

# ASSOCIATION BETWEEN FOOD INTAKE AND ANTHROPOMETRIC AND METABOLIC PROFILE OF BRAZILIAN ADULT WOMEN

## ASOCIACIÓN ENTRE INGESTA ALIMENTARIA Y PERFIL ANTROPOMÉTRICO Y METABÓLICO DE MUJERES ADULTAS BRASILEÑAS

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### ABSTRACT

**Introduction:** Alterations in the lipid, glycemic and hemodynamic profile may increase the risk of developing chronic diseases and mortality. **Objective:** Associate the metabolic and anthropometric parameters and food intake of Brazilian adult women. **Methods:** A cross-sectional study was conducted with 34 Brazilian women aged 20-59 years old. Alcohol consumption, smoking, physical exercise, blood pressure, anthropometric and food intake data were collected. Glycated hemoglobin and lipid fractions were also evaluated. **Results:** There was a positive association between energy consumption and body mass ( $\beta = 0.377, p = 0.028$ ) and waist circumference ( $\beta = 0.373, p = 0.030$ ), and between protein intake and body fat percentage ( $\beta = 0.368, p = 0.032$ ). There was also a positive association between waist circumference and the values of glycated hemoglobin ( $\beta = 0.401, p = 0.019$ ), and HDL-cholesterol was influenced directly by protein intake ( $\beta = 0.573, p = 0.013$ ) and inversely by lipid intake ( $\beta = -0.597, p = 0.010$ ). **Conclusion:** Anthropometry, metabolic profile and food intake were associated among the Brazilian adult women evaluated.

### RESUMEN

**Introducción:** Las alteraciones en el perfil lipídico, glucémico y hemodinámico pueden aumentar el riesgo de enfermedades crónicas y mortalidad. **Objetivo:** Asociar los parámetros metabólicos, antropométricos y el consumo de alimentos de mujeres adultas brasileñas. **Métodos:** Se realizó un estudio transversal con 34 mujeres brasileñas de 20 a 59 años. Se recogieron datos sobre el consumo de alcohol, tabaco, ejercicio, presión arterial, antropometría y consumo de alimentos. También se evaluaron la hemoglobina glicosilada y las fracciones lipídicas. **Resultados:** Se encontró una asociación positiva entre el consumo de energía y los valores de masa corporal ( $\beta = 0.377, p = 0.028$ ) y la circunferencia de la cintura ( $\beta = 0.373, p = 0.030$ ), y entre el consumo de proteínas y el porcentaje de grasa corporal ( $\beta = 0.368, p = 0.032$ ). También hubo una influencia positiva de la circunferencia de la cintura en los valores de hemoglobina glicosilada ( $\beta = 0.401, p = 0.019$ ), y el HDL-c estuvo directamente influenciado por el consumo de proteínas ( $\beta = 0.573, p = 0.013$ ) e inversamente por el consumo de grasas ( $\beta = -0.597, p = 0.010$ ). **Conclusión:** La antropometría, el perfil metabólico y el consumo de alimentos se asociaron entre las mujeres adultas brasileñas evaluadas.

### INTRODUCCIÓN

One of the major health problems found in the Brazilian population is related to excess body mass, which involves both physical limitations and metabolic alterations that directly influence the economic, social and health conditions, not only of the individual, but also of the whole society.<sup>1,2</sup> Regarding metabolic profile, obese individuals, when compared to eutrophic ones, present higher levels of total cholesterol, LDL-cholesterol,

triglycerides and blood pressure.<sup>3</sup>

In this sense, the evaluation of biomarkers related to lipid profile, blood glucose, anthropometry and food intake may reduce the risk of developing chronic diseases, such as cardiovascular and diabetes mellitus, which increase morbidity and reduce life expectancy.<sup>2,4</sup> For this evaluation, the use of statistical measures, such as regression coefficient ( $\beta$ ) e determination coefficient ( $R^2$ ), are efficient in

assessing the degree of relationship among these variables, which would contribute to the planning of actions to improve these health parameters.<sup>5</sup>

In Brazil, the Family Health Strategy (FHS) is a program created with the aim of reorganizing primary care through an interdisciplinary approach focused on health promotion, prevention, rehabilitation and cure of diseases<sup>6</sup>, and epidemiological studies in some regions of the country have shown that adult women seek more medical care than men, for reasons such as greater concern about health.<sup>1</sup>

Therefore, it is necessary to investigate the health status of Brazilian individuals assisted by FHS, taking into consideration their anthropometric, metabolic and nutritional characteristics, instead of evaluating only an isolated factor. This expanded assessment allows for specific actions focused on their health issues. Thus, the objective of the present study was to associate the metabolic, anthropometric and food consumption parameters of Brazilian adult women.

