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Original

The consumption of low glycemic meals reduces abdominal obesity in subjects with excess body weight

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Abstract

Objective: **To evaluate the effect of the glycemic index (GI) on food intake, anthropometric measurements and body composition in subjects with excess body weight.**

Methods: **Crossover study, in which 17 subjects participated in two study sessions (high GI or low GI). Two daily meals were consumed in laboratory for 30 consecutive days in each session. Subjects also consumed under free living conditions 3 daily isocaloric servings of fruits, presenting the same GI as the session in which they were participating. At each 15 days, subjects were submitted to body composition (lean mass and fatty mass) and anthropometric indexes (weight, height, body mass index, waist circumference (WC), hip circumference, hip-waist relation (WHC)) assessment. Habitual food intake was assessed before and at the end of each session. Subjects were instructed to maintain the same level of physical activity during the study.**

Results: **There was a significant reduction on WC and WHC after the low GI session. The other parameters did not differ between the treatments applied in this study.**

Conclusion: **These results suggest that the consumption of low GI foods may favor the prevention and control abdominal obesity and the associated metabolic diseases.**

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Key words: *Glycemic index. Appetite. Food intake. Anthropometric measurements. Body composition. Obesity.*

EL CONSUMO DE COMIDAS POCO GLUCÉMICAS REDUCE LA OBESIDAD ABDOMINAL EN LOS INDIVIDUOS CON EXCESO DE PESO CORPORAL

Resumen

Objetivo: **Evaluar el efecto del índice glucémico (IG) sobre la ingesta de alimentos, las medidas antropométricas y la composición corporal en sujetos con exceso de peso corporal.**

Métodos: **Estudio cruzado en el que participaron 17 sujetos en dos sesiones de estudio (IG alto o IG bajo). Se consumían dos comidas al día en el laboratorio durante 30 días consecutivos en cada sesión. Los individuos también consumían en condiciones de vida libre 3 raciones isocalóricas de fruta al día que presentaban el mismo IG que el de la sesión en la que estaban participando. Cada 15 días se evaluaba la composición corporal [masa magra y masa grasa) y los índices antropométricos (peso, talla, índice de masa corporal, circunferencia de la cintura (CC), circunferencia de la cadera, relación cadera-cintura (RCC)]. Se evaluó el consumo habitual de alimentos antes y después de cada sesión. Se instruía a los sujetos para mantener el mismo nivel de actividad física durante el estudio.**

Resultados: **Hubo una reducción significativa de la CC y RCC tras la etapa de la sesión con IG bajo. El resto de parámetros no difirieron entre los tratamientos aplicados en este estudio.**

Conclusión: **Estos resultados sugieren que el consumo de alimentos con un IG bajo podría favorecer la prevención y el control de la obesidad abdominal y las enfermedades metabólicas asociadas.**

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Palabras clave: *Índice glucémico. Apetito. Consumo de alimentos. Medidas antropométricas. Composición corporal. Obesidad.*

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Abbreviations

GI: Glycemic Index.
BIA: Electrical Bioimpedance.
WC: Waist Circumference.
GL: Glycemic Load.
HC: Hip Circumference.
EER: Estimated Energy Requirement.
BMI: Body Mass Index.
WHR: Waist-Hip Relation.
TCV: Total Caloric Value.

Introduction

Eating habits in Brazil is characterized by the excessive consumption of sugar and industrialized products such as cookies and soft drinks. There has also been a reduction of the consumption of beans and an insufficient consumption of fruits and vegetables.[1] Such eating habits reflect the consumption of high glycemic index (GI) diets, favoring the manifestation of obesity and of non-transmittable chronic diseases.[2]

The consumption of high GI meals induces a quick increase of glycemia and insulinemia in the post-prandial period, leading to a reactional hypoglycemia. This answer can stimulate the appetite in subsequent meals, favoring the increase in daily caloric intake[3,4] although some authors argue agaisnt these effects.[5] However, in one of the previously mentioned studies,[3] the low GI meals had more protein and had a more solid consistency than the high GI meals. Scientific evidences indicate that proteins are more satiating than the other macronutrients.[6] Besides, food rheology plays an important role on hunger control.[7] Thus, the differences in test meals macronutrients composition and rheology[3] humper the interpretation of the obtained results. It must also be emphasized that the diets tested in the studies conducted by Ebbeling et al.[4] and Bouché et al.[5] difered in terms of fiber content. A higher consumption of fiber can reduce food intake[8] and, consequently, the parameters assessed in these studies.

