# Respiratory Quotient, Substrate Oxidation and Energy Expenditure After Consumption of Low versus High Carbohydrate Meals


Julie Smith, Sarah Bergman, Melissa Kumagai, Diane Stadler

Graduate Programs in Human Nutrition,
Oregon Health & Science University, Portland, OR



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## Introduction

Macronutrient consumption affects respiratory quotient, substrate oxidation and energy expenditure in vivo. Energy expenditure and fat oxidation may be greater following low carbohydrate (LC) meals vs. high complex carbohydrate (HC) meals. Higher rates of fat catabolism and energy expenditure after consumption of LC than HC meals may confer a metabolic advantage that facilitates greater weight loss with preferential loss of fat mass.

**This study used indirect calorimetry and urine urea nitrogen to measure and compare fasting and postprandial respiratory quotient, substrate oxidation, and energy expenditure in healthy, normal weight adults before and after consumption of LC and HC meals.**

## Methods

10 healthy, weight-stable, male (3) and female (7) adults completed two 4-day controlled dietary phases with at least a 3 day washout period between visits. Subjects consumed a standard diet for 3 days (51% CHO, 35% Fat, 19% PRO) and LC or HC meals providing 10 kcal/kg body weight on day 4. All study related procedures were performed at the Oregon Clinical & Translational Research Institute at OHSU.

Resting energy expenditure was measured for 45 minutes with an indirect calorimeter (Vmax 29n, SensorMedics Corp, Yorba Linda, CA). Subjects then consumed a HC or LC meal, and postprandial energy expenditure was measured for 45 minutes of every hour for four hours. A 2nd meal of the same composition was served and postprandial energy expenditure was again measured for 45 minutes of every hour for four hours.

Weight and height were measured with a digital scale (Scale-Tronic, model 5002, Wheaton, IL) and well-mounted stadiometer (Holtain, Ltd, UK). Fat free mass was measured by DXA (Discovery A Densitometers, Hologic Inc, Bedford MA). Urine urea nitrogen was measured in a 24 hour sample using the enzymatic conductivity rate method.

Total and incremental area under the curve analyses were calculated using the trapezoidal method. Incremental area under the curve subtracts the fasting value to isolate the energy expenditure attributable to thermic effect of food. All values were compared using one tailed paired t-tests. Comparisons at each time point were evaluated using one sided t-tests with a Bonferroni adjustment. P-values ≤ 0.005 were considered significant.