## MATERIALS AND METHODS

### Study design and ethical aspects

This cross-sectional study was conducted in February 2017 with adult women from the Midwest region of Brazil. This research was approved by the Research Ethics Committee of the Federal University of Goiás (protocol n° 784.446 / 2014). All the participants signed the Term of Free and Informed Consent.

### Sample size and selection criteria

In total, 51 subjects agreed to participate, but 15 did not meet the inclusion criteria, so data were collected from 34 women, 20 to 59 years old. The sample size of the study presented an effect size of 0.25, which means that the sample presented a small effect size, determined from a sample power of 0.80,  $\alpha = 0.05$  and  $\beta = 0.20$ , according to the sample calculation performed in the G\*Power program version 3.1.

As most people who attend the FHS are female, and to standardize the sample, inclusion criteria were: be female and adult (population within the age group 20-59 years old). Pregnant women, children, adolescents and people with physical and/or cognitive limitations that made it impossible to collect data were excluded.

### Evaluation protocols

Lifestyle, physical activity practice, blood pressure, anthropometry, biochemical parameters and food consumption data were collected.

Alcohol and tobacco consumption and physical exercise practice were collected through a specific questionnaire for the evaluation of lifestyle.

For the hemodynamic evaluation, systolic (SBP) and diastolic (DBP) blood pressure were measured in duplicate with the electronic and digital equipment Omron® (model HEM-705 CP, Hoofddorp, Netherlands). SBP values  $\geq 140$  mmHg and/or DBP  $\geq 90$  mmHg, or who used antihypertensive drugs, were considered as hypertensive.<sup>7</sup>

Body mass (BM), height (H), body mass index (BMI), waist circumference (WC), waist-to-height ratio (WHtR) and percentage of body fat (%BF) were evaluated as anthropometric parameters. BM was measured on an electronic scale (Plenna®, acqua model, São Paulo, Brazil) and H was measured in a portable stadiometer (Seca®, model 213, Hamburg, Germany). From these two variables, BMI ( $\text{kg}/\text{m}^2$ ) was obtained, and individuals with values between 18.5–24.9  $\text{kg}/\text{m}^2$  were considered eutrophic, between 25–29.9  $\text{kg}/\text{m}^2$  overweight and  $\geq 30$   $\text{kg}/\text{m}^2$  obese.<sup>8</sup> The WC was measured in duplicate at the midpoint between the lower portion of the last rib and the iliac crest with an inextensible anthropometric tape (Cescor®, Porto Alegre, Brazil). WC values  $< 80$  cm were classified as optimal and  $\geq 80$  cm as high.<sup>9</sup> The WHtR was calculated by dividing the WC by H, with values  $\leq 0.5$  being considered as optimal.<sup>10</sup> The %BF was determined from the resistance and reactance obtained by bioimpedance (Bioelectrical Impedance Analyzer, RJL Systems®, model Quantum II, Michigan, United States). Body Compositions Analysis 2.1 software was used to analyze the values obtained. All procedures followed the manufacturer's recommendations.

The metabolic profile was evaluated considering glycated hemoglobin and lipid fractions (total cholesterol, HDL-cholesterol, LDL-cholesterol, non HDL-cholesterol and triglycerides). Approximately 8mL of blood was collected, with women fasting for 10 hours. A colorimetric test was performed for the determination of glycated hemoglobin (TP-Analyzer Thermoplate®, semi-automatic biochemical analyzer). Glycated hemoglobin  $<$

5.7 % were classified as optimal and  $\geq 5.7$  % as high (5.7-6.4 % classified with prediabetes and  $\geq 6.5$  % with diabetes).<sup>11</sup>

The fractions of HDL-cholesterol, total cholesterol and triglycerides were analyzed in the Labmax Plenno® equipment. The LDL-cholesterol were obtained from the subtraction of total cholesterol by HDL-cholesterol and VLDL-cholesterol, and non HDL-c was calculated by subtracting total cholesterol by HDL-cholesterol. Total cholesterol  $< 190$  mg/dL, LDL-cholesterol  $< 130$ mg/dL, HDL-cholesterol  $> 40$  mg/dL in men and  $> 50$  mg/dL in women, non HDL-cholesterol  $< 160$ mg/dL and triglycerides  $< 150$  mg/dL were considered optimal.<sup>12</sup>