It has been claimed that the rapid increase in the glycemia and insulinemia in response to the consumption of high GI foods favors the occurrence of anabolic reactions, promoting the increase in body fat.[9] Besides, such foods can lead to the increase of contra-regulatory hormone secretion such as cortisol, growth hormone and glucagon, stimulating protein catbolism.[3] Therefore, these responses can favor the increase in body fat and the reduction of lean body mass.

On the other hand, the consumption of food low in GI can have an important role in the prevention and treatment of diabetes and cardiovascular diseases,[9] by reducing the risk of obesity. In a study involving 107 obese children, the consumption of low GI diet favored the reduction in body weight. However, the low GI diet also had a lower carbohydrates content and higher protein content.[10] Therefore, the result of that study cannot be attributed to the GI only.

The discrepancy in the results of these studies indicates the need to conduct well designed studies to assess the real effect of GI in the control of body weight. Brand-Miller & Foster-Powell[11] suggested that the consumption of two daily low GI meals is enough to promote beneficial effects in body weight and body composition. Therefore, the purpose of this study was to assess the effect of the consumption of two daily low GI or high GI meals on food intake, anthropometric measurements and body composition of subjects with excess body weight.

Methods

In this crossover study, 17 subjects with a body mass index (BMI) > 25.0 kg/m^2[12] participated in random order of two study sessions (high GI and low GI), separated by a washout period of 7 days. The following exclusion criteria were considered: smokers, use of medications that interfer on food intake and/or nutrient metabolism, pregnant or lactating women, on a weight loss diet, non-stable body weight (variation greater than 3 kg over the last 3 months), diabetics. Subjects were sedentary,[13] and had a dietary restraint level ≤ 14.[14]

Two daily meals (breakfast and afternoon snack) were consumed in the laboratory for 30 consecutive days. Test meals were consumed within 15 minutes. The subjects received a list indicating the GI of foods and were instructed to include in the other meals consumed during the rest of the day only high GI or low GI foods, according to the study session in which they were participating. Three daily isocaloric servings of fruits, presenting the same GI as the session in which the subjects were participating, were provided and consumed under free living conditions. Immediately before and at the 15th and 30th day of each study session, the participants were submitted to body composition and anthropometric evaluation. The habitual food intake was assessed before and at the end of each session. The participants were instructed to maintain the same level of physical activity during the study.

The study protocol was approved by the Ethics Committee in Human Research of the Federal University of Viçosa (document nº 080/2007), Brazil.

Tested meals

During the study 28 preparations were served (14 high GI and 14 low GI), resulting in 7 different types of breakfast and afternoon snack menus for each study session, which were repeated throughout the experiment. Each meal provided 15% of each subject's nutritional needs, determined by the estimated energy requirements (EER).[15]

Table I
Mean ± DP glycemic index, energy density, macronutrition and fiber contents of the test meals

Characteristics	*HGI meals*	*LGI meals*
GI	74.1 ± 2.9[a]	41.2 ± 2.2[b]
Energy density (kacl/g)	1.5 ± 0.2	1.5 ± 0.2
Carbohydrate (g)	53.7 ± 4.5	53.6 ± 2.4
Protein (g)	5.0 ± 1.6	4.8 ± 1.7
Fat (g)	6.4 ± 2.3	6.3 ± 2.3
Fiber (g)	3.6 ± 1.5	2.9 ± 1.0

GI: Glycemic index; HGI: High glycemic index; LGI: Low glycemic index,
Values followed by different lower case letter in the same line differ from each other ($p < 0.05$).

The GI of the meals was determined, according to the method proposed by FAO.[16] The selection of the foods to be included in the test meals was made according to the International Table of GI Values[17] and the Brazilian Table of Food Compostions[18]. The high GI (IG ≥ 70) and the low GI (IG ≤ 55) meals[19] had similar energy density; macronutrient and fiber content (table I).

