ASSOCIATION BETWEEN ANTHROPOMETRIC AND BIOCHEMICAL MEASURES, BODY COMPOSITION AND FOOD INTAKE IN OVERWEIGHT INDIVIDUALS

Associação entre medidas antropométricas, de composição corporal, bioquímicas e de consumo alimentar em indivíduos com excesso de peso

Asociación de medidas antropométricas, composición corporal, bioquímicas y de consumo alimentario em indivíduos com exceso de peso

Original Article

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ABSTRACT

Objective: To evaluate the association between the anthropometric and biochemical measures, body composition and food intake in overweight individuals. **Methods:** Cross-sectional study with a convenience sample of 31 individuals, aged between 19 and 59 years. Anthropometric and biochemical variables were assessed and diet composition was analyzed. The diet quality index (DQI) was then calculated. In the statistical analysis, the Shapiro-Wilk test checked the distribution of variables, the Wilcoxon-Mann-Whitney-U checked the differences between them and Spearman/Pearson correlation tracked the association between the values. It was adopted p with 5% of probability. **Results:** The diet composition analysis showed an average intake above the Dietary Reference Intakes for carbohydrate (323.31±33.11g), protein (80.15±29.84g), lipid (77.42±31.87g) and sodium (2,896.99±1,119.05mg). The DQI values varied between 2 and 12 points, with mean value of 6.5 ± 2.2. Correlations were found between DQI and the suprailiac skinfold, total cholesterol, LDL-cholesterol (mg/dL), among others. **Conclusion:** The sample showed a food intake profile comprising food rich in carbohydrates, lipids and sodium. The high average score of DQI (poor diet) reflects the importance of intervention measures aiming to improve the food pattern of these individuals.

Descriptors: Nutritional Status; Food Consumption; Body Composition.

RESUMO

Objetivo: *Avaliar a associação entre medidas antropométricas, de composição corporal, bioquímicas e de consumo alimentar em indivíduos com excesso de peso.* **Métodos:** *Estudo do tipo transversal, com amostra de conveniência composta por 31 indivíduos, com idade entre 19 e 59 anos. Foram realizadas avaliações antropométricas, bioquímicas e análise da composição da dieta. Após, foi calculado o índice de qualidade da dieta (IQD). Na análise estatística, o teste de Shapiro-Wilk verificou a distribuição das variáveis, Wilcoxon-Mann-Whitney-U as diferenças entre as variáveis e correlação de Spearman/Pearson rastreou a associação entre os valores. Foi adotado um p com 5% de probabilidade.* **Resultados:** *A análise da composição da dieta permitiu observar uma média de consumo acima das Dietary Reference Intakes para carboidrato (323,31±33,11g), proteína (80,15±29,84g), lipídeo (77,42±31,87g) e sódio (2896,99±1119,05mg). Os valores para o IQD variaram entre 2 e 12 pontos, apresentando valor médio de 6,5±2,2. Foram encontradas correlações entre IQD e prega cutânea suprailíaca, colesterol total, e LDL-c (mg/dL), dentre outras.* **Conclusão:** *A amostra estudada apresentou um perfil de ingestão alimentar composto por alimentos ricos em carboidratos, lipídeos e sódio. A elevada média da pontuação do IQD (dieta pobre) reflete a importância de medidas de intervenção visando à melhoria do padrão alimentar desses indivíduos.*

