

## Short Communication

# Clinical experience with a relatively low carbohydrate, calorie-restricted diet improves insulin sensitivity and associated metabolic abnormalities in overweight, insulin resistant South Asian Indian women

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South Asian Indians are at increased risk for cardiovascular disease associated with insulin resistance and a dyslipidemia characterized by high triglyceride and low high-density lipoprotein cholesterol concentrations. The purpose of this study is to determine the effects of a calorie-restricted, relatively low carbohydrate diet on weight loss, insulin sensitivity, and associated cardiovascular disease risk factors in overweight, insulin resistant, but apparently healthy, South Asian Indian women. Twenty-three, overweight, insulin resistant, apparently healthy, South Asian Indian women were advised on a calorie-restricted diet containing 40 percent carbohydrate for 3 months. Change in weight, insulin sensitivity (quantified by the steady state plasma glucose concentration during the insulin suppression test), and associated cardiovascular disease risk factors were measured. Weight fell from 75.5 to 70.5 kg ( $p < 0.001$ ), associated with significant decreases in diastolic blood pressure, plasma concentrations (mg/dL) of steady state plasma glucose (217 to 176,  $p < 0.001$ ), triglycerides (137 to 101,  $p = 0.003$ ), and glucose (98 to 92,  $p = 0.005$ ). A calorie-restricted diet, moderately lower in carbohydrate, can lead to weight loss, decreased insulin resistance, and reduction in several cardiovascular disease risk factors in overweight, insulin resistant, apparently healthy, South Asian Indian women.

**Key Words:** weight loss, insulin resistance, cardiovascular disease risk factors, overweight, South Asian Indian

## INTRODUCTION

Individuals of South Asian Indian (SA) ancestry tend to be insulin resistant, with high triglyceride (TG) and low high-density lipoprotein cholesterol (HDL-C) concentrations,<sup>1,2</sup> most likely contributing to their increased risk of cardiovascular disease (CVD).<sup>3</sup> Although low fat/high carbohydrate diets are recommended to decrease CVD risk, this intervention tends to increase TG and lower HDL-C concentrations,<sup>4</sup> a defect already present in SA women. In this context, a recent study showed that insulin resistant subjects of European origin, advised on a calorie-restricted diet moderately restricted in carbohydrate (CHO = 40% of total calories), lost as much weight, but had a greater decrease in CVD risk compared to those who ate more conventional low fat/high CHO diets.<sup>5</sup> We studied whether these benefits would occur in SA women, an ethnic group characterized by insulin resistance and a traditional diet high in carbohydrate content.<sup>6</sup>

## METHODS

The study population consisted of overweight, apparently healthy women of SA ethnicity, selected from 42 individuals who had responded to print advertisements seeking volunteers for our studies, which focused on the rela-

tionship between obesity, insulin resistance, and CVD risk. The Stanford Human Subjects Committee had approved the protocol, and all subjects gave informed consent. In order to qualify for this study, volunteers had to be between 30–65 years of age, in apparently good general health with a body mass index (BMI)  $\geq 23$  kg/m<sup>2</sup>, a normal physical examination and medical history, non-diabetic as defined by the American Diabetes Association criteria,<sup>7</sup> with normal liver/kidney function, and no anemia. They were admitted to the General Clinical Research Center for measurement of insulin-mediated glucose uptake by determining the steady-state plasma glucose (SSPG) concentration as described and validated by our research group,<sup>8</sup> the higher the SSPG, the more insulin resistant the individual.<sup>4</sup> Volunteers whose SSPG concen-

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tration was  $\geq 150$  mg/dL were classified as being insulin resistant: a cut point based on a previous study in 490 apparently healthy individuals indicating that this value defined the 50% of the population that was most insulin resistant.<sup>9</sup> Twenty-three individuals met this criterion and were willing to proceed to the weight loss part of the protocol.

The 23 insulin resistant SA women were instructed to follow a diet containing (as % of total calories) 40-45% CHO, designed to result in a caloric deficit of 500 kcal per day, based on estimated caloric requirements using the Mifflin St Jeor Equation.<sup>10</sup> Subjects received an initial 1-2 hours of nutrition education in order to help them make the transition from the traditional SA diet to one lower in CHO. For example, they were instructed to use olive oil instead of ghee, decrease the portion size of CHO, substitute brown rice and cracked wheat for white rice, and add tofu and ground nuts to traditional atta used to make rotis and chappathis. Subjects returned each week to be weighed and to visit with the study dietitian. Finally, they were encouraged not to change their level of physical activity during the study. At the end of the 3 month period, the subjects were re-admitted to the GCRC, and all the baseline measurements were repeated.

Data are expressed as the mean  $\pm$  standard error (SE). Student's *t*-test was used to make comparisons between pre and post measures. All statistical evaluations were performed with the Excel software package for Windows and SPSS (13.0 for Windows Student Version). Statistical significance was assigned at  $p < 0.05$ .

## RESULTS

Four women lost  $< 5$  pounds, and their data have not been included in the following analyses. The 19 insulin resistant women whose data make up this report had a mean  $\pm$  SD age of  $44 \pm 9$  years and BMI of  $30.2 \pm 0.8$  kg/m<sup>2</sup>.

