium and long terms, compromising the developed activities, as well as showing other diseases arising from the lower consumption.

The consumed sodium was 3.5 times higher than the amount recommended as the maximum ingestion limit for the Brazilian population. There was excess in the amount of fibers of the offer (60%) and upon consumption (24%). Fibers have an important role in the prevention of cardiovascular and gastrointestinal diseases and help in the prevention of chronic diseases related to the diet[22], demonstrated by studies[29,30].

High amounts of fibers are derived from the high consumption of beans, a legume with high fiber amount. Still, the fiber contribution by vegetables and fruits is low, since we observed low consumption of fruit and salads with raw vegetables.

The daily sodium consumption was high (8.626 mg) when compared to Institute of Medicine recommendation (2.300 mg/day), which can lead this population to various chronic diseases etiologically related to the excessive sodium intake, such as hypertension, cardiovascular diseases, heart disease, gastric cancer, osteoporosis and obesity[33]. Confirming this result, a study indicates that the sodium ingestion is high in Brazil, surpassing five times the daily needs[34]. This factor is directly related to the excessive addition of salt during preparation of food and also of the use of industrialized spices (meat broth, complete spice with salt and garlic), which contains high sodium amount. Therefore, we can suggest that natural condiments are used, such as parsley, chives, garlic, coriander, oregano, and anise.

The dishes that most contributed to the high intake of this mineral were white rice, which is consumed daily, and the main courses, that is, protein dishes. It is important a better menu planning in order to reduce waste; nutritional adequacy; less repetition of preparations and monotony of menus; reduction of high sodium spices and artificial juices; and improvement of food habits in the population. Furthermore, this demonstrates the need for job training and awareness of people that handle food. Nutritional education for soldiers is important for changes in the composition and consumption of these meals.

CONCLUSION

Since this is a population with great physical strain due to military functions, it is important to evaluate the composition of their meals. Most soldiers presented fat percentage and BMI within the amount recommended for the age and physical activity level.

The energetic value offer for the population was 3.636 ± 359 kcal; it is in accordance with EER for the population (3.600 kcal). However, the consumption was only 3.197 ± 413 kcal, which is lower to the energy needs of the population. This can be explained by the high percentage of remaining portions in the main meals (lunch and dinner), which possibly indicates low acceptance of the offered meals.

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As for the energy distribution of the consumed meals, we verified that the average calorie contribution of carbohydrate percentage was above the recommended amount (DRI); lipids below the minimum recommended amount and proteins within the recommendation limit.

As for the nutritional quality of the served meals, little offer of fruits and vegetables throughout the day was observed, which can probably lead these individuals to have some deficiency of micronutrients in the future, since these are contained in these foods.

We also observed that preparations show excessive amount of sodium, emphasizing the need for nutritional adequacy of meals which must daily provide the energy and nutrients contribution required for health, work and optimal functioning of the whole body.

Therefore, we remark the need of menus' reformulation through adequate planning for this kind of population in order to present nutritional adequacy; improvement of menu acceptance; increase of different types of preparations; inclusion of fruits and vegetables; revision of TPF to avoid high sodium spices and meals; and adequacy of nutrients' distribution. More studies are necessary to evaluate populations' demands.

The present study showed the limitation of only analyzing the adequacy of menus related to nutritional aspects, offer and consumption by Brazilian army soldiers. However, it is important to enlarge this study considering other quality aspects of menus and meals such as sensorial, hygienic, cultural, and symbolic, and sustainability.

CONTRIBUTORS

RBA BOTELHO, F AVENA, M VERAS and RP ZANDONADI designed research and analyzed data. F AVENA and M VERAS conducted research. RBA BOTELHO and RP ZANDONADI wrote the paper and had primary responsibility for final content. All authors read and approved the final manuscript.

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Refinement of the Brazilian Household Food Insecurity Measurement Scale: Recommendation for a 14-item EBIA

Aprimoramento da Escala Brasileira de Medida Domiciliar de Insegurança Alimentar: recomendação de EBIA com 14 itens

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ABSTRACT

Objective

To review and refine Brazilian Household Food Insecurity Measurement Scale structure.

Methods

The study analyzed the impact of removing the item "adult lost weight" and one of two possibly redundant items on Brazilian Household Food Insecurity Measurement Scale psychometric behavior using the one-parameter logistic (Rasch) model. Brazilian Household Food Insecurity Measurement Scale psychometric behavior was analyzed with respect to acceptable adjustment values ranging from 0.7 to 1.3, and to severity scores of the items with theoretically expected gradients. The socioeconomic and food security indicators came from the 2004 National Household Sample Survey, which obtained complete answers to Brazilian Household Food Insecurity Measurement Scale items from 112,665 households.

Results

Removing the items "adult reduced amount..." followed by "adult ate less..." did not change the infit of the remaining items, except for "adult lost weight", whose infit increased from 1.21 to 1.56. The internal consistency and item severity scores did not change when "adult ate less" and one of the two redundant items were removed.

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Conclusion

Brazilian Household Food Insecurity Measurement Scale reanalysis reduced the number of scale items from 16 to 14 without changing its internal validity. Its use as a nationwide household food security measure is strongly recommended.

Indexing terms: Food security. Hunger. Psychometrics. Scale.

RESUMO

Objetivo

Revisar e aprimorar a estrutura da Escala Brasileira de Medida Domiciliar de Insegurança Alimentar.

Métodos

A avaliação do impacto resultante da remoção do item "adulto perdeu peso" e de um de dois itens possivelmente redundantes sobre o comportamento psicométrico da Escala Brasileira de Medida Domiciliar de Insegurança Alimentar foi realizada com uso de análise estatística por modelo logístico de parâmetro único de Rasch. O comportamento psicométrico da Escala Brasileira de Medida Domiciliar de Insegurança Alimentar foi analisado em relação a valores aceitáveis de ajustamento ao modelo, entre 0,7 e 1,3 e escore de severidade dos itens com gradientes teoricamente esperados. Para as análises, foram usados dados da Pesquisa Nacional Por Amostra de Domicílios de 2004, com 112 665 domicílios visitados e com respostas completas para os itens da Escala Brasileira de Medida Domiciliar de Insegurança Alimentar.

Resultados

Retirando o item "adulto diminuiu os alimentos" e posteriormente "adulto comeu menos" não foi observada mudança nos ajustes dos demais itens, exceto quanto a "adulto perdeu peso", que passou de 1,21 para 1,56. Posteriormente, este e um dos itens redundantes foram excluídos, sendo mantidos adequados a consistência interna e os valores de severidade dos itens.

Conclusão

A reanálise reduziu os itens da escala de 16 para 14, o que manteve a validade interna da escala. Sua adoção como medida nacional da segurança alimentar domiciliar é, portanto, fortemente recomendada.

Termos de indexação: *Segurança alimentar. Fome. Psicometria. Escala.*

INTRODUCTION

In January 2003, around the time when the program *Fome Zero* (Zero Hunger)[1] was launched, a series of studies were undertaken to adapt and validate to the Brazilian reality an instrument that directly measures household food security. Back then, the absence of direct methods or indicators for following and assessing public policies against food insecurity and hunger was recognized.