Descritores: *Estado Nutricional; Consumo de Alimentos; Composição Corporal.*

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RESUMEN

Objetivo: *Evaluar la asociación de medidas antropométricas, composición corporal, bioquímicas y consumo alimentario en individuos con exceso de peso.* **Métodos:** *Estudio del tipo trasversal, con muestra de conveniencia constituida de 31 individuos con edad entre los 19 y 59 años. Fueron realizadas evaluaciones antropométricas, bioquímicas y el análisis de la composición de la dieta. Después, fue calculado el índice de calidad de dieta (ICD). En el análisis estadístico, la prueba de Shapiro-Wilk verificó la distribución de las variables, Wilcoxon-Mann-Whitney-U las diferencias entre las variables y la correlación de Spearman/Pearson rastreó la asociación entre los valores. Fue adoptado un p con el 5% de probabilidad.* **Resultados:** *El análisis de la composición de la dieta permitió observar una media de consumo por encima de las Dietary Reference Intakes para carboidrato (323,31±33,11g), proteína (80,15±29,84g), lipidio (77,42±31,87g) y sodio (2896,99±1119,05mg). Los valores para el IQD variaron entre 2 y 12 puntos, presentando valor medio de 6,5±2,2. Fueron encontradas correlaciones entre el IQD y pliega cutánea suprailiaca, colesterol total, y LDL-c (mg/dL), entre otras.* **Conclusión:** *La muestra estudiada presentó un perfil de ingesta alimentaria constituido por alimentos ricos en carbohidratos, lípidos y sodio. La elevada media de la puntuación del IQD (dieta pobre) refleja la importancia de medidas de intervención con el objetivo de mejorar el patrón alimentario de esos individuos.*

Descriptores: *Estado Nutricional; Consumo de Alimentos; Composición Corporal.*

INTRODUCTION

The obesity is a complex and multifactorial disease, characterized by excessive accumulation of body fat. Its etiology is not easy to identify, since there are several involved factors which may interfere for its development, such as: the behavioral, cultural, genetic, physiological and psychological factors[1,2].

The World Health Organization considers that obesity is a public health problem that affects both developed and developing countries[1-5]. WHO data show that the number of obese people between 1995 and 2000 increased from 200 to 300 million people, reaching almost 15% of the world population. In Brazil, the analysis of secular trend shows that obesity among adults is expanding and it has reached, between 2008 and 2009, at least 10% of the population in all regions of the country[6].

The excessive body fat, especially abdominal, is associated with cardiovascular risk factors such as: dyslipidemia, type 2 diabetes and hypertension, besides metabolic disorders, various cancers types, digestive disorders and cerebrovascular diseases[1,7,8]. For being strongly associated with the development of cardiovascular disease and having a high correlation to laboratory methods for body composition assessment, the measurement of waist circumference has been widely used in population-based studies as an indicator of body fat.

Another method to detect excessive adiposity – traditionally used as an anthropometric indicator due to easy application and low operating cost – is the Body Mass Index (BMI)[5], which shows a good correlation between body fat and metabolic changes arising from obesity[9].

In addition to anthropometry, eating habits allows for the detection of risk of comorbidities. In order to quantify the dietary pattern, indexes have been proposed, such as the Diet Quality Index (DQI)[10,11], whose method, developed in the 90's[12], allowed the creation of a measurement instrument of the global diet quality that would reflect a gradient of risk of many nutrition-related chronic diseases. Such instrument enables the identification of people who have high-quality diet, based on the range of nutritional needs, without increasing the intake of total and saturated fat. This index is based on the importance of certain nutrients and the dietary recommendations of Diet and Health[10].

Individuals who are overweight may have poor quality diets, which leads to changes in lipid, glucose, inflammatory and hormonal metabolism. The alteration in metabolic homeostasis can exert influence on body composition, increasing the risk for chronic diseases. Considering the increasing prevalence of obesity and its associated risk factors, it becomes important to better understand the food patterns of these individuals[13].

Thus, the aim of this study was to evaluate the association between body composition, food intake, anthropometric and biochemical measures in overweight individuals.

METHODS

This is a pilot cross-sectional study conducted between 2009 and 2010 with adults assisted at the Clinic of the Nutrition School located in the Health Center of the Federal University of Ouro Preto (UFOP). The study used a consecutive non-probability sampling. Individuals who sought nutritional care were invited to participate in this research, reaching a total of 31 individuals between 19 and 59 years old who were overweight.

In order to be included in the study, the volunteers, regardless of gender, should be over 18 years old and have nutritional diagnosis of overweight or obesity. Those who signed the Free Informed Consent and met the inclusion criteria were selected to participate in the present study. Children and teens who were 18 years old or younger and individuals with nutritional diagnosis of eutrophy or underweight were excluded.

First, an interview was carried out for the identification of patients and then the nutritional assessment (anthropometric, biochemical, clinical and dietary) was performed.