Food consumption was assessed using a validated food frequency semi-quantitative questionnaire.<sup>13</sup> From these data, the average daily intake of energy (kcal), carbohydrate (g), protein (g), lipid (g), cholesterol (mg), fiber (g), sodium (mg), iron (mg), calcium (mg) and vitamin C (mg) were obtained. In order to assess the adequacy of energy consumption, a 5 % variation in the estimated energy requirement (EER) was calculated, according to the Institute of Medicine.<sup>14</sup> Carbohydrate values between 45-65 % of EER, protein up to 0.8 g/kg body mass/day, lipid between 20-35 % of EER, fiber  $> 25$  g/day, sodium  $< 2300$  mg/day, iron  $> 18$  mg/day, calcium  $> 1000$  mg/day, vitamin C  $> 75$  mg/day and cholesterol  $< 300$  mg/day were classified as optimal.<sup>14-16</sup> These nutrients were selected because they are widely found in food composition tables.

#### Statistical analysis

Data with normal distribution were expressed as mean and standard deviation, and non-parametric variables in median and interquartile range (25th and 75th percentiles). Categorical variables were presented in relative frequency (%). Multiple linear regression was performed to evaluate the association between the anthropometric profile, food intake and biochemical variables, considering the adjustment for age. For this analysis, logarithmic transformation of non-parametric variables was performed, and only the independent variables that significantly influenced the dependent variables were presented in the tables. The data were analyzed in the SPSS (Statistical Package Science Social) software, version 21.0, considering the level of significance of 5% ( $p < 0.05$ ).

## RESULTS

Study participants were  $39.6 \pm 10.7$  years old, only 2.9% ( $n=1$ ) were smokers, 26.5% ( $n=9$ ) ingested alcohol and all participants were sedentary. The mean value of SBP and DBP were  $116.15 \pm 14.39$  and  $77.7 \pm 10.8$  mmHg, respectively, and 11.8% ( $n=4$ ) were hypertensive.

The mean values of BM, H, WC, WHtR and %BF were  $77.1 \pm 19.0$  kg,  $1.61 \pm 0.07$  m,  $91.2 \pm 13.3$  cm,  $0.6 \pm 0.1$  and  $31.4 \pm 11.8$  %, respectively; while the median of BMI was  $28.0 (25.8-33.7)$  kg/m<sup>2</sup>. The analysis of BMI, WC and WHtR indicated that 79.4% ( $n=27$ ) presented overweight and high WHtR, and 82.4% ( $n=28$ ) high WC.

The analysis of the biochemical profile revealed that glycated hemoglobin was high in 55.9% ( $n=19$ ) of women (29.4% had prediabetes and 26.5% had diabetes) (Table 1).

Regarding food consumption, EER was  $1920.80 (1776.73-2084.55)$  kcal, more than 47.0% of the women presented high intake of energy, carbohydrate, protein and cholesterol, and more than 70.0% had low intake of iron and calcium (Table 2).

Multiple regression analysis revealed a positive association between energy consumption and BM ( $\beta = 0.377$ ,  $p = 0.028$ ) values and WC ( $\beta = 0.373$ ,  $p = 0.030$ ), and between protein consumption and %BF ( $\beta = 0.368$ ,  $p = 0.032$ ) (Table 3). The other food consumption variables were not associated with the anthropometric profile ( $p \geq 0.05$ ). Regarding the association of biochemical indexes with food consumption and anthropometry, it was found that WC was positively associated with glycated hemoglobin ( $\beta = 0.401$ ,  $p = 0.019$ ), and HDL-cholesterol was directly influenced by protein ( $\beta = 0.573$ ,  $p = 0.013$ ) and inversely by lipid consumption ( $\beta = -0.597$ ,  $p = 0.010$ ) (Table 4). The other variables of food consumption and anthropometric profile were not associated with biochemical parameters ( $p \geq 0.05$ ).

## DISCUSIÓN

In the present study, an association was found between anthropometric, biochemical and food intake parameters among Brazilian adult women assisted by FHS.

The positive relationship between WC

**Table 1.** Perfil bioquímico de las mujeres adultas atendidas por la Estrategia de Salud de la Familia, Brasil

Variables	Serum values	Optimal ‡	High ‡	Low ‡
Glycated hemoglobin (%)	5.8(5.4-6.5) †	15(44.1)	19(55.9)	-
Total cholesterol (mg/dL)	175.1±49.0 †	22(64.7)	12(35.3)	-
LDL-c (mg/dL)	109.1±43.5 †	22(64.7)	12(35.3)	-
HDL-c (mg/dL)	46.5±8.2 †	28(82.4)	-	6(17.6) †
Non HDL-c (mg/dL)	128.6±46.6 †	27(79.4)	7(20.6)	-
Triglycerides (mg/dL)	97.9±42.3 †	29(85.3)	5(14.7)	-

\* Variables without normal distribution: median (25th–75th percentile).