In early 2003, a multicentric project was carried out to validate a scale that measured household food security directly, resulting in the, *Escala Brasileira da Insegurança Alimentar* (EBIA, Brazilian Household Food Insecurity Measurement Scale). Six research institutions participated in all phases of this project, namely the *Universidade Estadual de Campinas* (Unicamp), coordination, *Universidade de Brasília* (UnB), *Universidade Federal da Paraíba* (UFPB), *Universidade Federal do Mato Grosso* (UFMT), *Instituto Nacional de Pesquisa Amazônica* (INPA), and University of Connecticut (UCONN)[2,3]. The North American household food security scale, known as Household Food Security Survey Module (HFSSM), was then considered an appropriate starting point for building a similar instrument in Brazil[4].

The first stage of the study used qualitative methods in the North, Northeast, Central West, and Southeast regions of Brazil. This phase concerned analyzing the adequacy of HFSSM's food security-related concepts and scale items for the Brazilian population. Seven discussion forums

with groups of nutrition experts and Food and Nutrition Security (FNS) policy managers were organized, followed by 11 focal groups with representatives from rural and urban communities[2,3,5].

The second stage of EBIA's validation process administered quantitative surveys to convenience samples in the same areas of the four Brazilian regions mentioned above, where the expert and focus group meetings took place[2,3].

The Brazilian Household Food Insecurity Measurement Scale version resulting from the study conducted in 2003 had 15 items, three less than the number of items of the HFSSM, the scale that provided EBIA's foundation. Important structural changes were also made, but they did not affect the theoretical assumptions upon which experience-based household food security scales rest[2-4]. These assumptions constitute the grouping of concepts that enable estimating food security prevalences and classifying households into three levels of food insecurity severity, namely mild, moderate, and severe.

All quantitative analyses showed that EBIA is an instrument with high internal consistency and ability to reliably predict (external validity) food security and insecurity[6,7]. The external validity analysis relied on food intake and traditional food access predictors, such as income and education level[2,3].

In 2003 the *Ministério do Desenvolvimento Social e do Combate a Fome* (MDS, Ministry of Social Development and Fight against Hunger) managers recommended and provided the required resources to include EBIA as a special module in the 2004 *Pesquisa Nacional por Amostra de Domicílios* (PNAD, National Household Income and Expenditures Survey) questionnaire, developed by the *Instituto Brasileiro de Geografia e Estatística* (IBGE, Brazilian Institute of Geography and Statistics)[8]. EBIA provided the first nationally representative diagnosis of food security/insecurity in Brazil, and included both urban and rural areas. These results became the reference baseline for later surveys, such as the *Pesquisa Nacional de Demografia e Saúde* 2006 (PNDS, National Demographic and Health Survey) and PNAD 2009[9,10].

National surveys and many academic studies confirmed EBIA's appropriateness and validity[11-14]. Nevertheless, the results also indicated the possibility of improving EBIA by adjusting and suppressing some items, and this observation was consistent with the new information that became available in the specialized scientific literature[15-21].

The decision to review EBIA after its widespread use for more than six years was communicated to MDS's evaluation managers, who decided to support a meeting of experts to discuss EBIA's reanalysis results. The statistical analyses were discussed by experts and summarized in a technical report for MDS and IBGE.

The objective of this communication is to describe EBIA's refinement process and compare the two versions of the scale with respect to their psychometric characteristics using the Rasch model.

METHODS

The analytical procedures aiming to refine EBIA relied on a one-parameter logistic model, the Rasch model[6,7,22,23]. The Rasch model has historically been used in education knowledge testing. Like other techniques based on Item Response Theory (IRT), this model analyzes binary answers (correct/incorrect or yes/no) to questions distributed in a continuum of increasing difficulty. More recently, this statistical technique has been used for analyzing the internal validity of food security measurement scales with similar item structure and psychometric characteristics[6,7].

Rasch model-based analysis estimates the severity of food insecurity (expected scores) of a household and item most consistent with the answers, according to model-dependent assumptions[4,23,24]. These procedures also provide close fit statistics (item-infit) for assessing the degree to which each household and each scale

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item meet the model's assumptions. This statistic compares the discrimination ability of each item with the mean discrimination given by all items[23,24]. The final score of the level of food insecurity of each household constitutes a nonlinear scale with intervals distributed along increasing levels of item severity.

As has been done in the field of education[23], the following assumptions must be met to justify using the Rasch model for analyzing the psychometric behavior of food insecurity measurement scales[8]:

a) As the severity expressed by an item of the scale increases, the probability that it is affirmed decreases;

b) As the food insecurity of the interviewee increases (as food access becomes harder), the probability that he/she will answer yes to all items increases. The higher the food insecurity of the interviewee (greater difficulty to access food), the higher the probability that he/she will answer affirmatively to all items.

c) The relationship between food insecurity and affirmed items is described by a mathematical formula that corresponds to a logistic model in which the odds of a household classified with a certain degree of food insecurity severity (h) of affirming an item (i) is equal to the power of (h-i):

$$p_{h,i}=e^{(h-i)}/(1+e^{(h-i)})$$

d) All scale items have the same power of discrimination.

The use of the Rasch model for assessing the psychometric behavior of food security measurement scales is justified by a fact observed in previous analyses, which indicate that the scales' items are sufficiently consistent with these assumptions[4,8]. During the process of validation of the original 15-item EBIA for inclusion in the 2004 PNAD's questionnaire, the question "…member older than 18 years cut meal size or skipped meals…" should actually be asking two different things, namely "cutting meal size" and "skipping meals," - thus, this question was disaggregated into two questions. Since this did not change the validity of the scale significantly, this modification was maintained, leading to the 16-item EBIA. The 2004 PNAD analyses included 112,665 households of which 68,369 had at least one member aged less than 18 years, and the remainder 44,296 households had only adults. All the households sampled by PNAD 2004 that had no missing data for any of the 16 EBIA items were included in the analyses.

The Brazilian Household Food Insecurity Measurement Scale reanalysis using the Rasch model included the progressive and alternated exclusion of each item. First, the item "interviewee lost weight" (EB9) was removed, followed by the item "adult cut meal size" (EB5a), and lastly, "adult started skipping meals" (EB5b). The Rasch analysis was repeated at each step, as each item was excluded, to measure the psychometric behavior of the resulting scale. Basically, the fit of the items to the expected model (infit) was analyzed, with values between 0.7 and 1.3 being considered appropriate, observing the severity measure sequence of each item. At the end, this analysis was repeated with the 14-item EBIA (EBIA14).

In the second stage of the study, we tested the predictive or external validity of EBIA14. Tentative cut-off points were used for classifying households with and without individuals under 18 years of age into different levels of household food insecurity. These levels were then associated with different socioeconomic and demographic factors, including household income and skin color of the household head. Chi-square tests were used for examining these statistical associations using $p<0.05$ as a criterion for statistical significance.

RESULTS

Table 1 shows the Rasch analysis for 68,369 households with at least one person under

18 years of age. The items' fit (infit) and severity were similar in the 16-item scale and the alternative 15-item and 14-item scales. This shows that the omitted items did not affect EBIA's internal consistency.

In the 15-item Brazilian Household Food Insecurity Measurement Scale, when the following items were removed one at a time, "adult ate less than he/she felt he/she should" and "adult cut meal size", the fit statistic (infit) changed slightly; the most significant change occurred in the item "adult lost weight": the infit value increased from 1.21 to 1.55 and 1.56, respectively, hence beyond the appropriate limits (0.7 and 1.3). However, when only the item "adult lost weight" was excluded, all items presented appropriate infit values, and the item "worried" presented a marginally acceptable value (1.36). Also, in the 15-item EBIA, the fit of the item "individual aged less than 18 years did not consume a healthy and varied diet" fell within the optimal interval (0.8 to 1.2), contrasting with its less than optimal fit in the 16-item EBIA (Figure 1).