The anthropometric assessment was made from measurements of body weight (kg), height (m), arm circumference (AC-mm), waist circumference (WC-cm), hip circumference (HC-cm), triceps skinfold (TSF-mm), biceps skinfold (BSF-mm), subscapular skinfold (SSF-mm), suprailiac skinfold (SISF-mm), BMI and waist-hip ratio (WHR)[14-18].

The body weight measurement was done using a digital scale (*Welmy*™ - capacity of 150 kg) with volunteers standing still on the center of the scale on barefoot and wearing light clothes. Height was measured using a metal stadiometer attached to the digital balance with a 0.1 mm precision[14].

The BMI was calculated by the following formula: BMI = weight (kg) / height^2 (m^2). The nutritional status of overweight individuals was classified according to the cutoff points proposed by the WHO (1997)[15], which consider the BMI between 25.0 and 29.9kg/m^2 (overweight), 30.0 and 34.9kg/m^2 (obesity I), 35.0 e 39.9kg/m^2 (obesity II) and ≥40.0 kg/m^2 (obesity III). This study included individuals with excess weight (overweight) and obesity.

The AC was measured using an inelastic measuring tape with precision of 0.1 cm at the midpoint between the acromion and olecranon[14,16]. WC was measured using the same inelastic tape at the midpoint between the last rib and the iliac crest (on the natural curvature)[17]. HC was measured using the flexible tape around the widest portion of the buttocks[18].

The waist-hip ratio (WHR), determined by the equation WHR = WC / HC, was used to identify the type of fat distribution and the risk for developing cardiovascular diseases[18]. The measures of TSF, BSF, SSF and SISF were obtained using Cescorf™ skinfold caliper according to WHO guidelines[14]. Reference data were used to classify the AC and TSF[17].

During the first consultation, it was required the following laboratory tests: complete blood count, lipid profile (total cholesterol, its fractions and triglycerides) and glucose for later determination in the Pilot Laboratory of Clinical Analysis (LAPAC/DEACL/UFOP).

The evaluation of the diet intake was done through a 24-hour recall – individuals reported foods and beverages consumed on the day before. In cases in which there was not a 24-hour recall, the dietary intake was assessed by the first day of the 72-hour food record – a method which individuals record the food and drinks they consume in three alternate days, two weekdays (typical days) and one day of the weekend (atypical day). These data were typed in VirtualNutri™ software to obtain the quantitative analysis of macro and micronutrients in the diet of the participants. With this result, it was obtained a database (Microsoft Excel™) which allowed for the evaluation of the diet quality using the DQI.

The DQI incorporates eight elements of the diet: total fat, saturated fat, cholesterol, number of servings of fruits and vegetables, number of servings of cereals and legumes, and protein, sodium and calcium intake. The scoring, stratified into three scores (0, 1 and 2) added according to the eight recommendations, showed the DQI of the volunteers. Those who have received a minimum score (zero) were classified as "excellent diet" and diets with a maximum score (16) were rated as "poor diet"[10].

For statistical analysis, it was used the descriptive analysis of the conditions assessed (anthropometric nutritional status, biochemical profile and dietary pattern). The data were presented using mean, standard deviation and interquartile range. The Shapiro-Wilk test with a 5% significance level verified the data distribution (variables with parametric and non-parametric distribution). The comparisons between variables were performed using the Wilcoxon-Mann-Whitney-U test, and Spearman/Pearson correlation tracked the association between the studied variables. These statistical tests were performed in the SPSS software, 17.0 version.

The study was approved by the Research Ethics Committee of the Federal University of Ouro Preto under protocol No. CEP 073/2011. All volunteers signed the Free Informed Consent.

RESULTS

In the present study, the volunteers had an average age of 33 years old; 74% (n=23) were women and 26% (n=8) men.

The studied sample showed excessive adiposity verified by waist and hip circumference, TSF, BSF, SSF, SISF, WHR and BMI. This was expected, since the volunteers that were selected to participate in this study should be overweight (BMI>25.0) (Table I).

