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Consuming a hypocaloric high fat low carbohydrate diet for 12 weeks lowers C-reactive protein, and raises serum adiponectin and high density lipoprotein-cholesterol in obese subjects

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ABSTRACT

Objective. High fat, low carbohydrate (HFLC) diets have become popular tools for weight management. We sought to determine the effects of a HFLC diet compared to a low fat high carbohydrate (LFHC) diet on the change in weight loss, cardiovascular risk factors and inflammation in subjects with obesity.

Methods. Obese subjects (29.0–44.6 kg/m^2) recruited from Boston Medical Center were randomized to a hypocaloric LFHC (n = 26) or HFLC (n = 29) diet for 12 weeks.

Results. The age range of subjects was 21–62 years. As a percentage of daily calories, the HFLC group consumed 33.5% protein, 56.0% fat and 9.6% carbohydrate and the LFHC group consumed 22.0% protein, 25.0% fat and 55.7% carbohydrate. The change in percent body weight, lean and fat mass, blood pressure, flow mediated dilation, hip:waist ratio, hemoglobin A1C, fasting insulin and glucose, and glucose and insulin response to a 2 h oral glucose tolerance test did not differ ($P > 0.05$) between diets after 12 weeks. The HFLC group had greater mean decreases in serum triglyceride ($P = 0.07$), and hs-CRP ($P = 0.03$), and greater mean increases in HDL cholesterol ($P = 0.004$), and total adiponectin ($P = 0.045$) relative to the LFHC. Secreted adipose tissue adiponectin or TNF-α did not differ after weight loss for either diet.

Conclusions. Relative to the LFHC group, the HFLC group had greater improvements in blood lipids and systemic inflammation with similar changes in body weight and composition. This small-scale study suggests that HFLC diets may be more beneficial to cardiovascular health and inflammation in free-living obese adults compared to LFHC diets.

Abbreviations: HFLC, high fat low carbohydrate; LFHC, low fat high carbohydrate; hs-CRP, high sensitivity-C-reactive protein; HDL, high density lipoprotein; LDL, low density lipoprotein; HMW, high molecular weight; TNF-α, tumor necrosis factor-alpha; BMI, body mass index; HbA1C, hemoglobin A1C; DXA, dual energy x-ray absorptiometry; FMD, flow mediated dilation; ELISA, enzyme-linked immunosorbent assay; OGTT, oral glucose tolerance test; HOMA-IR, homeostatic model assessment-insulin resistance; AUC, area under the curve.

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1. Introduction

Obesity has become a global epidemic with approximately 500 million individuals affected worldwide [1]. Due to the multitude of co-morbidities associated with this disease, great efforts have been placed on developing treatment strategies for weight reduction. Dietary manipulation remains the first-line treatment for individuals who are overweight and obese. High fat, low carbohydrate (HFLC) diets have received considerable attention in recent years, particularly for the beneficial effects that have been reported on cardiovascular risk markers in overweight and obese individuals [2]. However, some of the results from these studies have been inconsistent, particularly with respect to inflammation. For example, improvements in systemic inflammation have been shown to be improved in several studies when a HFLC diet is consumed, while others have seen improvements with low fat, high carbohydrate (LFHC) diets [3–8]. Some of these discrepancies in outcomes may be due to greater weight loss achieved by a high fat (50-60% kcal), low carbohydrate (20–60 g/d carbohydrate) diet compared to a low fat (20–30% kcal), high carbohydrate (50–60% kcal) diet.

We designed our intervention to promote equal weight loss between two diets varying in macronutrient composition, but with identical calorie deficits. The objective of this study was to determine the effects of hypocaloric LFHC and HFLC diets on the change in anthropometric measures, blood lipids, glucose metabolism, and vascular function in free-living obese adults. We hypothesized that the eucaloric diets would cause similar weight loss and improvements in outcome measures. To test this hypothesis, we utilized an intensive behavioral program that included regular interaction with a registered dietitian in an outpatient setting.

In addition, weight loss has been shown to reduce obesity-associated inflammation [9–12] and there is some evidence to suggest that improvement in adipose tissue inflammation with weight loss may also be influenced by the macronutrient content of the diet [13]. However, no previous studies have directly compared the effects of hypocaloric LFHC and HFLC diets on adipose tissue inflammation in obese individuals. Thus, the secondary objective of this study was to determine how macronutrient content affects serum and adipose tissue inflammation after moderate weight loss in a group of healthy, obese individuals.

2. Methods

2.1. Subjects

Obese subjects (BMI 29.0–44.6 kg/m^2) were recruited between April 2009 and October 2010 from the Nutrition and Weight Management Center at Boston Medical Center (Boston, MA). Individuals with cardiovascular disease, type 2 diabetes with HbA1C >8.0% and on anti-diabetes medication, recent body weight loss (≥3% within 3 months), weight loss medication use within 4 weeks (phentermine, orlistat, or sibutramine), eating disorder, renal or hepatic disease, prior bariatric surgery, pregnancy, tobacco use, thyroid disorder or current use of angiotensin receptor blocker medications were excluded from the study. Subjects were also asked to refrain from taking non-steroidal anti-inflammatory medications 7 days prior to the baseline and follow up measures. All subjects provided written, informed consent prior to participating in this study, which was approved by the institutional review board at Boston University Medical Center.

2.2. Study design and intervention

One week prior to randomization at the baseline study visit, subjects were counseled by a registered dietitian to follow the American Heart Healthy diet [14]. After the run-in period, subjects were randomized to either the LFHC or HFLC diet and were individually counseled by the study dietitian on a bi-weekly basis to consume a 500 kcal deficit diet targeted to induce 0.5–1 lb weight loss per week (5–10% total weight loss over 12 weeks). Daily caloric needs were estimated by the Mifflin-St Jeor equation [15]. Subjects randomized to the LFHC diet were counseled to consume ~60% of calories from complex carbohydrates, 25% from fat (<7% kcal saturated fat), and 15% from protein. Subjects randomized to the HFLC were counseled to consume ≤40 g/d carbohydrates and 60% kcal as fat (<7% kcal saturated fat) and the remainder of calories from protein (~35%). All subjects completed take home 3-day food records (two weekdays and one weekend day) every two weeks. Energy, and macro- and micronutrient content of the diets were determined by Nutrition Data System for Research (NDSR, Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN).

2.3. Anthropometry and body composition

Subjects' height, weight, body mass index (BMI), blood pressure, and waist and hip circumference were measured at baseline and after the 12 week intervention by the same study coordinator or nurse. Body composition was determined at baseline and follow-up by dual energy x-ray absorptiometry (DXA). All scans were performed at Boston Medical Center's General Clinical Research Unit on a Hologic QDR Series® (Discovery W) DXA Machine.

2.4. Vascular function

Vascular function was assessed prior to and following the 12 week intervention by non-invasive ultrasound of the brachial artery before and 1-minute following induction of reactive hyperemia by a 5-minute upper arm cuff occlusion as described previously [9]. Briefly, brachial artery vasoreactivity was measured by trained blinded sonographers using standardized method of ultrasound imaging on a Toshiba Powervision 6000 system (Toshiba Medical USA, Tustin, CA). All vasoactive medications were withheld 24 h before examination and ultrasounds were performed in a temperature-controlled room with subjects resting supine in a fasting state. Flow-mediated dilation (FMD), expressed as relative change (%) in arterial diameter, of the brachial artery was examined as a measure of endothelium-dependent macro-vascular function. An investigator blinded to clinical information performed all analyses of digitized end-diastolic images.