In relation to the Brazilian Food Insecurity Measurement Scale 14, the magnitude of the severity measures of the items follows the same pattern. When EBIA16 and EBIA14 are compared, the item severity values have very similar magnitudes and follow the same sequence order. As theoretically expected the severity values of the items decreases exponentially from the more to the less severe items (Figure 2). The item "the child did not eat all day" has the highest and the item "household members were worried" has the lowest severity measure. The ordering of the items according to their level of severity meets one of the key assumptions of the Rasch model: "the higher the severity of a scale item, the lower its probability of being answered affirmatively" (p.66)[8].

Table 1. Infit and severity values of the items of the Brazilian Household Food Security Scale with 16, 15 and 14 items in households with at least one person younger than 18 years. Brazil, 2010.

Items	EBIA16 items		EBIA15 items[a] without "AD ate less"		EBIA15 items without "AD lost weight"		EBIA15 items without "AD cut meal size"		EBIA14 items without "AD lost weight" and "AD cut meal size"	
	I[d]	S[e]	I	S	I	S	I	S	I	S
1. Worried	1.39	1.52	1.35	1.48	1.38	1.63	1.36	1.41	1.36	1.52
2. Ran out of food	1.13	3.93	1.08	3.87	1.14	4.05	1.09	3.83	1.09	3.94
3. Not healthy and varied diet	0.91	2.25	0.89	2.2	0.92	2.36	0.88	2.14	0.88	2.25
4. Few foods	0.93	2.99	0.9	2.94	0.94	3.10	0.91	2.88	0.91	2.99
5A. AD[b] cut meal size	0.83	4.25	0.91	4.18	0.85	4.37	____	____	____	____
5B. AD skipped meal	0.95	7.03	0.97	6.93	0.99	7.20	0.96	6.90	1.00	7.07
6. AD ate less	0.77	4.79	____	____	0.80	4.91	0.85	4.67	0.86	4.79
7. AD felt hungry	0.88	7.53	0.89	7.42	0.95	7.71	0.89	7.40	0.95	7.59
8. AD lost weight	1.21	9.19	1.55	9.09	____	____	1.56	9.07	____	____
9. AD ate one meal or less/day	1.09	8.41	1.03	8.31	1.15	8.66	1.03	8.29	1.16	8.55
10. Child[c] did not eat a healthy and varied diet	1.32	4.01	1.33	3.95	1.20	4.13	1.14	3.90	1.14	4.02
11. Child ate less	0.82	6.22	0.77	6.12	0.79	6.36	0.78	6.09	0.78	6.23
12. Child cut meal size	0.85	6.05	0.80	5.95	0.81	6.19	0.81	5.92	0.81	6.06
13. Child skipped meal	0.80	8.45	0.76	8.35	0.81	8.71	0.77	8.33	0.80	8.59
14. Child felt hungry	0.77	8.62	0.74	8.52	0.81	8.90	0.75	8.50	0.80	8.79
15. Child did not eat all day	1.02	10.78	0.83	10.68	1.08	11.71	0.84	10.67	1.08	11.62

Note: [a]Scales with less than 16 items were obtained from the sucessive exclusion of items 6, 8, and 5A; [b]AD: Adult= individual 18 years old or older; [c]Child: individual aged less than 18 years; [d]Infit value; [e]Severity value.

Source: *Pesquisa Nacional por Amostra de Domicílios*, 2004 (National Household Income and Expenditures Survey).

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It is possible to group items according to the proximity of the clustering of their severity measures, taking into account the theoretical assumptions of the household food security measurement scales: a) in a mild food insecurity situation, families develop strategies to ensure access to foods that may compromise the quality of their diet; b) if the coping strategies are not effective or the condition that compromised food access did not change, there is food restriction, especially for the adults, and c) the household adults and children experience hunger[4]. The

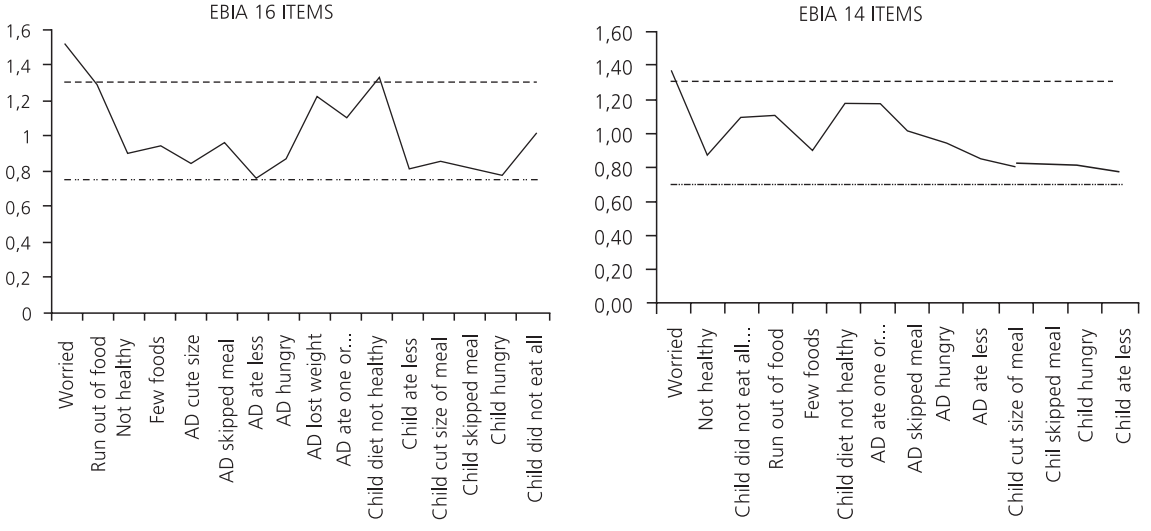

Figure 1. Distribution of infit values of the Brazilian Household Food Security Scale items by type of scale in households with at least one person younger than 18 years. Brazil, 2010.

Source: *Pesquisa Nacional por Amostra de Domicílio,* 2004 (National Household Income and Expenditures Survey).

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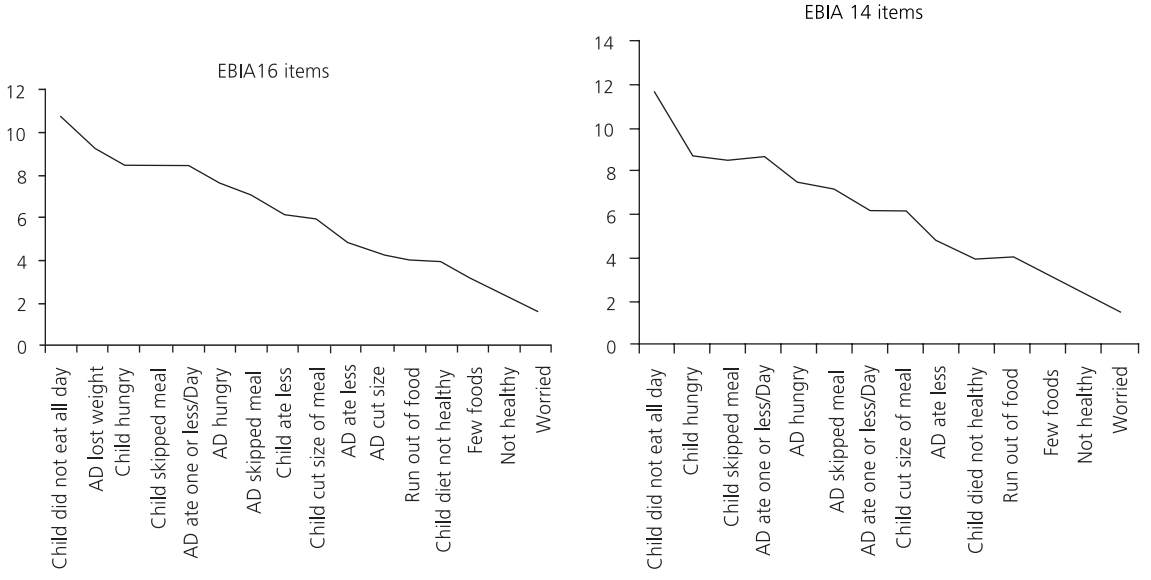

Figure 2. Distribution of severity values of the Brazilian Household Food Security Scale items by type of scale in households with at least one person younger than 18 years. Brazil, 2010.

