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Dietary intake of vitamin D and its relation to insulin resistance in obese women

Ingestão dietética de vitamina D e sua relação com a resistência à insulina em mulheres obesas

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ABSTRACT

The aim of this study was to assess the relation between dietary intake of vitamin D and insulin resistance in obese and nonobese women. This cross-sectional study included 93 women, aged between 20 and 50 years, who were subdivided into two groups: the obese group (n = 46) and the age-matched control group (n = 47). Vitamin D and calcium intake was monitored using 3-day food records and Dietpro software version 5.1. Measurements of serum glucose and serum insulin were based on an enzymatic colorimetric method and a chemiluminescence assay, respectively. Insulin resistance was assessed by means of homeostasis model assessment of insulin resistance (HOMA-IR). The median values of vitamin D content in the diet were found to be lower than those recommended, although there was a significant difference between groups ($p < 0.001$). The mean values of calcium intake were found to be above the recommendations, although there was no significant difference between the groups ($p > 0.05$). The values of serum glucose, serum insulin, and HOMA-IR were higher in obese women than in the control group. The correlation analysis indicated that the association between the dietary intake of vitamin D and insulin resistance was not significant. The results of this study indicate that dietary vitamin D does not influence parameters of glycemic control in obese women.

KEYWORDS

Vitamin D, Obesity, Insulin Resistance.

RESUMO

O objetivo do estudo foi avaliar a relação entre a ingestão dietética de vitamina D e resistência à insulina em mulheres obesas e não obesas. Este estudo transversal incluiu 93 mulheres, com idades entre 20 e 50 anos, que foram subdivididos em dois grupos: obesos (n = 46) e o grupo controle pareados por idade (n = 47). A ingestão de vitamina D e cálcio foi estimada por meio dos registros alimentares de 3 dias e analisada pelo software DietPro versão 5.1. As mensurações séricas de glicose e insulina foram baseadas em um método colorimétrico enzimático e um ensaio de quimiluminescência, respectivamente. A resistência à insulina foi avaliada por meio do modelo de avaliação da homeostase da resistência à insulina (HOMA-IR). Os valores médios do teor de vitamina D na dieta foram mais baixos do que os recomendados, embora houvesse uma diferença significativa entre os grupos ($p < 0,001$). Os valores médios de ingestão de cálcio estavam acima das recomendações, apesar de não haver diferença significativa entre os grupos ($p > 0,05$). Os valores de glicose sérica, insulina sérica, e HOMA-IR foram maiores em mulheres obesas que no grupo de controle. A análise de correlação

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indicou que a associação entre a ingestão de vitamina D e resistência à insulina não foi significativa. Os resultados deste estudo indicam que a vitamina D na dieta não influencia os parâmetros de controle glicêmico em mulheres obesas.

PALAVRAS-CHAVE

Vitamina D, Obesidade, Resistência à Insulina.

ABREVIATURAS

1,25(OH2)D3: 1,25-diidroxivitamina D3.

DRIs*:* Dietary Reference Intakes.

EAR: Estimated Average Requirement.

VDR: Vitamin D receptor.

INTRODUCTION

Obesity is a chronic disease with high prevalence and is associated with various metabolic disorders, such as chronic low-grade inflammation, oxidative stress, and insulin resistance[1]. Insulin resistance is characterized by impaired transport and metabolism of glucose stimulated by insulin in the peripheral tissues, with a consequent increased release of hepatic glucose. This metabolic disorder may result in part from changes in the route of transmission of this hormone's signaling[2-3].

Studies have shown the participation of various nutrients in the mechanisms underlying the manifestation of insulin resistance in obesity, e.g., vitamin D. This vitamin plays an important role in glucose homeostasis by acting on increased hepatic and peripheral glucose uptake and by promoting insulin secretion from pancreatic β-cells[4-5].

Research shows inadequate dietary intake of vitamin D, which appears to be due to the high intake of processed foods and reduced consumption of healthy food. Furthermore, the reduced exposure to sunlight contributes to this deficiency in obese individuals, accentuating the insulin resistance present in this disease[6-7].