In biochemical analysis, it was observed changes in the average levels of LDL-c (107.20±36.56 mg/dL) and HDL-c (49.25±13.57mg/dL) (Table I).

The diet composition analysis showed an average consumption above the DRIs for: carbohydrates (323.31±33.11g), which the reference value is 130g; protein (80.15±29.84g) which has a DRI of 56g for men and 46g for women; lipids (77.42±31.87g) and sodium (2896.99±1119.05mg) whose daily values recommended are 55g and 2400mg, respectively.

The average intake of Vitamin A (682.59±748.90µg) was below the recommended daily value of 900µg for men

Table I - Anthropometric, body composition, clinical and biochemical data of the sample volunteers (n = 31). Ouro Preto (MG), 2009-2010.

Variables	Mean±SD	IQ	*p*
BMI (kg/m²)	32.83±4.93	29.57-34.64	<0.0044
WC (cm)	103.32±12.06	96.50-110.25	<0.5897
HC (cm)	114.4±29.89	110-120	<0.3035
WHR	0.89±0.085	0.84-0.93	<0.0008
TSF (mm)	39.38±44.34	26-37.30	<0.0001
BSF (mm)	50.37±63.11	30.75-35.75	<0.0001
SSF (mm)	52.56±76.35	19-48	<0.0001
SISF (mm)	68.81±106.05	24-32	<0.0001
Red Blood Cells (x10⁶/mm³)	4.81±0.50	4.6-5.1	<0.6432
Hematocrit (%)	41.48±4.54	37.9-46	<0.5115
Hemoglobin (g/dL)	13.67±2.27	12.65-15.25	<0.0128
MCV(u³)	86.89±6.86	84.3-91.7	<0.1737
MCH (pg)	28.95±2.84	28.0-30.40	<0.0287
MCHC (%)	32.66±2.51	32-34	<0.0001
Platelets (mm³)	263.18±88.35	224.5-282.5	<0.0003
Leukocytes (mm³)	7.36±1.64	6.25-8.40	<0.5103
Segs(mm³)	10.79±16.89	3.90-6.0	<0.0001
Eosinophils (mm³)	216.46±223.97	2.9-404	<0.0491
T- lymphocytes (mm³)	103.21±389.73	1.88-3.36	<0.0001
Monocytes (mm³)	378±144.81	301-504	<0.8002
Glucose (mg/dL)	93.13±17.01	85-96	<0.0040
Cholesterol (mg/dL)	186.01±38.13	143.7-212	<0.1698
Triacylglycerols (mg/dL)	135.08±64.09	75-190	<0.2009
LDL-c (mg/dL)	107.20±36.56	81.5-138.8	<0.8911
HDL-c (mg/dL)	49.25±13.57	40-59	<0.6786

SD: Standard deviation; IQ: Interquartile range (Q25 – Q75); BMI: Body Mass Index; WC: waist circumference; HC: hip circumference; WHR: waist-hip ratio; TSF: triceps skinfold; BSF: biceps skinfold; SSF: subscapular skinfold; SISF: suprailiac skinfold; MCV: mean corpuscular volume; MCH: mean corpuscular hemoglobin, MCHC: mean corpuscular hemoglobin concentration, LDL-c: low density lipoprotein, HDL-c: high density lipoprotein. *Shapiro-Wilk p*< 0,05.

and 700µg for women, just like the intake of calcium and magnesium which presented average values of 784.16 mg (±536.76) and 190.67mg (±82.05), respectively. The total fiber intake was below the DRIs (25g) with an average of 16.89g (±8.02). The intake of soluble (2.91±2.4g) and insoluble (5.00±2.74g) fibers was also below the recommended daily intake, which is 5 to 10g of soluble fibers and 15 to 20g of insoluble fibers. The DQI values ranged from two to 12 points with an average value of 6.5±2.2.

In the analysis of the correlation between anthropometric measurements of body composition and clinical measures and DQI values (Table II), there was a correlation between SISF and DQI ($p<0.05$). For the other variables, no significant correlation was found ($p>0.05$). When correlating the biochemical values to the DQI, it was observed an association of total cholesterol and LDL-c with DQI ($p<0.05$); however, there was no significant correlation for the other variables (Table II).