## Results

**Table 1. Subject Characteristics†**

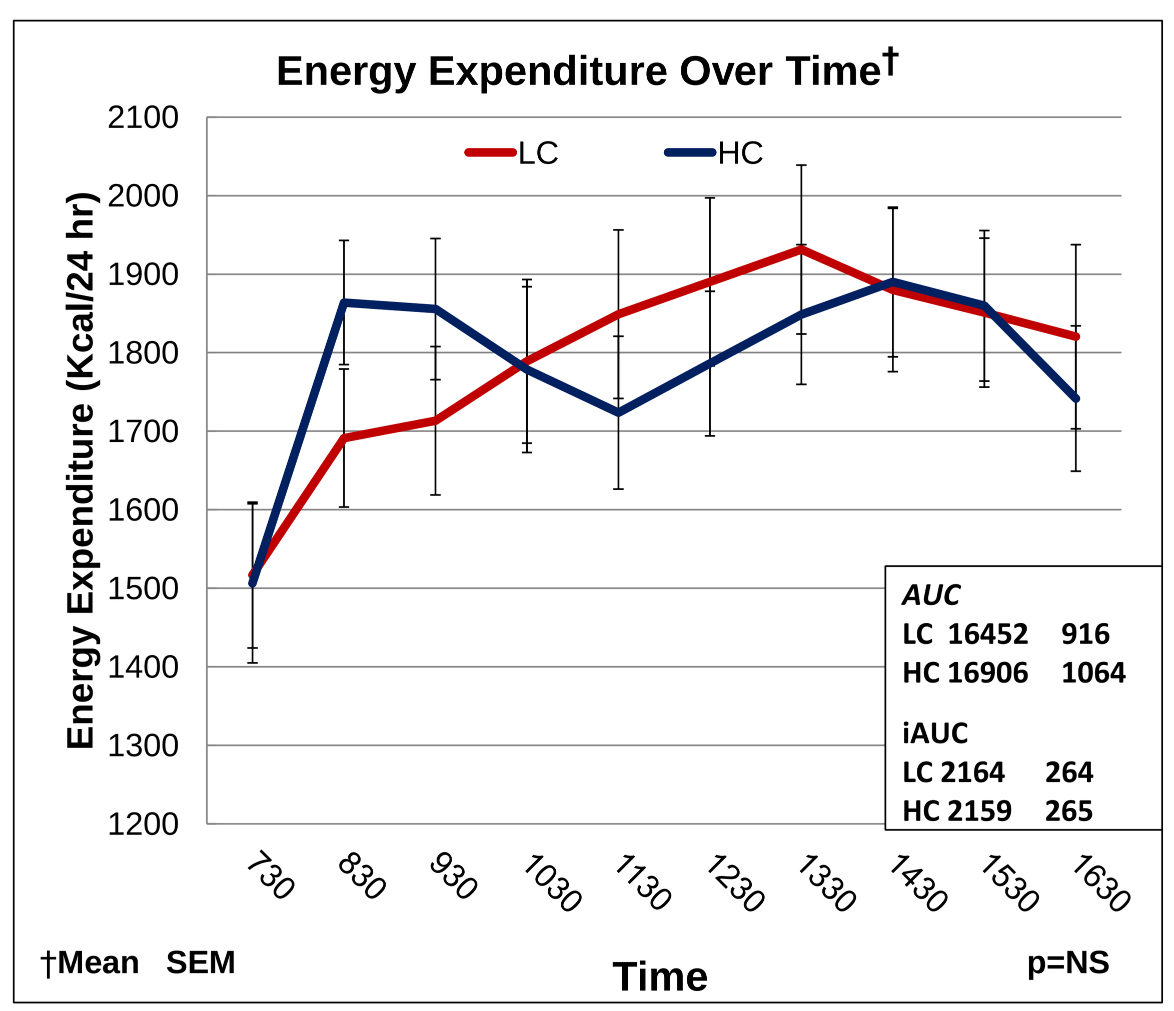
| | Total (n=10) | Women (n= 7) | Men (n=3) |
|---|---|---|---|
| Age (yr) | 27.5 2.4 | 28.7 3.4 | 24.7 0.2 |
| Weight (kg) | 65.2 3.8 | 59.7 2.6 | 78.1 3.7 |
| Height (cm) | 171.5 2.9 | 167.0 2.1 | 182.0 2.4 |
| BMI (kg/m²) | 22.0 0.7 | 21.3 0.7 | 23.5 0.9 |
| Fat-Free Mass (kg) | 47.2 3.1 | 42.1 2.1 | 59.1 3.3 |