Although research has revealed the presence of alterations in glycemic control as well as a vitamin D deficiency in obese people, data on dietary intake of this vitamin and its relation to the pathogenesis of insulin resistance in these individuals are still scarce. Thus, this study was aimed at evaluating the dietary levels of vitamin D and identification of a possible relation with insulin resistance parameters in obese women.

MATERIALS AND METHODS

This was a cross-sectional study that included 93 women, aged between 20 and 50 years. Participants were subdivided into two groups: the obese (n = 46) and the control (n = 47). The participants were selected according to the following criteria: body mass index between 18.5 and 24.9 kg/m^2 (control group) or between 30 and 39.9 kg/m^2 (obese group); nonsmokers; not pregnant or lactating; absence of diabetes mellitus, cardiovascular disease, cancer, chronic renal failure, and liver disease; and not taking vitamin and mineral supplements.

This study's protocol was approved by the Research Ethics Committee of the Federal University of Piaui (protocol No. 13489613.5.0000.5214) and was conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent.

Evaluation of Nutritional Status

To assess this status, we determined the body-mass index, calculated as the participant's body weight divided by the square of the height. The classification of nutritional status was performed according to the recommendations of the World Health Organization[8]. The measurement of waist circumference was performed using a flexible, inelastic tape surrounding the natural waistline; the narrowest area between the chest and the hips served as a reference value, as proposed by the World Health Organization[9].

Measurement of Vitamin D and Calcium Intake

Food consumption was recorded by means of a 3-day food diary, and subsequently, the magnesium content of the diet was calculated using the analysis software Dietpro, 5.i version. The estimated average requirements (EAR) for vitamin D and calcium were used as a reference value for the suitable intake, respectively, at 10 μg/day and 800 mg/day for females aged between 19 and 50 years[10].

Determination of Glycemic Control

The analysis of fasting glucose was performed by the colorimetric enzymatic method and with Labtest kits. The values between 75 and 99 mg/dl were considered healthy, according to criteria defined by the American Diabetes Association[11].

The assessment of serum insulin concentrations was conducted using the chemiluminescence method, assuming that the reference range is between 6 and 27 μU/ml.

HOMA-IR was calculated from the concentrations of fasting glucose and fasting insulin[12].

Statistical Analysis

Data were analyzed using the SPSS software, version 20.0 for Windows® (Chicago, SPSS Inc.). The Kolmogorov-Smirnov test was used to verify data normality. To compare the outcomes between the two groups, Student's *t* test and the Mann-Whitney *U* test were conducted for parametric and non-parametric data, respectively. Associations between variables were assessed using the Chi-square test. In addition, Spearman's test was performed to identify any potential cor-

relations between data sets. A difference was considered statistically significant when the p value was <0.05, with a 95% confidence interval.

RESULTS

Mean age of obese women and control group was 37.30 ± 6.86 and 39.72 ± 6.82, respectively (p=0.092). There was a significant difference between body weight (85.47 ± 7.97; 53.39 ± 6.01), body mass index (35.37 ± 2.59; 22.18 ±1.55) and waist circumference (101.68 ± 7.57; 74.41 ± 4.63) (p<0.05).

The mean values and standard deviations for energy consumption and the amount of macronutrients and calcium found in the diets consumed by obese individuals and normal-weight people are shown in Table 1. There was a significant difference in the energy and carbohydrate intake between the groups (p < 0.05).

Table 2 shows the median values and maximum and minimum intake of vitamin D by the obese and control groups. There was a statistically significant difference between the groups in relation to the vitamin D content in the diet (p < 0.001).

The percentage distribution of individuals according to the reference values for dietary intake of vitamin D (10 mg/day for individuals aged 19–50 years, according to the EAR) showed that 73,9% and 40,4% of obese woman and control group, respectively, ingested this vitamin bellow the EAR values. There was a significant association between the dietary consumption of vitamin D and obesity (p < 0.001).

Table 2. Median, maximum and minimum intake of vitamin D by the obese and control group.

Group	Median	Minimum	Maximum
Obese (n=46)	1,34	0,31	105,31
Control (n=47)	19,80	0,67	160,80

Mann-Whitney U-test (p<0,001).