Source: *Pesquisa Nacional por Amostra de Domicílio,* 2004 (National Household Income and Expenditures Survey).

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grouping by level of severity and the corresponding frequencies of affirmed items (Table 2) characterize these conditions: group A represents mild food insecurity, group B, moderate food insecurity, and group C, severe food insecurity. These conceptual groupings along with the Rasch analysis results provide the basis for establishing the cutoff points of the 14-item scale, which are not presented in this article.

The Brazilian Food Insecurity Measurement Scale 14's predictive ability (external validity) was also studied by assigning households to food insecurity using tentative cutoff points. In households with a family income per member equivalent to 25.0% of the minimum salary or less, the prevalence of severe food insecurity is 28.9%. By contrast, the corresponding prevalence is 0.2% in households whose members have an income of five minimum salaries or more. Similar results were found when the sociodemographic characteristics of the household head were analyzed by level of food insecurity. Severe food insecurity is 3.5 times more prevalent among families with a Black *vs*. a White household head. Severe food insecurity is 2.9 times more prevalent in households where the head has 5 years or less *vs*. more than 5 years of schooling. Other indicators, such as household size, employment, and gender of the household head, are associated in similar ways with food insecurity. All of these associations are statistically significant.

DISCUSSION

Food insecurity can be associated with both weight loss and weight gain[19,20-22]. This change is especially appropriate in the context of the nutritional transition seen in Brazil[16] characterized by high prevalences of overweight and obesity, especially among the poorest, and therefore, most vulnerable to food insecurity[17,22]. The exclusion of this item was based on psychometric analysis and does not affect the conceptual foundation of EBIA.

Additionally, the identification of two questions with similar semantic meaning, "adult

Table 2. Frequency of affirmative answers (%) to items and severity values in households with at least one person younger than 18 years by EBIA with 16 items and EBIA with 14 items. Brazil, 2010.

Groups	EBIA14 items	Frequency of Affirmative Answers (%)	Item Severity	
		EBIA16 and 14[d]	EBIA16	EBIA14
A	1[a] Worried	37.8	1.52	1.52
	3 Not healthy and varied diet	33.8	2.25	2.25
	4 Few types of foods	31.8	2.99	2.99
	2 Ran out of food	27.1	3.93	3.94
	10 Child[b] did not eat healthy and varied diet	23.7	4.01	4.02
B	6 Adult[c] ate less	20.6	4.79	4.79
	12 Child had to cut meal size	13.7	6.05	6.06
	11 Child ate less	12.9	6.22	6.23
	5b Adult skipped meal	10.8	7.03	7.07
	7 Adult felt hungry	9.1	7.53	7.59
C	9 Adult ate one meal/day or less	7.2	8.41	8.55
	13 Child skipped meal	6.0	8.45	8.59
	14 Child felt hungry	5.6	8.62	8.79
	15 Child did not eat all day	2.3	10.78	11.62

Note: [a]The number order 1 to 15 corresponds to the items in the original scale, except item 5b that was the last part of item 5; [b]Child: individual aged less than 18 years; [c]Adult: individual aged 18 years or more; [d]Brazilian Household Food Insecurity Measurement Scale (EBIA) 16 and EBIA14 have the same value of affirmative answers since they relate to the same household and same interviewees.
Source: *Pesquisa Nacional por Amostra de Domicílio,* 2004 (National Household Income and Expenditures Survey).

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Quadro 1. Escala Brasileira de Medida de Insegurança Alimentar com 14 itens (EBIA14) para classificação da condição de segurança alimentar nos domicílios, nos três meses anteriores à entrevista. Brasil, 2010.

1. Nos últimos três meses, os moradores deste domicílio tiveram a preocupação de que os alimentos acabassem antes de poderem comprar ou receber mais comida?	1. In the last 3 months, did household members worry that they would run out of food before being able to buy or receive more food?
2. Nos últimos três meses, os alimentos acabaram antes que os moradores deste domicílio tivessem dinheiro para comprar mais comida?	2. In the last 3 months, did household members run out of food before having money to buy more?
3. Nos últimos três meses, os moradores deste domicílio ficaram sem dinheiro para ter uma alimentação saudável e variada?	3. In the last 3 months, did household members run out of money to have a healthy and varied diet?
4. Nos últimos 3 meses os moradores deste domicílio comeram apenas alguns poucos tipos de alimentos que ainda tinham, porque o dinheiro acabou?	4. In the last 3 months, did household members eat only a few kinds of foods they still had because they had run out of money?
5. Nos últimos três meses, algum morador de 18 anos ou mais de idade, deixou de fazer alguma refeição, porque não havia dinheiro para comprar comida?	5. In the last 3 months, did any household member 18 years old or older skip a meal because there was no money to buy food?
6. Nos últimos três meses, algum morador de 18 anos ou mais de idade, alguma vez, comeu menos do que achou que devia, porque não havia dinheiro para comprar comida?	6. In the last 3 months, did any household member 18 years old or older eat less than what he/she felt he/she should because there was no money to buy food?
7. Nos últimos três meses, algum morador de 18 anos ou mais de idade, alguma vez, sentiu fome mas não comeu, porque não havia dinheiro para comprar comida?	7. In the last 3 months, did any household member 18 years old or older feel hungry but did not eat because there was no money to buy food?
8. Nos últimos três meses, algum morador de 18 anos ou mais de idade, alguma vez, fez apenas uma refeição ao dia ou ficou um dia inteiro sem comer, porque não havia dinheiro para comprar a comida?	8. In the last 3 months, did any household member 18 years old or older have just one meal a day or didn't eat for a whole day because there was no money to buy food?
9. Nos últimos três meses, algum morador com menos de 18 anos de idade, alguma vez, deixou de ter uma alimentação saudável e variada, porque não havia dinheiro para comparar comida?	9. In the last 3 months, did any household member aged less than 18 years stop having a healthy and varied diet because there was no money to buy food?
10. Nos últimos 3 meses, algum morador com menos de 18 anos de idade alguma vez, não comeu quantidade suficiente de comida porque não havia dinheiro para comprar comida?	10. In the last 3 months, did any household member aged less than 18 years not have enough to eat because there was no money to buy food?
11. Nos últimos três meses, alguma vez foi diminuída a quantidade de alimentos das refeições de algum morador com menos de 18 anos de idade, porque não havia dinheiro para comprar a comida?	11. In the last 3 months, did any person in your household aged less than 18 years have to reduce the size of meals because there was no money to buy food?
12. Nos últimos três meses, alguma vez, algum morador com menos de 18 anos de idade deixou de fazer alguma refeição, porque não havia dinheiro para comprar a comida?	12. In the last 3 months, did any household member aged less than 18 years skip a meal because there was no money to buy food?
13. Nos últimos três meses, alguma vez, algum morador com menos de 18 anos de idade sentiu fome, mas não comeu porque não havia dinheiro para comprar mais comida?	13. In the last 3 months, did any household member aged less than 18 years feel hungry but could not eat because there was no money to buy more food?
14. Nos últimos três meses, alguma vez algum morador com menos de 18 anos de idade fez apenas uma refeição ao dia ou ficou sem comer por um dia inteiro, porque não havia dinheiro para comprar comida?	14. In the last 3 months, did any household member aged less than 18 years have just one meal a day or went without eating for a whole day because there was no money to buy food?