Food intake assessment

Habitual food intake was assessment on the week before the beginning of the study. Food intake in response to the applied treatments was assessed in the last week of each study session. The assessment of food intake was conducted using dietary records of 3 non-consecutive days (2 week days and 1 weekend day).[20] All dietary records were revised in the presence of the volunteer to ensure precision. The home measurements of ingested food were converted into grams and the caloric ingestion and macronutrients were analyzed using the software Diet Pro[â] (version 5.0).[21] The glycemic load of the diet ingested during the study was calculated.[17]

Anthropometric and body composition assessment

BMI was calculated dividing the weight (kg) by the height (m) squared.[22] The waist circumference (WC) and hip (HC) were checked according to Heyward & Stolarczyk.[23] The waist to hip ratio (WHR) was calculated dividing the WC by the HC.[19] The percentage of body fat was assessed using electric bioimpedance (BIA) (Biodynamics model 310), according to the manufacturer's instructions.

Physical activity assessment

The level of physical activity of the volunteers was estimated as they were recruited, applying the International Physical Activity Questionnaire.[13] The value obtained was used to estimate the energy expenditure by EER.[15]

Table II
Mean ± DP of age, level of physical activity, anthropometric characteristics and body composition presented by the volunteers before the intervention

Variables	*n = 17*
Age (years)	25.41 ± 5.77
PA	1.0 ± 0.04
BMI (kg/m^2)	26.33 ± 3.15
WC (cm)	94.53 ± 9.96
WHR	0.85 ± 0.07
BF (%)	31.78 ± 5,72
LM (kg)	57.6 ± 13.4

PA: Physical activity; BMI: Body Mass Index; WC: Waist circumference; HC: Hip circumference; WHP: Waist-hip relation; BF: Body fat; LM: Lean mass.

Statistical analysis

The inter and intra group data were statistically analysed by Student's t-Test and Mann-Whitney test. Wilcoxon test or paired t-Test was used to check the differences between data obtained at baseline and after 30 days of intervention. Friedman or RM Anova on Ranks tests were used to detect differences in response to the treatments at times 0, 15 and 30 days. The analysis were made using the software SigmaStat 2.0, considering a significance level of $p < 0.05$.

Results

The test meal differed only in terms of GI (table I). A total of 11 overweight individuals, 4 obese class I and 2 obese class II, participated in the study. Most of the participants (n = 10; 58.8%) were women. The age, level of physical activity, anthropometric characteristics and body composition of the participants at baseline is shown on table II.

There was a reduction ($p \leq 0.008$) in the daily consumption (laboratorial + free living conditions) of calories,and macronutrients, and in the GI and GL of the diet consumed at the end of the low GI session compared to baseline. On the other hand, at the end of the high GI session there was a reduction ($p = 0.02$) in energy intake and an increase ($p = 0.08$) in the GI of the daily consumed diet (laboratorial + free living conditions) compared to baseline. Although energy intake did not differ between treatments, at the end of the low GI session the energy intake was approximately 220 kcal less than at the end of the high GI session. Fiber intake did not differ ($p \geq 0.99$) during the study (table III).

There was no difference on anthropometric and body composition in response to the high GI treatment. At the end of low GI session there was a mean weight

Table III

Mean ± DP of the glycemic index, glycemic load, macronutrients content, food fiber and calories of the diet ingested by the volunteers before (base period) and at the end of each intervetion period

Variables	*Base period*	*End of HGI*	*Value of p*	*End of LGI*	*p*	*p between stage*
GI	57.9 ± 4.9	61.6 ± 2.8	0.008[?]	47.5 ± 3.8	0.001[?]	0.001[Δ]
GL	38.1 ± 15.5	33.5 ± 8.3	0.09	25.6 ± 10.7	0.001[?]	0.03[Δ]
FIB (g)	22.3 ± 12.7	22.2 ± 7.9	0.96	22.4 ± 8.9	0.99	0.99
CHO (g)	311.0 ± 101.5	282.3 ± 71.8	0.07	260.3 ± 83.2[a]	0.008[?]	0.29
PTN (g)	79.9 ± 21.2	70.9 ± 31.1	0.06	61.8 ± 20.5	0.001[?]	0.12
LIP (g)	75.6 ± 20.1	66.3 ± 24.7	0.13	50.4 ± 23.0	0.001[?]	0.07
TCV (kcal)	2,244.9± 594.6	1,996.5 ± 587.0	0.02[?]	1,777.9 ± 581.0	0.001[?]	0.11