When correlating the DQI to the data referring to macronutrients in the diet, it could be observed significant correlations ($p<0.05$) for carbohydrate, lipid, polyunsaturated, monounsaturated and saturated fat percentages (Table II). Regarding micronutrients, there were significant correlations ($p<0.05$) for vitamin E, vitamin B12, sodium, zinc and selenium. No significant correlations were found for the other data ($p>0.05$).

Table II - Significant correlations between DQI and anthropometric, body composition, clinical and dietary data of the sample volunteers (n = 31). Ouro Preto (MG), 2009-2010.

Variables	**DQI**	
	r	***p***
SISF (mm)	0.89865	*0.0149*
Cholesterol (mg/dl)	0.52977	*0.0237*
LDL-c (mg/dl)	0.47433	*0.0544*
% Carbohydrate	0.68790	*<0.0001*
Lipids(g)	0.48177	*0.0052*
Polyunsaturated (g)	0.61112	*0.0002*
Monounsaturated (g)	0.68512	*<0.0001*
Saturated (g)	0.56964	*0.0007*
% Saturated	0.73741	*<0.0001*
Vitamin B12 (µg)	0.37352	*0.0352*
Vitamin E (mg)	0.38056	*0.0317*
Zinc (mg)	0.40577	*0.0212*
Selenium (mg)	0.37000	*0.0371*

SISF: suprailiac skinfold; LDL-c: low density lipoprotein.
r: *Spearman/Pearson correlation*; $p < 0.05$.

DISCUSSION

The analysis of anthropometric data and body composition data showed adiposity excess once the volunteers who were selected to participate in the study were overweight. The average BMI was 32.83 kg/m^2, a value close to that found in a study that aimed to identify the prevalence of overweight and its association with other variables in individuals treated at a Basic Healthcare Unit in Nova Prata, RS[19]. In a study conducted in 2010 with adult volunteers who were overweight or obese, the average BMI was 32.2 kg/m^2[20].

Obesity is a worldwide disease that is present in both developed and developing countries, being considered one of the major health problems nowadays[21]. The overweight and weight alterations in adulthood are related to the increase in mortality risk and the development of non-communicable chronic diseases (NCDs), including the increased incidence of breast cancer, cardiovascular disease and metabolic syndrome (MS)[22].

A study that analyzed medical records to assess the socioeconomic, anthropometric, biochemical and lifestyle profile of patients participating in the "Weight Control Program" of the Hospital of the Federal University of Goiás found average levels of 47mg/dL for HDL-c and 130mg/dL for LDL-C[23]. The same result was found in another study that evaluated the clinical and metabolic characteristics of obese patients at a multidisciplinary clinic of a University Hospital in Salvador, BA[24]. These results were similar to those found in the present study, which found values of LDL-C above the reference for biochemical tests and HDL-c levels below the reference.

It is known that the intake of food rich in fat, sugar and pasta, and the low intake of fruits, vegetables and legumes contributed to the increase in obesity development[25]. A study conducted between 2000 and 2006 with overweight and obese patients of a clinic in Porto Alegre, RS, observed a high consumption of lipids, carbohydrates and proteins and a reduced intake of fruit and vegetables[26]. A similar result was found in another study[27] that assessed the diet quality of the employees of a public university through the Healthy Eating Index (HEI). In this study, it was observed a low intake of total fiber because of the reduced intake of fruit and vegetables and the high intake of fat food. The same result was observed in the current study, which showed a high intake of carbohydrate, lipid and protein, and a low intake of fruit, vegetables and legumes.

The insufficient fiber intake is associated with excess weight, since cereal fibers and products made from whole grains are able to prevent obesity and weight gain, besides contributing to the decrease in the risk for type 2 diabetes development[28].

This study observed that the average intake of vitamin A is below what is recommended. A similar result was found in a study that identified the antioxidant nutrients consumption profile in patients with metabolic syndrome[29]. Vitamin A has been extensively studied due to its antioxidant activity and capacity to help prevent NCDs, besides playing an important role in the regulation of body composition. The adipose tissue is responsible for up to 20% of the body retinol, and studies have shown that in the occurrence of vitamin A deficiency, there is increased mobilization of preadipocytes into mature adipocytes, besides the thermogenesis and apoptosis inhibition, contributing to the increase in body adiposity, especially the retroperitoneal adiposity[29].