† Variables with normal distribution: mean ± standard deviation.

‡ Data are presented in n(%).

**Table 2.** Food profile of adult women attended by the Family Health Strategy, Brazil.

Variables	Quantity consumed *	Optimal †	High †	Low †
Energy (kcal)	2153.4(1705.2-2871.3)	4(11.8)	18(52.9)	12(35.3)
Carbohydrate (g)	312.0(227.0-390.5)	12(35.3)	16(47.1)	6(17.6)
Protein (g/kg body mass)	1.2(1.0-1.6)	3(8.8)	30(88.3)	1(2.9)
Lipid (g)	61.7(47.7-75.9)	20(58.8)	8(23.5)	6(17.7)
Cholesterol (mg)	323.0(253.8-407.8)	14(41.2)	20(58.8)	-
Fiber (g)	37.0(25.9-45.8)	25(73.5)	-	9(26.5)
Sodium (mg)	1279.4(911.3-1587.6)	21(61.8)	13(38.2)	-
Iron (mg)	10.1(7.6-18.8)	10(29.4)	-	24(70.6)
Calcium (mg)	485.0(361.0-640.6)	2(5.9)	-	32(94.1)
Vitamin C (mg)	369.6(209.7-619.4)	33(97.1)	-	1(2.9)

\* All variables did not present normal distribution, and the amount consumed was presented in median (25th–75th percentile).

† Data are presented in n(%).

**Table 3.** Association between the anthropometric profile and food consumption of adult women attended by the Family Health Strategy, Brazil.

		$\beta$ *	R <sup>2</sup> †	P value ‡
Body mass				
	Energy	0.377	0.116	0.028
Body fat percentage				
	Protein	0.368	0.108	0.032
Waist circumference				
	Energy	0.373	0.112	0.030

\* Regression coefficient.

† Determination coefficient.

‡ Multiple linear regression. All values were adjusted for age, but there was no influence on the results of the analyses ( $p > 0.05$ ).

and glycated hemoglobin can be explained by excess intake of macronutrients, which generates adipose tissue expansion and dysfunction.<sup>17,18</sup> Adipocytes release substances that impair insulin sensitivity and the effective use of glucose, converting it into fat, which increases adiposity, including abdominal.<sup>19,20</sup>

The relationship between these two variables was also found in other populations, such as Chilean adults.<sup>21</sup> Therefore, it can be inferred that young Chilean adults with high WC are more likely to develop diabetes mellitus and cardiovascular disease, since the accumulation of fat in the abdominal region is an independent

**Table 4.** Association of biochemical indexes with food consumption and anthropometric profile of adult women attended by the Family Health Strategy, Brazil.

	$\beta^*$	R <sup>2</sup> †	P value ‡
Glycated hemoglobin			
Waist circumference	0.401	0.135	0.019
HDL-c			
Protein	0.573	0.169	0.013
Lipid	-0.597		0.010

\* Regression coefficient.

† Determination coefficient.

‡ Multiple linear regression. All values were adjusted for age, but there was no influence on the results of the analyses ( $p > 0.05$ ).

factor for the development of metabolic abnormalities, such as insulin resistance and dyslipidemia.<sup>21</sup> It is also worth mentioning that individuals with overweight and high WC have a high mortality risk.<sup>22</sup> Then, WC assessment is a non-invasive, quick and complementary way to BMI to assess metabolic risk.<sup>23</sup> In the present study, individuals with high BMI, WC or WHtR had a very similar prevalence of high glycated hemoglobin (55.6%, n=15; 60.7%, n=17; and 55.6%, n=15; respectively).

The fact that approximately 80.0% of the evaluated women presented high BMI, WC and WHtR, and all were sedentary, also deserves attention. There is a causal relationship between the increase in the practice of physical exercise and the improvement of BMI and body fat,<sup>24</sup> since the increase in energy expenditure induced by exercise reduces these anthropometric indices.<sup>25</sup> This may be related to the fact that when the demand for energy by skeletal muscle is low, as in a sedentary lifestyle, there is an increase in the storage of glucose and fatty acids in adipose tissue.<sup>26</sup>

The evaluation of dietary intake revealed that more than 70.0% of the women had a low intake of iron and calcium, similar to the results found in a study with Brazilian adults.<sup>27</sup> The participants of this study had a mean iron and calcium intake of 16.5±14.8 mg/day and 527.1±222.5 mg/day, respectively, and the recommendation of these minerals is 18 mg/day and 1000 mg/day, respectively.<sup>15</sup> In order to achieve these recommendations, an intake of food sources is necessary, such as cow's milk (123 mg of calcium/100mL) and lean beef (2.8 mg of iron/100g).<sup>28</sup>