Table 1 displays the weight and SSPG concentrations before and after the diet intervention. There was a significant decrease in weight, from 75.5 to 70.5 kg ( $p < 0.0001$ ), with a range from 2.3 to 13.5 kg. Mean SSPG concentration decreased from 217 to 176 mg/dl ( $p < 0.001$ ), with a range from + 44 to - 117 mg/dl.

**Table 1.** Pre and Post Characteristics of Subjects (N=19)

	Pre	Post	<i>p</i> value
BMI (kg/m <sup>2</sup> )	30.2 $\pm$ 0.8	28.2 $\pm$ 0.8	< 0.0001
Weight (kg)	75.5 $\pm$ 1.7	70.5 $\pm$ 1.6	< 0.0001
Systolic blood pressure (mm Hg)	118 $\pm$ 4	115 $\pm$ 4	0.089
Diastolic blood pressure (mm Hg)	71 $\pm$ 1	68 $\pm$ 2	0.042
Pulse (bpm)	67 $\pm$ 2	64 $\pm$ 2	0.011
Fasting glucose (mg/dl)	98 $\pm$ 2	92 $\pm$ 3	<0.005
SSPG (mg/dl)	217 $\pm$ 12	176 $\pm$ 16	<0.001
Cholesterol (mg/dl)	173 $\pm$ 6	166 $\pm$ 6	0.13
Triglycerides (mg/dl)	137 $\pm$ 13	101 $\pm$ 8	<0.005
HDL-C (mg/dl)	41 $\pm$ 2	41 $\pm$ 2	0.39
LDL-C (mg/dl)	107 $\pm$ 5	104 $\pm$ 5	0.28

CVD risk factors measured before and after the weight loss period are also given in Table 1. These data show that pulse ( $p = 0.011$ ) and both systolic ( $p = 0.09$ ) and diastolic ( $p = 0.04$ ) blood pressure were lower following the period of dietary intervention, as were fasting plasma glucose ( $p = 0.005$ ) and TG ( $p = 0.003$ ) concentrations. However, no significant changes were seen in total cholesterol, low-density lipoprotein cholesterol, or HDL-C concentrations.

## DISCUSSION

The results indicated that 19 of the 23 women entering the study lost  $\geq 5$  pounds, with a maximum loss of 13.5 kg. In addition, post-weight loss measurements demonstrated that insulin sensitivity was significantly enhanced ( $p < 0.001$ ) following the weight loss period, accompanied by a lower pulse rate, blood pressure, fasting plasma glucose and TG concentrations. These changes are comparable to the results of a study of overweight, insulin resistant women of European ancestry,<sup>5</sup> advised on a diet with essentially the same macronutrient content, but lasting for one month longer. The current study was not designed to separately assess the effects of weight loss independent of carbohydrate intake, as our previous study has already established the superiority of a 40% carbohydrate diet (compared with 60% carbohydrate) in improving insulin concentrations, independent of amount of weight lost.<sup>5</sup> The current study provides evidence that insulin resistant women of SA ancestry are able to lose weight in response to a calorie-restricted, relatively low CHO diet, with a macronutrient content different from their habitual cuisine, and improve their insulin sensitivity and decrease their risk factors for type 2 diabetes and CVD to a comparable degree to that previously documented in European women.<sup>5</sup> These benefits were seen despite the fact that insulin resistance is characteristic of this ethnic group,<sup>1,2</sup> and the fact that they were advised to consume a diet that varied considerably from what they normally consumed.

## AUTHOR DISCLOSURES

There are no significant financial or other conflicts of interests. This research was supported by the General Clinical Research Center, Stanford Medical Center (RR-00070) and a National Institute of Child Health and Human Development K12 Award (5K12HD043452-02).

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## 有過重及胰島素阻抗的印度裔婦女攝取較低醣類及限制熱量飲食可以改善胰島素敏感性及相關的代謝性異常之臨床試驗

南亞印度裔族群有較高的心血管疾病的風險，並與胰島素阻抗及高三酸甘油酯、低的高密度脂蛋白濃度的血脂異常特性有關。此研究目的是評估在過重與有胰島素阻抗但外表健康的印度裔婦女，攝食限制熱量及較低的醣類飲食對於她們的體重降低、胰島素敏感性及相關的心血管疾病危險因子之影響。對 23 名過重及有胰島素阻抗但外表健康的印度裔婦女建議攝取熱量限制飲食，其中醣類熱量佔 40%，為期 3 個月。測量體重、胰島素敏感性(採用胰島素阻抗測驗，量化穩定狀況下的血糖濃度)及相關的心血管疾病危險因子的改變。平均體重由 75.5 降到 70.5 kg ( $p < 0.001$ ) 並伴隨舒張壓、血漿中(mg/dL)穩定狀況血糖(217 to 176,  $p < 0.001$ )、三酸甘油酯(137 to 101,  $p = 0.003$ )及空腹血糖(98 to 92,  $p = 0.005$ )濃度下降。限制熱量及適度降低醣類的飲食可以促使過重及有胰島素阻抗但外表健康的印度裔婦女體重降低，減少胰島素阻抗性及降低數種心血管疾病危險因子。

**關鍵字：**體重減輕、胰島素阻抗、心血管疾病危險因子、體重過重、南亞印度裔