According to the 2008-2009 Household Budget Survey (POF), the Brazilian population showed an increase of 37% in the intake of processed food, industrial mixes and fruit (17.9%) – compared to the 2002-2003 POF – and significant reduction in the purchase of oilseeds, cereals and legumes. The number of obese people is growing every day, which shows that these small changes do not contribute, effectively to reducing overweight and obesity prevalence in the Brazilian population[30].

It was observed an average intake of sodium above the recommended daily value, a result that contrasts with those described in two studies[31,32] that found an average sodium intake of 1531±1041mg and 1483±777.9mg, respectively. The high sodium intake and overweight are associated with the high prevalence of hypertension, a problem that is considered dangerous and difficult to control[31,32].

The quantitative analysis of the diet composition was performed using the 24-hour recall method, which uses the memory of the interviewee and the interviewer's technical capacity, making it imprecise and subjected to measurement errors. Moreover, for considering one day of recall only, it may end up not representing the individual's usual intake due to the variability in nutrients intake[33]. On the other hand, the use of the 24-hour recall for quantitative analysis of calcium intake may be a suitable method since the number of samples is reasonable (between 50 and 100 volunteers) and it is used during three days at least[34].

The calcium and magnesium intake observed in this study was lower than the DRI. Studies[35,36] have shown that a low calcium intake in the diet is directly associated with NCDs. The increased calcium intake reduces salt sensitivity and lowers blood pressure, especially in hypertensive individuals. However, the calcium-obesity relationship is explained by the increased intracellular availability, capable of promoting lipogenesis increase and lipolysis inhibition. Calcium is also related to the adiposity and metabolic disorders control by associating with fatty acids in the gastrointestinal tract, decreasing the intestinal absorption of fat[35,36].

In order to evaluate the diet quality in this study, it was used the DQI, which assesses the compliance degree of healthy diet according to certain nutrients and their recommendations. The values found for the DQI ranged from two to 12 points with an average value of 6.5±2.2. It was observed that the sample of volunteers showed an inadequacy regarding to the quality of the diet. A study that evaluated the diet quality of adults in metropolitan regions of São Paulo demonstrated that about 21% of the sample presented an inadequate diet and 75% needed adjustments in the dietary composition[37].

When analyzing the anthropometric variables and the DQI, it was observed a significant correlation ($p<0.05$) between SISF and DQI. However, no data were found in the literature to corroborate such results.

Diets classified as "poor diets" and rich in saturated fats may lead to increased concentrations of total cholesterol and LDL-c and decreased levels of HDL-c, besides providing a lower release of proteins related to satiety, leading to a higher caloric intake and a positive energy balance, which is one of the main causes of obesity[38].

In the present study it was observed a positive association between DQI and carbohydrate, monounsaturated, polyunsaturated and saturated fat intake. A similar result was found in the study that assessed the diet quality through the HEI[27]. The study[39] which sought to adapt and apply the U.S DQI to assess the diet quality of individuals who lived in Botucatu, SP, found inverse associations between DQI and lipid, percentage of saturated fat and sodium[39] – a result that differs from the findings of this study.

It is clear that an inadequate diet, rich in saturated fats, carbohydrates and protein, and a low intake of micronutrients that are essential for health, like calcium and magnesium, can significantly contribute to the development of obesity and other chronic diseases.

CONCLUSION

The results of this study showed that the food intake was characterized by a high consumption of foods rich in carbohydrates, lipids and sodium, and a low consumption of foods rich in fiber, vitamins and minerals. This fact was already expected since overweight individuals can present, in general, greater preference for tastier food, like fats and simple sugars with high calorie density.

Through the calculation of the DQI, it was observed a high scoring average. This result shows the importance of intervention measures aimed to improve the diet quality of these individuals, and preventive measures for obesity and chronic diseases.

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