Chart 1. Brazilian Household Food Security Scale with 14 items (EBIA14) for classifying household food security in the last three months. Brazil, 2010.

Note: Data Source: IBGE - PNAD 2004; FI: Food Insecurity.

Source: *Pesquisa Nacional por Amostra de Domicílio,* 2004 (National Household Income and Expenditures Survey).

cut meal size" and "adult ate less," led to the realization that these items had similar infit values and severity measures, confirming that they were redundant, and therefore, one of them should be excluded. Hence, the former reports of interviewees interpreting these two questions similarly are confirmed.

These analyses enabled the study authors, IBGE researchers, food security policy management technicians, and other experts to gather in a seminar promoted by the MDS and adopt, by consensus, the new EBIA14 scale (Chart 1). On this occasion, IBGE researchers decided to reanalyze PNAD 2004 data and analyze PNAD 2009 data with the new scale, thereby allowing comparison of the results of these two nationally representative surveys[10].

Only a few countries besides Brazil use the scientific data produced by reliable and valid measures to analyze their public policies against food insecurity. Data generated by academic studies[11-15,19,20,25,26] supported or not by public and governmental research institutions like IBGE[8-10] have been useful for the development of evidence-based public food and nutrition security policies[27] and thus help to improve food security governance[28], a fact that strongly motivated us to refine EBIA.

CONCLUSION

The changes proposed for EBIA consist of refinements that update it with respect to the Brazilian nutritional reality and simplify its content by excluding a redundant item. At the same time, it reduces the costs of its administration by national surveys conducted by IBGE.

The Brazilian Food Insecurity Measurement Scale's refinement did not change its internal consistency or modify the ordering of the 14 items when these were compared against the expected theoretical sequence.

The Brazilian Food Insecurity Measurement Scale 14 has high internal consistency and high predictive ability (external validity), which strongly encourages its nationwide use as an instrument for measuring household food security and insecurity.

The next step in this research study is to determine EBIA14's cutoff points for classifying households with (14 items) and without (8 items) individuals under 18 years of age according to the level of household food (in)security. The goal is for these cutoff points to detect equivalent levels of severity in household with and without children using Rasch item severity comparative analyses. These analyses will involve comparing Rasch item severities in households with and without individuals under 18 years of age. For this purpose we will use representative EBIA14 data drawn from diverse national surveys, including PNAD 2004, PNAD 2009, PNAD 2013, PNDS 2006, and other surveys conducted in specific vulnerable populations. The cutoff points will then be tested for consistency across surveys. Once the final set of cutoff points is determined, we will proceed to estimate the prevalences of household food insecurity and compare them with the prevalences previously determined by EBIA16 and their corresponding cutoff points. We expect that this effort will allow Brazil to monitor household food insecurity and help improve food security governance using well validated cutoff points for EBIA14 that we conclude, based on the findings reported herein, has very strong psychometric validity and utility in the Brazilian context. We strongly recommend Brazil to adopt EBIA14 as its national household food security measure.

CONTRIBUTORS

All authors helped to conceive and design the study; analyze and interpret the data; and review all versions of the article. AM SEGALL-CORRÊA performed the statistical analyses.

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Categoria dos artigos

A Revista aceita artigos inéditos em português, espanhol ou inglês, com título, resumo e termos de indexação no idioma original e em inglês, nas seguintes categorias:

Original: contribuições destinadas à divulgação de resultados de pesquisas inéditas, tendo em vista a relevância do tema, o alcance e o conhecimento gerado para a área da pesquisa (limite máximo de 5 mil palavras).

Especial: artigos a convite sobre temas atuais (limite máximo de 6 mil palavras).

Revisão (**a convite**): síntese de conhecimentos disponíveis sobre determinado tema, mediante análise e interpretação de bibliografia pertinente, de modo a conter uma análise crítica e comparativa dos trabalhos na área, que discuta os limites e alcances metodológicos, permitindo indicar perspectivas de continuidade de estudos naquela linha de pesquisa (limite máximo de 6 mil palavras). Serão publicados até dois trabalhos por fascículo.

Comunicação: relato de informações sobre temas relevantes, apoiado em pesquisas recentes, cujo mote seja subsidiar o trabalho de profissionais que atuam na área, servindo de apresentação ou atualização sobre o tema (limite máximo de 4 mil palavras).

Nota Científica: dados inéditos parciais de uma pesquisa em andamento (limite máximo de 4 mil palavras).

Ensaio: trabalhos que possam trazer reflexão e discussão de assunto que gere questionamentos e hipóteses para futuras pesquisas (limite máximo de 5 mil palavras).

Seção Temática (a convite): seção destinada à publicação de 2 a 3 artigos coordenados entre si, de diferentes autores, e versando sobre tema de interesse atual (máximo de 10 mil palavras no total).

Categoria e a área temática do artigo

Os autores devem indicar a categoria do artigo e a área temática, a saber: alimentação e ciências sociais, avaliação nutricional, bioquímica nutricional, dietética, educação nutricional, epidemiologia e estatística, micronutrientes, nutrição clínica, nutrição experimental, nutrição e geriatria, nutrição materno-infantil, nutrição em produção de refeições, políticas de alimentação e nutrição e saúde coletiva.

Pesquisas envolvendo seres vivos

Resultados de pesquisas relacionadas a seres humanos e animais devem ser acompanhados de cópia de aprovação do parecer de um Comitê de Ética em pesquisa.

Registros de Ensaios Clínicos

Artigos com resultados de pesquisas clínicas devem apresentar um número de identificação em um dos Registros de Ensaios Clínicos validados pelos critérios da Organização Mundial da Saúde (OMS) e do *Intemational Committee of Medical Journal Editors* (ICMJE), cujos endereços estão disponíveis no site do ICMJE. O número de identificação deverá ser registrado ao final do resumo.

Procedimentos editoriais

Autoria

A indicação dos nomes dos autores logo abaixo do título do artigo é limitada a 6. O crédito de autoria deverá ser baseado em contribuições substanciais, tais como concepção e desenho, ou análise e interpretação dos dados. Não se justifica a inclusão de nomes de autores cuja contribuição não se enquadre nos critérios acima.

Os manuscritos devem conter, na página de identificação, explicitamente, a contribuição de cada um dos autores.

Processo de julgamento dos manuscritos

Todos os outros manuscritos só iniciarão o processo de tramitação se estiverem de acordo com as Instruções aos Autores. Caso contrário, serão devolvidos para adequação às normas, inclusão de carta ou de outros documentos eventualmente necessários.