GI: Glycemic index; GL: Glycemic load; CHO: Carbohydrate; PTN: Protein; LIP: Lipid; FIB: Food fiber; TCV: Total caloric value; HGI: High glycemic index; LGI: Low glycemic index; g: Grams; Kcal: Kilocalories.
[?]Difference (delta = 30th day-1st day) between the base period and the post-intervention periods by the Wilconson test ($p < 0.05$).
[Δ]Differences between treatments (HGI-LGI) by the Mann-Whitney test ($p < 0.05$).

loss ($p = 0.08$) of 580 g compared to baseline. A significant reduction ($p \leq 0.003$) on WC and WHR was verified in response to the low GI diet consumption (fig. 1).

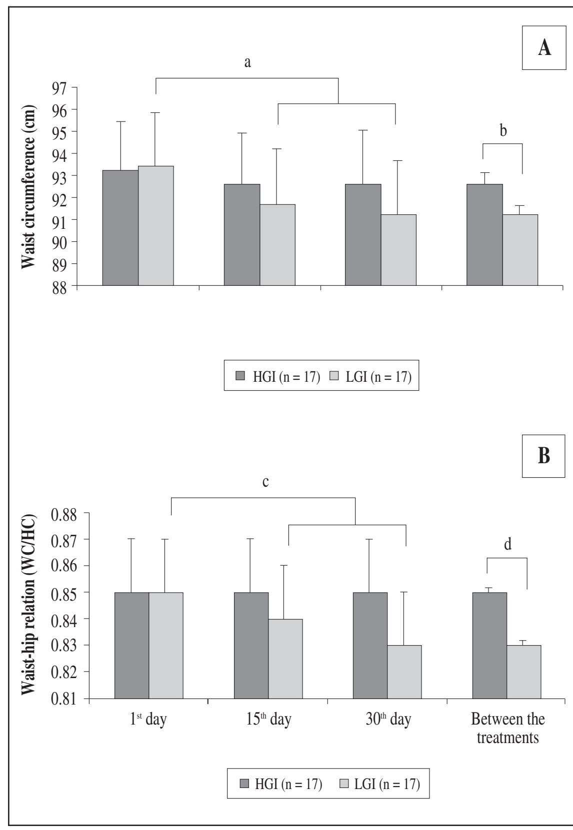

Fig. 1.—Mean ± EP of the waist circumference (WC) (A) and the waist-hip relation (WHR) (B) presented by volunteers every 15 days of the stages of high glycemic index (HGI) and low glycemic index (LGI), and comparison of the mean values + EP presented during the treatments of the study. The values obtained in the 15th day and in the 30th day of the LGI stage are significant smaller ($^a p < 0.001$, $^c p < 0.002$). than the ones obtained in the 1st day. The mean of the values of WC ($^b p = 0.002$) and WHR ($^d p = 0.008$) obtained at the end of the LGI stage is significantly lower than the end stage of HGI.

Discussion

It has been suggested that the consumption of high GI foods leads to metabolic changes that favor a reduced satiation and increased apetite[3]. It has been argued that the increased appetite occurs in response to reactive hypoglycemia due to post-prandial insulin hyper secretion. There is also a reduction on lipolysis and fat oxidation in response to the reduction on hormone sensible lipase levels , leading to a reduction on free fatty acids concentration. Therefore, the low concentration of the main energy substrates (glucose and free fatty acids) is viewed by the body as a condition similar to starvation, leading to an increase in hunger sensation.[24] For this reason, the increase in obesity prevalence has been associated with the excessive intake of high GI diets[2]. However, this effect has been contested by a few authors.[25,26]