In Brazil, food pattern is mainly characterized by increased consumption of processed foods that are poor in these nutrients and have a high caloric density,<sup>29</sup> which may have contributed to the high daily energy consumption found in 52.9% of the women. In addition, caloric intake above the daily energy requirement, accompanied by an absence of physical exercise, would lead to a high prevalence of overweight as a result of a positive energy balance.<sup>25</sup>

Over 88.0% of the women consumed protein above the recommendation. High protein intake may be associated with high cholesterol intake found among the women evaluated (60.0%), since both nutrients are found in the same foods of animal origin,<sup>16</sup> and the population of this study used to consume high-fat cuts of beef, such as rib and short plate.

In a cross-sectional study with 720 volunteers, a positive association between total energy intake and BMI, abdominal fat and WC was found.<sup>30</sup> This finding corroborates with a study conducted with Indian adults, where the increase of 100 kcal in daily energy consumption was responsible for an increase of 45g in body fat.<sup>31</sup>

Protein intake was positively associated with body adiposity. Similar data were found in an observational study with adults from seven European countries.<sup>32</sup> In addition, a cohort of 373,803 European adults showed that individuals with more than 22.0% of energy intake from protein presented a 23.0% higher risk of presenting overweight when compared to adults who consumed up to 14.0% of daily energy consumption from this macronutrient.<sup>33</sup> The relationship between protein consumption

and body fat is controversial in the scientific literature and may be related to the amount and type of protein consumed. A study found that consumption of dairy protein has an inverse relationship with adiposity, while total protein consumption (including all sources) was positively associated with BMI.<sup>30</sup> Also, an association of high BMI with red and processed meat consumption was identified.<sup>32</sup> On the other hand, vegetable protein intake seems to have an inverse relationship with BM, WC and BMI,<sup>34</sup> and one of the reasons would be that foods with vegetable protein also present fiber, producing more satiety.<sup>28,35</sup> Thus, to further elucidate this issue, more studies about the qualitative and quantitative consumption of protein in different populations would be important.

Finally, there was a direct association of HDL-cholesterol with protein and inverse with lipid intake. The relationship between protein consumption and HDL-cholesterol levels is little evidenced in the literature; however, the usual consumption of approximately 1.5g of protein/kg/day is associated with higher values of HDL-cholesterol when compared to individuals who consume up to 0.8g protein/kg/day.<sup>36</sup>

Although the results found in this study between lipid intake and HDL-cholesterol converge with a study conducted with Korean adults,<sup>37</sup> a meta-analysis of clinical trials found that diets with lower lipid levels tend to decrease HDL-cholesterol.<sup>38</sup> In this sense, two points should be considered: first, the type of lipid consumed, since the trans fat intake is related to low levels of HDL-cholesterol,<sup>39</sup> while monounsaturated and polyunsaturated fatty acids can increase HDL-cholesterol.<sup>38,39</sup> Second, when it comes to overweight or obese people, it is important to assess whether HDL-cholesterol has its protective function preserved. In addition to its reverse cholesterol transport function, when it is associated with the Apolipoprotein A1 (Apo A1) molecule, it has

antioxidant, antiapoptotic, anti-inflammatory, antiatherogenic and antithrombogenic activity. However, in the presence of inflammation, Apo A1 associated with HDL-cholesterol becomes oxidized and enzymatically modified, losing its protective function.<sup>40</sup> Therefore, it is important to analyze the Apo A1 and perform a qualitative evaluation of the lipids ingested, which is a limiting factor of this study.

Other limiting factors were the sample size and the non-evaluation of oxidized lipoprotein fractions for a better diagnosis of the lipid profile, since most women showed optimal levels of total cholesterol, LDL-cholesterol, HDL-cholesterol, non HDL-cholesterol and triglycerides, and at the same time presented high values of anthropometric measures and glycated hemoglobin. The evaluation and association of several parameters related to the nutritional status (anthropometry, food intake and biochemical profile) is a strength of this research.

## CONCLUSION

From the data presented, we conclude that the nutritional status of the women in this study is inadequate, with anthropometric, biochemical and food consumption alterations. It was observed that there was a direct relationship between energy consumption and BM and WC, and between protein intake with the percentage of BF. Glycated hemoglobin was directly associated with WC, while protein intake was positively and lipid was negatively associated with HDL-cholesterol.

Thus, these findings demonstrate the need to monitor this population by the FHS in order to change their inadequate lifestyle and improve their health parameters.

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