Recomenda-se fortemente que o(s) autor(es) busque(m) assessoria linguística profissional (revisores e/ou tradutores certificados em língua portuguesa e inglesa) antes

de submeter(em) originais que possam conter incorreções e/ou inadequações morfológicas, sintáticas, idiomáticas ou de estilo. Devem ainda evitar o uso da primeira pessoa "meu estudo...", ou da primeira pessoa do plural "percebemos....", pois em texto científico o discurso deve ser impessoal, sem juízo de valor e na terceira pessoa do singular.

Originais identificados com incorreções e/ou inadequações morfológicas ou sintáticas **serão devolvidos antes mesmo de serem submetidos à avaliação** quanto ao mérito do trabalho e à conveniência de sua publicação.

Pré-análise: a avaliação é feita pelos Editores Científicos com base na originalidade, pertinência, qualidade acadêmica e relevância do manuscrito para a nutrição.

Aprovados nesta fase, os manuscritos serão encaminhados aos revisores *ad hoc* selecionados pelos editores. Cada manuscrito será enviado para dois revisores de reconhecida competência na temática abordada, podendo um deles ser escolhido a partir da indicação dos autores. Em caso de desacordo, o original será enviado para uma terceira avaliação.

Os autores devem indicar três possíveis revisores para o manuscrito. Opcionalmente, podem indicar três revisores para os quais não gostaria que seu trabalho fosse enviado.

Todo processo de avaliação dos manuscritos terminará na segunda e última versão.

O processo de avaliação por pares é o sistema de *blind review*, procedimento sigiloso quanto à identidade tanto dos autores quanto dos revisores. Por isso os autores deverão empregar todos os meios possíveis para evitar a identificação de autoria do manuscrito.

Os pareceres dos revisores comportam três possibilidades: a) aprovação; b) recomendação de nova análise c) recusa. Em quaisquer desses casos, o autor será comunicado.

Os pareceres são analisados pelos editores, que propõem ao Editor Científico a aprovação ou não do manuscrito.

Manuscritos recusados, mas com a possibilidade de reformulação, poderão retornar como novo trabalho, iniciando outro processo de julgamento.

Conflito de interesse

No caso da identificação de conflito de interesse da parte dos revisores, o Comitê Editorial encaminhará o manuscrito a outro revisor *ad hoc*.

Manuscritos aceitos: manuscritos aceitos poderão retornar aos autores para aprovação de eventuais alterações, no processo de editoração e normalização, de acordo com o estilo da Revista.

Provas: serão enviadas provas tipográficas aos autores para a correção de erros de impressão. As provas devem retornar ao Núcleo de Editoração na data estipulada. Outras mudanças no manuscrito original não serão aceitas nesta fase.

Publicação em inglês: em caso de aprovação, os artigos indicados pelo Conselho Editorial serão publicados na versão em inglês. Nestes casos para que o manuscrito seja publicado, os autores deverão providenciar sua versão completa (tal como aprovado) para o inglês, arcando com os custos de sua tradução. Para assegurar a qualidade e uniformidade dos textos traduzidos para a Língua Inglesa, esse trabalho deverá ser realizado, necessariamente, por um tradutor altamente capacitado e com experiência comprovada na versão de textos científicos, indicados e credenciados junto à Revista.

Preparo do manuscrito

Submissão de trabalhos

Serão aceitos trabalhos acompanhados de carta assinada por todos os autores, com descrição do tipo de trabalho e da área temática, declaração de que o trabalho está sendo submetido apenas à Revista de Nutrição e de concordância com a cessão de direitos autorais e uma carta sobre a principal contribuição do estudo para a área.

Caso haja utilização de figuras ou tabelas publicadas em outras fontes, deve-se anexar documento que ateste a permissão para seu uso.

Enviar os manuscritos via *site* <http://www.scielo.br/rn>, preparados em espaço entrelinhas 1,5, com fonte *Arial* 11. O arquivo deverá ser gravado em editor de texto similar ou superior à versão 97-2003 do *Word* (*Windows*).

É fundamental que o escopo do artigo **não contenha qualquer forma de identificação da autoria**, o que inclui referência a trabalhos anteriores do(s) autor(es), da instituição de origem, por exemplo.

O texto deverá contemplar o número de palavras de acordo com a categoria do artigo. As folhas deverão ter numeração personalizada desde a folha de rosto (que deverá apresentar o número 1). O papel deverá ser de tamanho A4, com formatação de margens superior e inferior (no mínimo 2,5cm), esquerda e direita (no mínimo 3cm).

Os artigos devem ter, aproximadamente, 30 referências, exceto no caso de artigos de revisão, que podem apresentar em torno de 50. Sempre que uma referência possuir o número de *Digital Object Identifier* (DOI), este deve ser informado.

O texto do artigo deverá empregar fonte colorida (cor azul) ou sublinhar, para todas as alterações, juntamente com uma carta ao editor, reiterando o interesse em publicar nesta Revista e informando quais alterações foram processadas no manuscrito. Se houver discordância quanto às recomendações dos revisores, o(s) autor(es) deverão apresentar os argumentos que justificam sua posição.

O título e o código do manuscrito deverão ser especificados.

Versão reformulada: a versão reformulada deverá ser encaminhada via <http://www.scielo.br/rn>. **O(s) autor(es) deverá(ão) enviar apenas a última versão do trabalho**.

Página de rosto deve conter

a) título completo - deve ser conciso, evitando excesso de palavras, como "avaliação do....", "considerações acerca de..." 'estudo exploratório....";

b) *short title* com até 40 caracteres (incluindo espaços), em português (ou espanhol) e inglês;

c) nome de todos os autores por extenso, indicando a filiação institucional de cada um. Será aceita uma única titulação e filiação por autor. O(s) autor(es) deverá(ão), portanto, escolher, entre suas titulações e filiações institucionais, aquela que julgar(em) a mais importante;

d) todos os dados da titulação e da filiação deverão ser apresentados por extenso, sem siglas;

e) indicação dos endereços completos de todas as universidades às quais estão vinculados os autores;

f) indicação de endereço para correspondência com o autor para a tramitação do original, incluindo fax, telefone e endereço eletrônico.

Observação: esta deverá ser a única parte do texto com a identificação dos autores.

Resumo: todos os artigos submetidos em português ou espanhol deverão ter resumo no idioma original e em inglês, com um mínimo de 150 palavras e máximo de 250 palavras.

Os artigos submetidos em inglês deverão vir acompanhados de resumo em português, além do *abstract* em inglês.

Para os artigos originais, os resumos devem ser estruturados destacando objetivos, métodos básicos adotados, informação sobre o local, população e amostragem da pesquisa, resultados e conclusões mais relevantes, considerando os objetivos do trabalho, e indicando formas de continuidade do estudo.

Para as demais categorias, o formato dos resumos deve ser o narrativo, mas com as mesmas informações.

O texto não deve conter citações e abreviaturas. Destacar no mínimo três e no máximo seis termos de indexação, utilizando os descritores em Ciência da Saúde - DeCS - da Bireme <http://decs.bvs.br>.

Texto: com exceção dos manuscritos apresentados como Revisão, Comunicação, Nota Científica e Ensaio, os trabalhos deverão seguir a estrutura formal para trabalhos científicos:

Introdução: deve conter revisão da literatura atualizada e pertinente ao tema, adequada à apresentação do problema, e que destaque sua relevância. Não deve ser extensa, a não ser em manuscritos submetidos como Artigo de Revisão.

Métodos: deve conter descrição clara e sucinta do método empregado, acompanhada da correspondente citação bibliográfica, incluindo: procedimentos adotados; universo e amostra; instrumentos de medida e, se aplicável, método de validação; tratamento estatístico.