We verified a significant reduction on abdominal obesity in response to the consumption of two daily low GI meals for 30 consecutive days. In a randomized crossover study, 19 women, with excess body weight (BMI between 25 and 47 kg/m^2), aged between 34 and 65 years old, were advised to include in at least 3 of their daily meals high GI or low GI foods. After 12 weeks, there was no difference on energy intake, body weight and WC in response to the study treatments. The analysis of the food records indicated that the diets consumed during the study presented a GI value corresponding to 63.9 (HGI) and 55.5 (LGI) (26). Therefore, the high GI diet consumed in that study[27] cannot be considered a high GI diet according to the criteria proposed by Brand-Miller et al.[19]

In an European study involving the participation of 5 countries the diet consumed by 48,631 men and women, was investigated during approximately 5.5 years using a food frequency questionnaire validated for the studied population. The increase in the GI of the consumed diet resulted in higher WC and BMI[28]. Such results suggest that the intake of a low GI diet can prevent the occurrence of obesity, especially of visceral obesity.

The effect of GI on body weigh was assessed in 28 children and teenagers (14 eutrophic and 14 with excess body weight), aged from 8 to 16 years. Food intake was assessed through the analysis of a food frequency questionnaire. The nutritional status and the eating habits of the participants were obtained from a secondary data base. It was verified that the eutrophic subjects consumed lower GI diets than the ones with excess body weight.[29]

In another study[30] involving 3,734 Italian school children, aged from 6 to 11 years, food intake was assessed throught a semi-quantitative food frequency questionnaire. There was a positive association of the GI versus BMI and WC independently from the gender and age of the participants.

Although these last three studies differed in methodologies, the results corroborate with the ones obtained in the present study. Such results indicate that the intake of high GI diets may favor the occurrence of anabolic reactions, promoting weight gain and accumulation of abdominal fat. This effect has been attributed to the resulting greater glycemic and insulinemic peaks observed after the consumption of high GI diets.

The effects of low GI diets on the metabolic control and anthropometric measures were assessed in patients with type 1 diabetes. A total of 79 euthrophic individuals, presenting WC, HC, and BMI within the normal ranges, and a mean age of 27.03 ± 12.27 years completed the study. After the consumption of a prescribed low GI diet for 6 months, a significant increase in body weight and a decrease in glicatedhemoglobin. WC, HC and BMI were not affected during the study.[31] Such results suggest that in type 1 diabetics the consumption of low GI diets may promote weight gain without affecting abdominal fat, contributing to an improvement in the glycemic control.

In a meta-analysis[32] involving 37 prospective cohort studies, the association of GI/GL in the risk for chronic diseases development was assessed. The consumption of low GI/GL diets decreased the risk for type 2 diabetes and cardiovascular diseases, which was independentof age, gender, BMI, smoking, alcohol consumption, physical activity level, among other variables. On the other hand, the hiperglycemia obtained after the consumption of high GI meals was considered responsible for the progression of such diseases.

Abdominal obesity favors the manifestation of diseases like diabetes and cardiovascular diseases.[33] This accumulation of abdominal fat in sedentary and genetically predisposed people can lead to insulin resistance for several years, before type 2 diabetes mellitus is diagnosed.[34] In the present study, almost 80% of the participants were sedentary. Despite this fact, a significant reduction was seen in WC and WHR, in response to the consumption of two daily low GI meals for 30 consecutive days. Thus, this dietary behavior can reduce the chances of the manifestation of such diseases.

In a cross-over study, high and low GI diets were consumed by men during 5 weeks each. Although food intake was not affected during the study, there was a significant reduction in the adiposity in response to the consumption of low GI diets. Although body weight was not affected, the consumption of the low GI diet tended to increase fat free mass.[5] Despite a reduction in energy intake was verified at the end of both study session compared to baseline, this reduction did not differ between treatments and did not affect body weight in the present study. However, compared to the high GI session, energy intake at the end of the low GI session was approximately 220 kcal lower, leading to a mean weight loss of 580 g compared to the weights participants presented at baseline. This result suggests that a longer period of intervention may result in more effective effects in body weight.

Conclusion

The consumption of 2 daily low GI meals for 30 consecutive days led to a significant reduction in WC and WHR in excessive body weight subjects . Energy intake, body weight and body fat was not affected. Therefore, the consumption of low GI diets can be useful to prevent and control abdominal obesity.

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