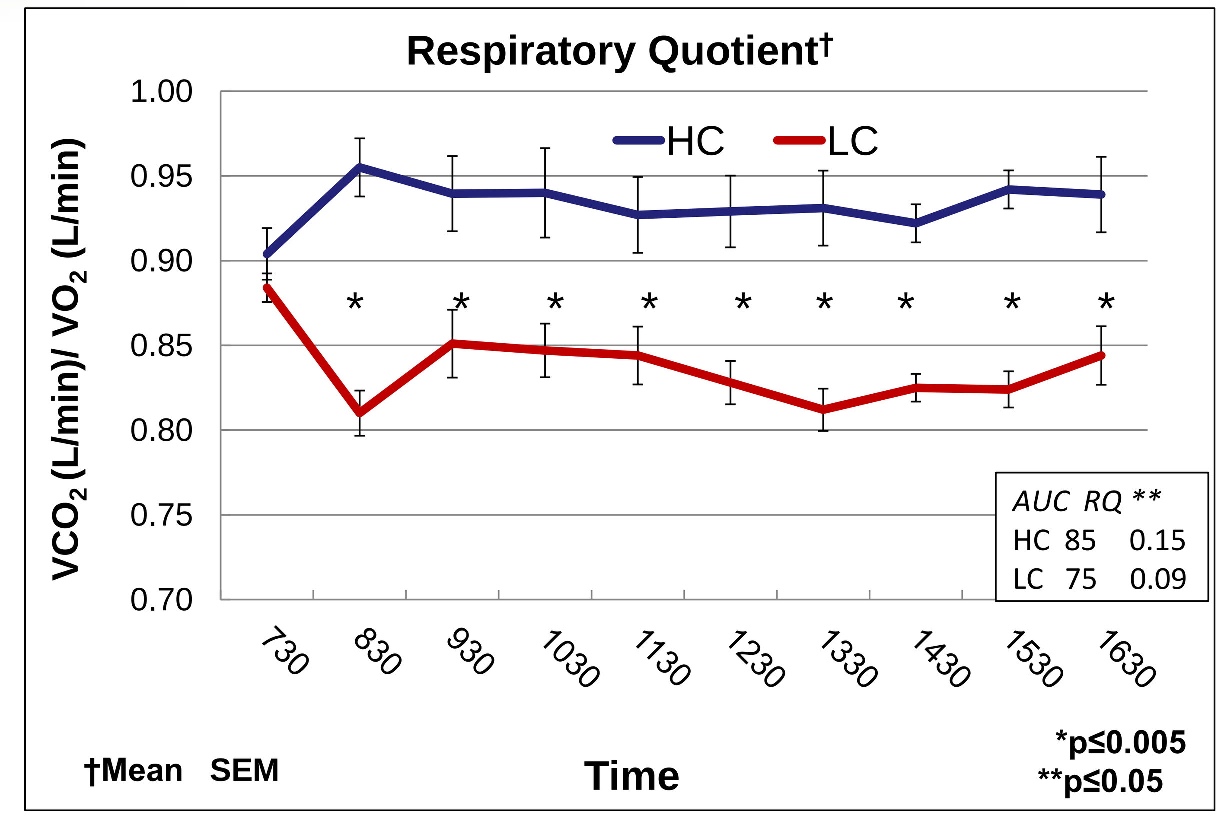
†Mean SD

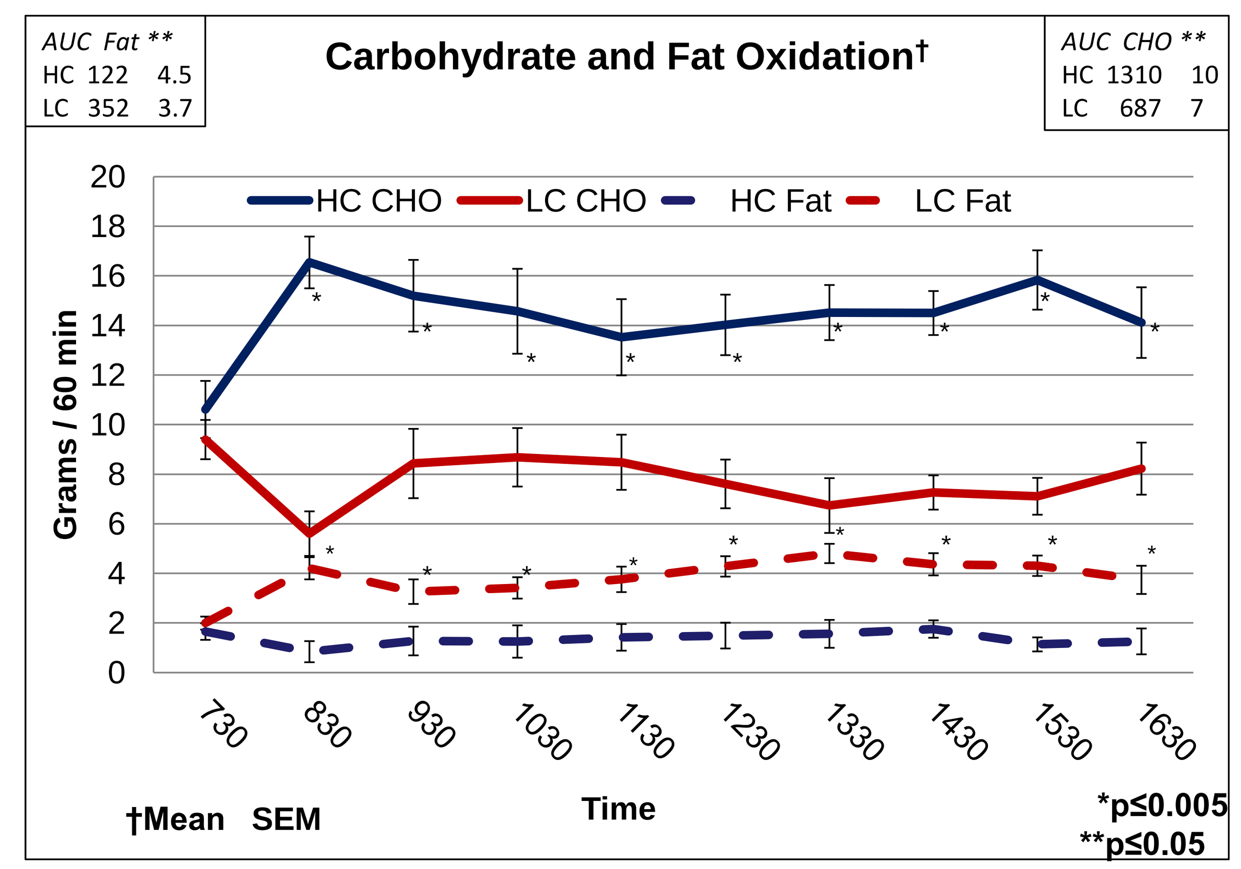
**Table 2. Nutrient Composition of Test Meals†**