Em relação à análise estatística, os autores devem demonstrar que os procedimentos utilizados foram não somente apropriados para testar as hipóteses do estudo, mas também corretamente interpretados. Os níveis de significância estatística (ex. $p<0,05$; $p<0,01$; $p<0,001$) devem ser mencionados.

Informar que a pesquisa foi aprovada por Comitê de Ética credenciado junto ao Conselho Nacional de Saúde e fornecer o número do processo.

Ao relatar experimentos com animais, indicar se as diretrizes de conselhos de pesquisa institucionais ou nacionais - ou se qualquer lei nacional relativa aos cuidados e ao uso de animais de laboratório - foram seguidas.

Resultados: sempre que possível, os resultados devem ser apresentados em tabelas ou figuras, elaboradas de forma a serem auto-explicativas e com análise estatística. Evitar repetir dados no texto.

Tabelas, quadros e figuras devem ser limitados a cinco no conjunto e numerados consecutiva e independentemente com algarismos arábicos, de acordo com a ordem de menção dos dados, e devem vir em folhas individuais e separadas, com indicação de sua localização no texto. **É imprescindível a informação do local e ano do estudo**. A cada um se deve atribuir um título breve. Os quadros e tabelas terão as bordas laterais abertas.

O(s) autor(es) se responsabiliza(m) pela qualidade das figuras (desenhos, ilustrações, tabelas, quadros e gráficos), que deverão ser elaboradas em tamanhos de uma ou duas colunas (7 e 15cm, respectivamente); **não é permitido o formato paisagem**. Figuras digitalizadas deverão ter extensão jpeg e resolução mínima de 400 dpi.

Gráficos e desenhos deverão ser gerados em programas de desenho vetorial (*Microsoft Excel*, *CorelDraw*, *Adobe Illustrator* etc.), acompanhados de seus parâmetros quantitativos, em forma de tabela e com nome de todas as variáveis.

A publicação de imagens coloridas, após avaliação da viabilidade técnica de sua reprodução, será custeada pelo(s) autor(es). Em caso de manifestação de interesse por parte do(s) autor(es), a Revista de Nutrição providenciará um orçamento dos custos envolvidos, que poderão variar de acordo com o número de imagens, sua distribuição em páginas diferentes e a publicação concomitante de material em cores por parte de outro(s) autor(es).

Uma vez apresentado ao(s) autor(es) o orçamento dos custos correspondentes ao material de seu interesse, este(s) deverá(ão) efetuar depósito bancário. As informações para o depósito serão fornecidas oportunamente.

Discussão: deve explorar, adequada e objetivamente, os resultados, discutidos à luz de outras observações já registradas na literatura.

Conclusão: apresentar as conclusões relevantes, considerando os objetivos do trabalho, e indicar formas de continuidade do estudo. **Não serão aceitas citações bibliográficas nesta seção**.

Agradecimentos: podem ser registrados agradecimentos, em parágrafo não superior a três linhas, dirigidos a instituições ou indivíduos que prestaram efetiva colaboração para o trabalho.

Anexos: deverão ser incluídos apenas quando imprescindíveis à compreensão do texto. Caberá aos editores julgar a necessidade de sua publicação.

Abreviaturas e siglas: deverão ser utilizadas de forma padronizada, restringindo-se apenas àquelas usadas convencionalmente ou sancionadas pelo uso, acompanhadas do significado, por extenso, quando da primeira citação no texto. Não devem ser usadas no título e no resumo.

Referências de acordo com o estilo *Vancouver*

Referências: devem ser numeradas consecutivamente, seguindo a ordem em que foram mencionadas pela primeira vez no texto, conforme o estilo *Vancouver*.

Nas referências com dois até o limite de seis autores, citam-se todos os autores; acima de seis autores, citam-se os seis primeiros autores, seguido de *et al*.

As abreviaturas dos títulos dos periódicos citados deverão estar de acordo com o *Index Medicus*.

Não serão aceitas citações/referências de **monografias** de conclusão de curso de graduação, **de trabalhos** de Congressos, Simpósios, *Workshops*, Encontros, entre outros, e de **textos não publicados** (aulas, entre outros).

Se um trabalho não publicado, de autoria de um dos autores do manuscrito, for citado (ou seja, um artigo *in press*), será necessário incluir a carta de aceitação da revista que publicará o referido artigo.

Se dados não publicados obtidos por outros pesquisadores forem citados pelo manuscrito, será necessário incluir uma carta de autorização, do uso dos mesmos por seus autores.

Citações bibliográficas no texto: deverão ser expostas em ordem numérica, em algarismos arábicos, meia linha acima e após a citação, e devem constar da lista de referências. Se forem dois autores, citam-se ambos ligados pelo "&"; se forem mais de dois, cita-se o primeiro autor, seguido da expressão *et al*.

A exatidão e a adequação das referências a trabalhos que tenham sido consultados e mencionados no texto do artigo são de responsabilidade do autor. Todos os autores cujos trabalhos forem citados no texto deverão ser listados na seção de Referências.

Exemplos

Artigo com um autor

Burlandy L. A construção da política de segurança alimentar e nutricional no Brasil: estratégias e desafios para a promoção da intersetorialidade no âmbito federal de governo. Ciênc Saúde Coletiva. 2009; 14(3):851-60. doi: 10.1590/S1413-81232009000300020

Artigo com mais de seis autores

Oliveira JS, Lira PIC, Veras ICL, Maia SR, Lemos MCC, Andrade SLL, *et al*. Estado nutricional e insegurança alimentar de adolescentes e adultos em duas localidades de baixo índice de desenvolvimento humano. Rev Nutr. 2009; 22(4): 453-66. doi: 10.1590/S1415-52732009000400002

Livro

Alberts B, Lewis J, Raff MC. Biologia molecular da célula. 5ª ed. Porto Alegre: Artmed; 2010.

Capítulos de livros

Aciolly E. Banco de leite. In Aciolly E. Nutrição em obstetrícia e pediatria. 2ª ed. Rio de Janeiro: Guanabara Koogan; 2009. Unidade 4.

Dissertações e teses

Duran ACFL. Qualidade da dieta de adultos vivendo com HIV/AIDS e seus fatores associados [mestrado]. São Paulo: Universidade de São Paulo; 2009.

Artigo em suporte eletrônico

Sichieri R, Moura EC. Análise multinível das variações no índice de massa corporal entre adultos, Brasil, 2006. Rev Saúde Pública. 2009 [acesso 2009 dez 18]; 43(Supl 2):

90-7. Disponível em: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-89102009000900012&lng=pt&nrm=iso>. doi: 10.1590/S0034-89102009000900012.

Livro em suporte eletrônico

Brasil. Alimentação saudável para pessoa idosa: um manual para o profissional da saúde. Brasília: Ministério da Saúde; 2009 [acesso 2010 jan 13]. Disponível em: <http://200.18.252.57/services/e-books/alimentacao_saudavel_idosa_profissionais_saude.pdf>.

Capítulo de livro em suporte eletrônico

Emergency contraceptive pills (ECPs). In World Health Organization. Medical eligibility criteria for contraceptive use. 4th ed. Geneva: WHO; 2009 [cited 2010 Jan 14]. Available from: <http://whqlibdoc.who.int/publications/2009/9789241563888_eng.pdf>.