The mean values and standard deviation of glycemic control parameters of the control group and obese patients are provided in Table 3. Significant differences were found in serum glucose, serum insulin, and in the index of insulin resistance (HOMA-IR; p < 0.05).

DISCUSSION

Obese women evaluated in this study ingested vitamin D content below the EAR values, with a statistically significant difference when compared to the control group. An important point to note is the lack of food sources of vitamin D in the

Table 1. Means and standard deviation of energy consumption and amount of macronutrients present in the diet of the obese and control groups.

Parameters	Obese (n=46) Mean ± SD	Control (n=47) Mean ± SD	p
Energy consumption (Kcal)	1848,48 ± 719,80	1683,50 ± 401,54	0,178
Carbohydrate (%)	48,90 ± 6,43	53,41 ± 8,00	0,004*
Protein (%) [a]	19,24 ± 3,70	20,90 ± 7,67	0,371
Lipid (%)	31,86 ± 5,30	29,42 ± 7,56	0,075
Calcium (mg/dia)	468,70 ± 166,43	539,20 ± 257,25	0,121

**Values significantly different between the obese and control groups using Student's t-test (p < 0.05). [a] Mann-Whitney U-test. SD = standard deviation. Reference values: 10%–35% for protein, 20%–35% for lipids, and 45%–65% for carbohydrates[12], EAR: 1000mg/day for calcium[12].

Table 3. Mean values and standard deviation of glycemic control parameters of the obese and control groups.

Parameters	Obese (n=46) Mean ± SD	Control (n=47) Mean ± SD	p
Glucose (mg/dL)	96,91 ± 20,15	81,81 ± 7,49	<0,001*
Insulin (□U/mL)	23,40 ± 7,82	14,03 ± 5,03	<0,001*
HOMA-IR	5,82 ± 2,92	2,86 ± 1,04	<0,001*

* Values significantly different between the obese and control groups using Student's t-test or Mann-Whitney U-test (p < 0.05). HOMA-IR = Homeostasis Model Assessment Insulin Resistance. Reference values: Fasting glucose = 75 a 99 mg/dL; serum insulin = 6 a 27 µU/mL; HOMA-IR < 2,71.

diet of women studied, such as fish liver oil, salmon, cod, sardines, tuna, mushrooms, and egg yolk; this situation contributes to the reduced consumption of this nutrient by the population[13].

The reduced consumption of this vitamin among the obese participants analyzed is a negative characteristic of the diet as it contributes to a deficiency in the body; this deficiency favors the manifestation of relevant metabolic disorders such as insulin resistance[14]. However, considering that vitamin D may also be acquired via sun exposure, it is difficult to say whether these women have a serum deficiency of this nutrient.

This study also involved food consumption analysis to verify intake of energy and macronutrients. The energy consumption was similar in the two groups and did not influence the intake of vitamin D because the averages for these micronutrients were below the reference range.

With regard to the proportion of macronutrients in the total energy value, the results revealed regular intake of proteins and lipids within the range recommended by DRI[15], in both groups. On the other hand, obese women had a lower intake of carbohydrates when compared to the control group.

On the results related to glycemic control, it was found that obese women showed higher serum glucose, fasting insulin, and average values of HOMA-IR when compared to the control group. Regarding this result, it should be stressed that the worst glycemic control observed in obese patients may result from insufficient intake of vitamin D in the diet.

Thus, in view of a better understanding of the results, we conducted a correlation analysis between dietary intake of vitamin D and calcium and glycemic control parameters. In this study, however, the dietary intake of these micronutrients did not correlate with glycemic control parameters, which may be due to own homeostasis of vitamin D in the body because this nutrient can be obtained via sun exposure, thus maintaining their serum concentrations, even when there are variations in dietary intake.

Thus, given the complexity of vitamin D actions on insulin secretion, there is a need for new studies on the topic for a better understanding of the metabolic behavior of this nutrient in known clinical complications of obesity, in particular insulin resistance.

CONCLUSION

This study shows the probabilities of inadequate vitamin D intake by the participants. Obese women have high glycemic control parameters. The correlation analysis conducted in this study did not show a significant association between insulin resistance parameters and vitamin D content of the diet, thus not supporting the possible effect of this vitamin in the diet on glycemic control in the obese.

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