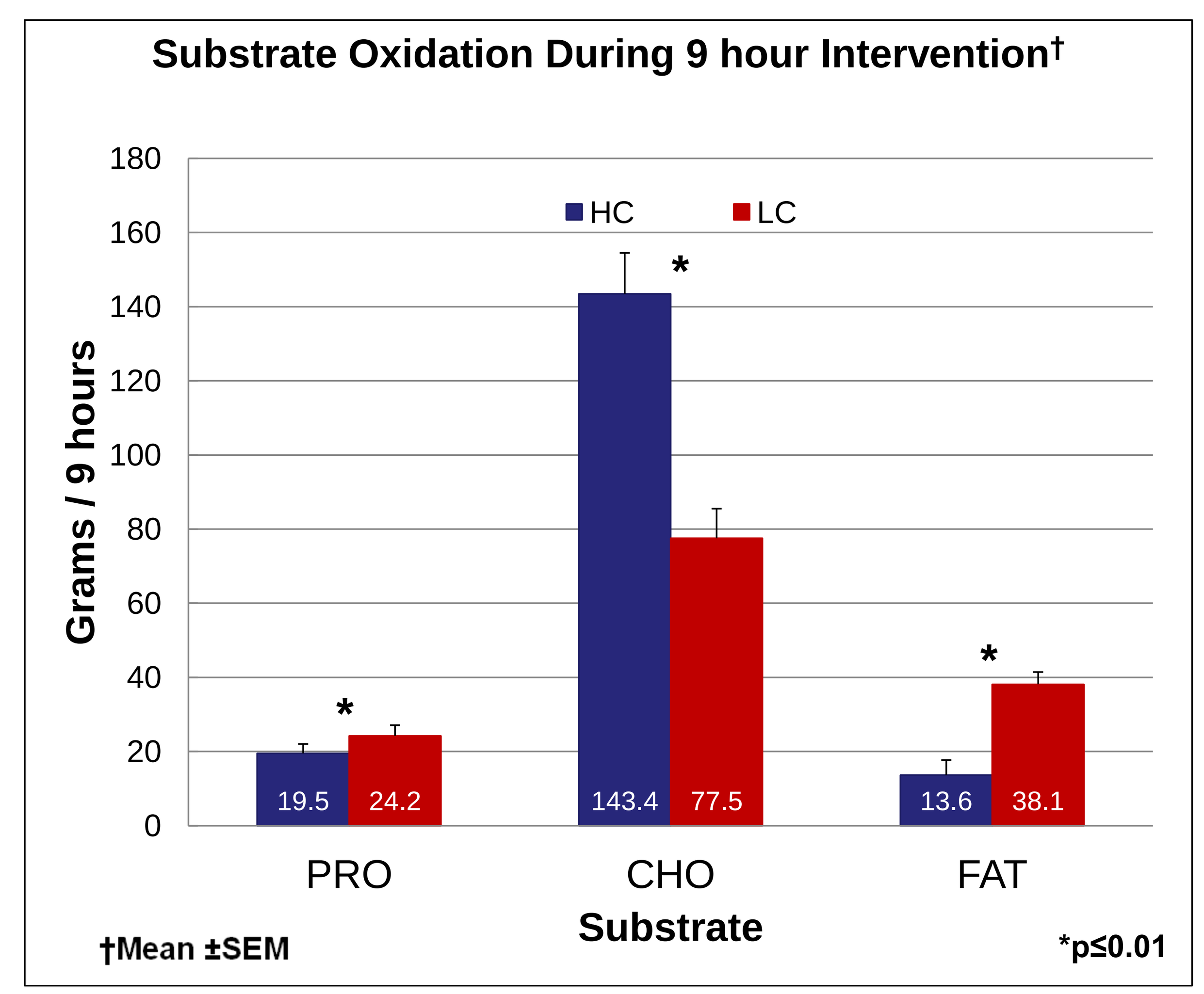
| Component | LC | HC |
|---|---|---|
| Energy (kcal) | 1304 231 | 1366 231 |
| Carbohydrate (g) | 11 2 | 184 33 |
| Fat (g) | 98 17 | 40 7 |
| Protein (g) | 95 16 | 60 11 |