Texto em formato eletrônico

Sociedade Brasileira de Nutrição Parental e Enteral. Assuntos de interesse do farmacêutico atuante na terapia nutricional. 2008/2009 [acesso 2010 jan 14]. Disponível em: <http://www.sbnpe.com.br/ctdpg.php?pg=13&ct=A>.

Para outros exemplos recomendamos consultar as normas do *Committee of Medical Journals Editors* (Grupo Vancouver) <http://www.icmje.org>.

Lista de checagem

- Declaração de responsabilidade e transferência de direitos autorais assinada por cada autor.

- Verificar se o texto, incluindo resumos, tabelas e referências, está reproduzido com letras fonte *Arial,* corpo 11 e entrelinhas 1,5 e com formatação de margens superior e inferior (no mínimo 2,5cm), esquerda e direita (no mínimo 3cm).

- Indicação da categoria e área temática do artigo.

- Verificar se estão completas as informações de legendas das figuras e tabelas.

- Preparar página de rosto com as informações solicitadas.

- Incluir o nome de agências financiadoras e o número do processo.

- Indicar se o artigo é baseado em tese/dissertação, colocando o título, o nome da instituição, o ano de defesa.

- Incluir título do manuscrito, em português e em inglês.

- Incluir título abreviado (*short title*), com 40 caracteres, para fins de legenda em todas as páginas.

- Incluir resumos estruturados para trabalhos submetidos na categoria de originais e narrativos para manuscritos submetidos nas demais categorias, com um número de 150 palavras e no máximo 250 palavras nos dois idiomas, português e inglês, ou em espanhol, nos casos em que se aplique, com termos de indexação.

- Verificar se as referências estão normalizadas segundo estilo *Vancouver*, ordenadas na ordem em que foram mencionadas pela primeira vez no texto, e se todas estão citadas no texto.

- Incluir permissão de editores para reprodução de figuras ou tabelas publicadas.

- Cópia do parecer do Comitê de Ética em pesquisa.

Documentos

Declaração de responsabilidade e transferência de direitos autorais

Cada autor deve ler e assinar os documentos (1) Declaração de Responsabilidade e (2) Transferência de Direitos Autorais, nos quais constarão:

- Título do manuscrito:

- Nome por extenso dos autores (na mesma ordem em que aparecem no manuscrito).

- Autor responsável pelas negociações:

1. Declaração de responsabilidade: todas as pessoas relacionadas como autoras devem assinar declarações de responsabilidade nos termos abaixo:

- "Certifico que participei da concepção do trabalho para tornar pública minha responsabilidade pelo seu conteúdo, que não omiti quaisquer ligações ou acordos de financiamento entre os autores e companhias que possam ter interesse na publicação deste artigo".

- "Certifico que o manuscrito é original e que o trabalho, em parte ou na íntegra, ou qualquer outro trabalho com conteúdo substancialmente similar, de minha autoria, não foi enviado a outra Revista e não o será, enquanto sua publicação estiver sendo considerada pela Revista de Nutrição, quer seja no formato impresso ou no eletrônico".

2. Transferência de Direitos Autorais: "Declaro que, em caso de aceitação do artigo, a Revista de Nutrição passa a ter os direitos autorais a ele referentes, que se tornarão propriedade exclusiva da Revista, vedado a qualquer

reprodução, total ou parcial, em qualquer outra parte ou meio de divulgação, impressa ou eletrônica, sem que a prévia e necessária autorização seja solicitada e, se obtida, farei constar o competente agradecimento à Revista".

Assinatura do(s) autores(s) Data ____/____/____

Justificativa do artigo

Destaco que a principal contribuição do estudo para a área em que se insere é a seguinte: _____

(Escreva um parágrafo justificando porque a revista deve publicar o seu artigo, destacando a sua relevância científica, a sua contribuição para as discussões na área em que se insere, o(s) ponto(s) que caracteriza(m) a sua originalidade e o consequente potencial de ser citado)

Dada a competência na área do estudo, indico o nome dos seguintes pesquisadores (três) que podem atuar como revisores do manuscrito. Declaro igualmente não haver qualquer conflito de interesses para esta indicação.

Toda correspondência deve ser enviada à Revista de Nutrição no endereço abaixo

Núcleo de Editoração SBI - *Campus* II
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Web: http://www.scielo.br/rn

GUIDE FOR AUTHORS

Scope and policy

The **Brazilian Journal of Nutrition** is a specialized periodical that publishes articles that contribute to the study of Nutrition in its many sub-areas and interfaces. It is published bimonthly and open to contributions of the national and international scientific communities.

Submitted manuscripts may be rejected without detailed comments after initial review by at least two **Brazilian Journal of Nutrition** editors if the manuscripts are considered inappropriate or of insufficient scientific priority for publication in the Journal.

The Board of Editors does not assume responsability for concepts and illustrations emitted in signed articles.

Article category

The Journal accepts unpublished articles in Portuguese, Spanish or English, with title, abstract and keywords in the original language and in English, in the following categories:

Original: contributions that aim to disclose the results of unpublished researches, taking into account the relevance of the theme, the scope and the knowledge generated for the research area (maximum limit of 5 thousand words).

Special: invited articles on current themes (maximum limit of 6 thousand words).

Review (by invitation): synthesis of the knowledge available on a given theme, based on analysis and interpretation of the pertinent literature, aiming to make a critical and comparative analysis of the works in the area and discuss the methodological limitations and its scope. It also allows the indication of perspectives of continuing studies in that line of research (maximum limit of 6 thousand words). There will be a maximum of two reviews per issue.

Communication: information reported on relevant themes and based on recent research, whose objective is to subsidize the work of professionals who work in the field, serving as a presentation or update on the theme (maximum limit of 4 thousand words).

Scientific note: partial unpublished data of an ongoing research (maximum limit of 4 thousand words).

Essay: works that can bring reflection and discussion of a subject that generates questioning and hypotheses for future research (maximum limit of 5 thousand words).

Thematic Section (by invitation): section whose aim is to publish 2 or 3 coordinated articles from different authors covering a theme of current interest (maximum of 10 thousand words).

Article's category and subject area

Authors should indicate the article's category and subject area, namely: food and social sciences, nutritional assessment, nutritional biochemistry, nutrition, nutrition education, epidemiology and statistics, micronutrients, clinical nutrition, experimental nutrition, nutrition and geriatrics, nutrition, maternal and infant nutrition in meal production, food and nutrition policies and health.

Research involving living beings

Results of research involving human beings and animals, must contain a copy of the Research Ethics Committee approval.

Registration of Clinical Trials

Articles with results of clinical researches must present an identification number in one of the Register of Clinical Trials validated by criteria established the the World Health Organization (WHO) and International Committee of Medical Journal Editors (ICMJE), whose addresses are available at the ICMJE site. The identification number must be included at the end of the abstract.

Editorial procedures

Authorship

The list of authors, included below the title, should be limited to 6. The authorship credit must be based on substantial contributions, such as conception and design, or analysis and interpretation of the data. The inclusion of authors whose contribution does not include the criteria mentioned above is not justified.

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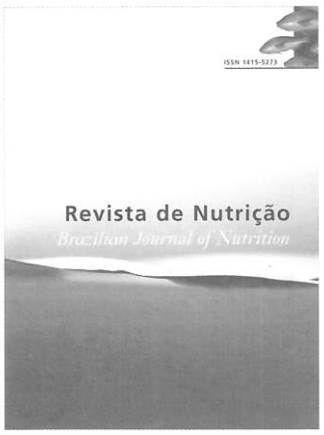

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