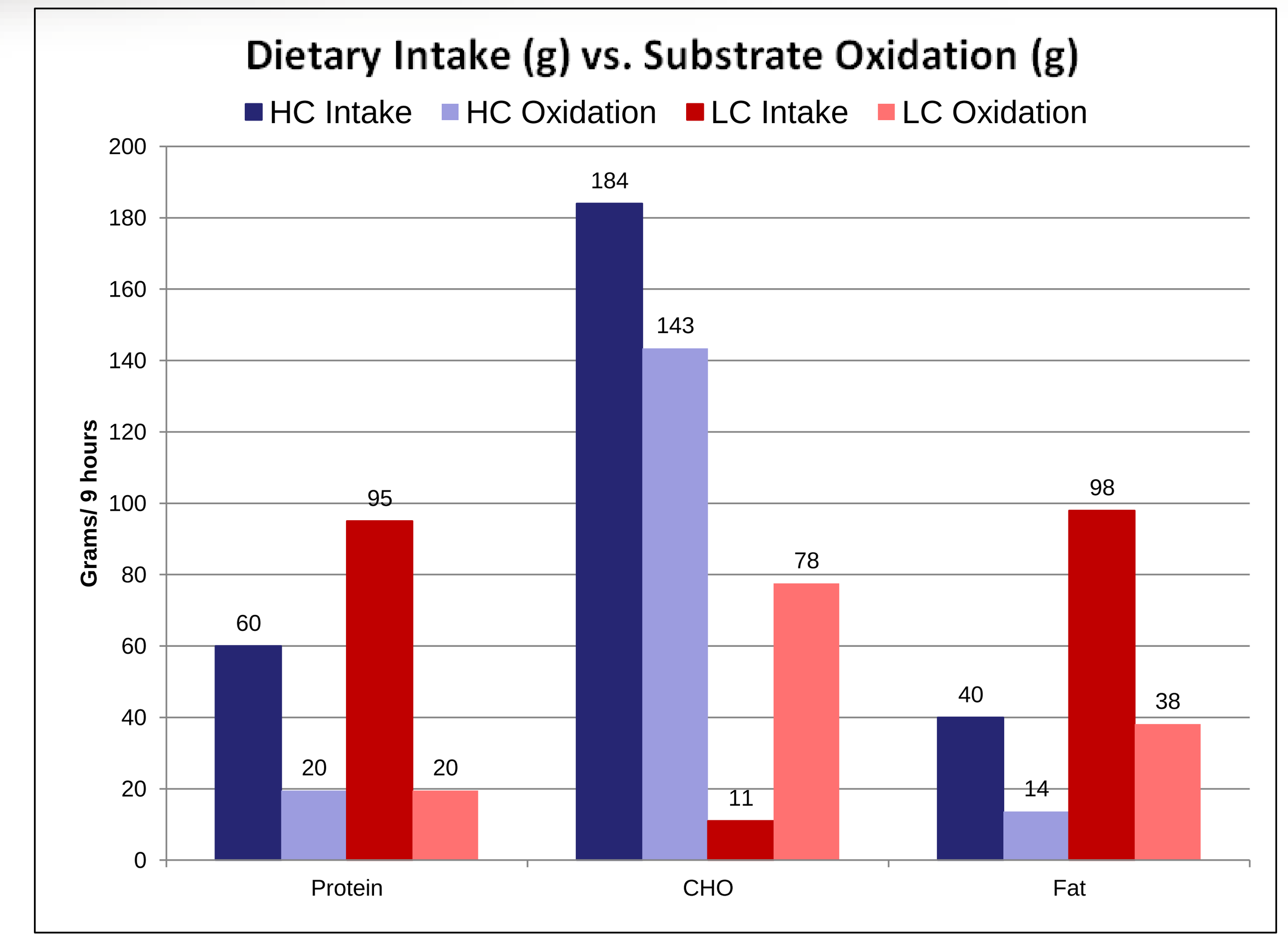
†Mean SEM




## Summary & Conclusions

There was no significant difference in energy expenditure between the diets over the 9 1/2 hours studied, however different patterns of energy expenditure between the diets suggest that there may be a difference if studied over a longer period of time. There were significant differences between diets in the first two hours immediately after breakfast.

Thermic effect of food was similar between diets, as measured by incremental area under the curve.

Respiratory quotient was significantly lower after consumption of LC meals, suggesting a higher rate of fat oxidation. Respiratory quotient was significantly different at each postprandial time point.

Rates of both carbohydrate and fat oxidation were significantly different at each postprandial time point. Following consumption of the LC meals, rate of fat oxidation was higher and rate of carbohydrate oxidation was lower, compared to the high carbohydrate diet.

The rate of protein oxidation was higher after the LC diet than the HC diet.

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