

Effect of a Plant-Based Low-Carbohydrate Diet on Body Weight and Blood Lipids in Hyperlipidemic Adults

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Boston Children's Hospital
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Disclosures

- Canadian Institutes of Health Research (CIHR)
 - Doctoral Research Award
 - Fellowship Award in the Area of Clinical Research
 - Randomized Controlled Trials - Mentoring Program Training Grant

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- William Singer

Study Funding



Personal Funding



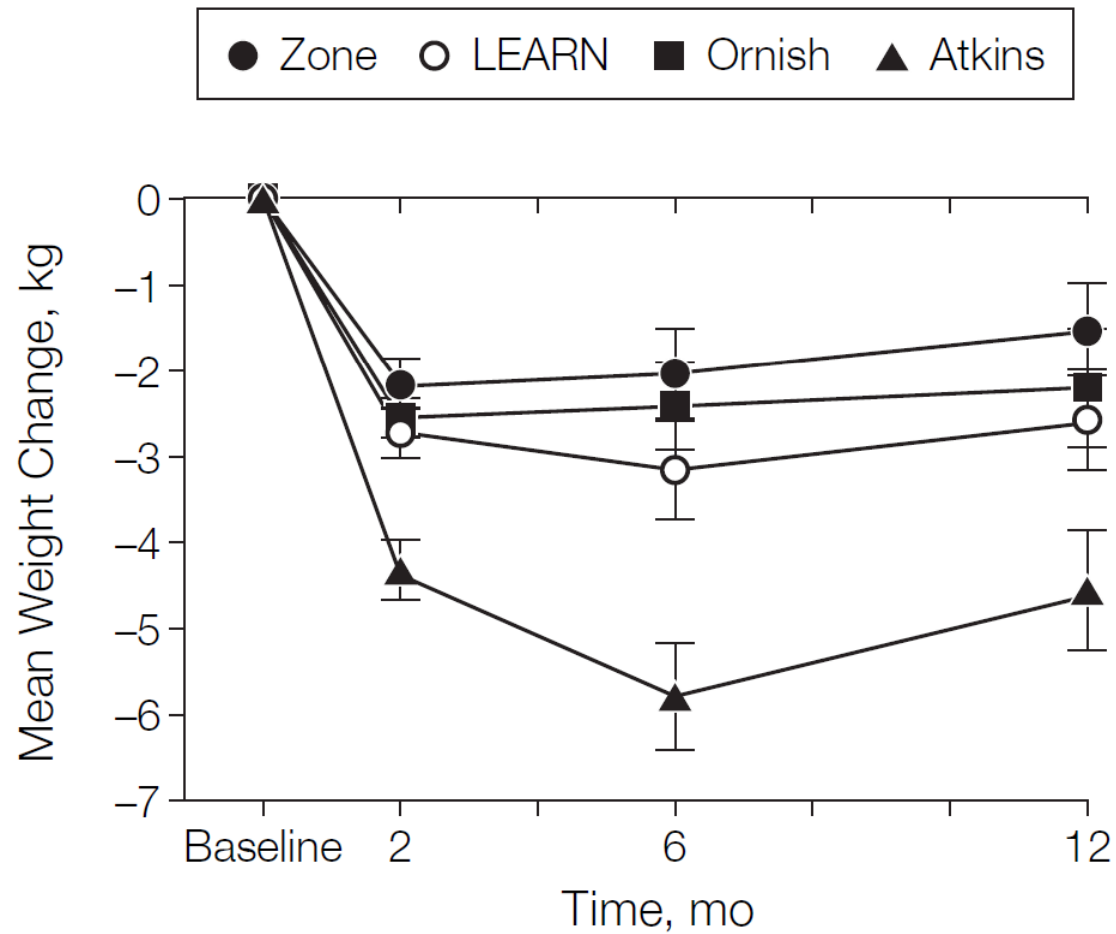
Doctoral Research Award

High Protein (Low-Carbohydrate) Atkins' Type Diets

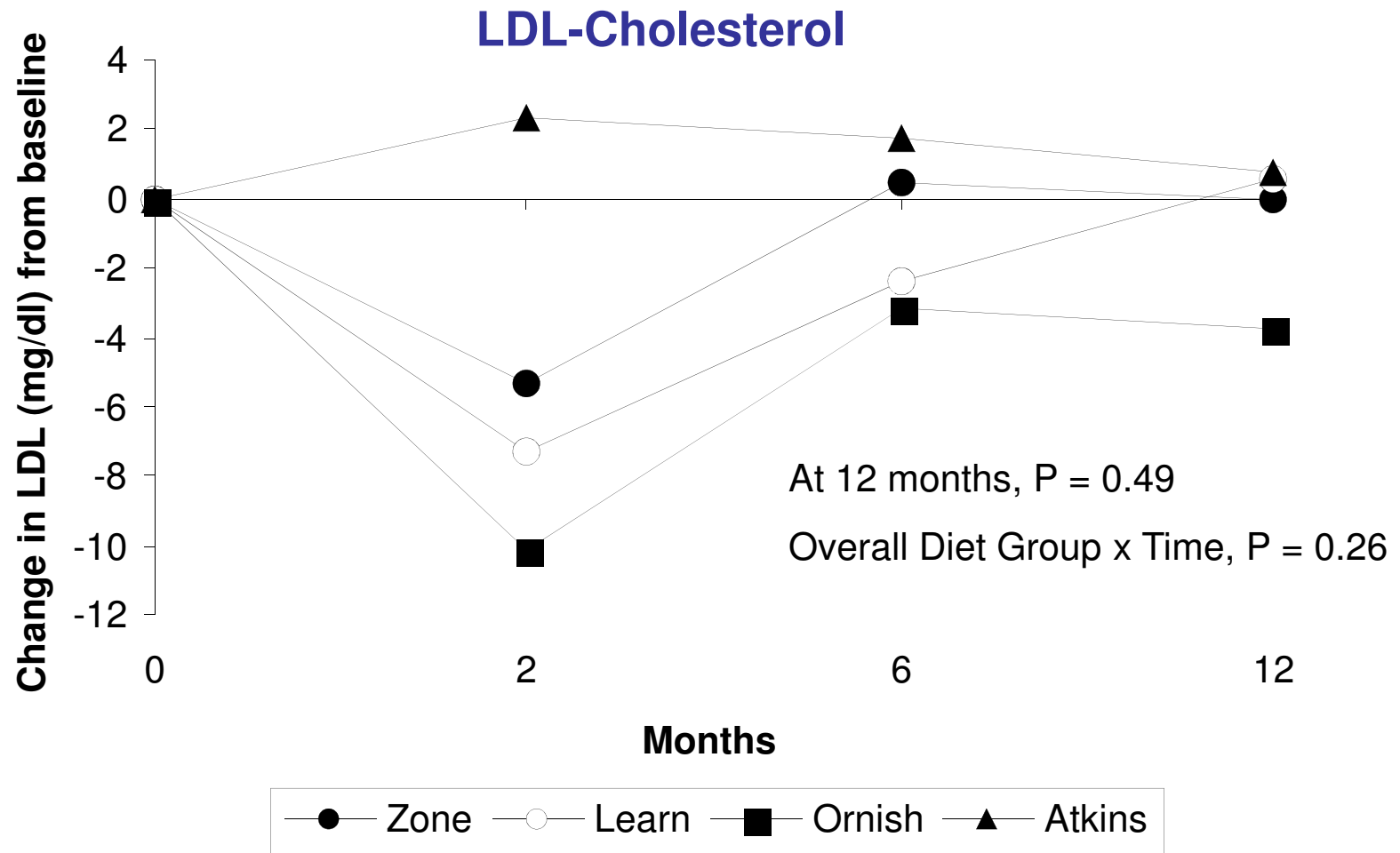
- Primarily for weight reduction
- \uparrow HDL-C, \downarrow TG, \leftrightarrow LDL-C
- Reasons:
 - caloric restriction and/or macronutrient composition
- Concern with high SFA & dietary cholesterol without weight loss may \uparrow blood lipids

Diet and Weight Loss

N=311



Diet and Serum Lipids

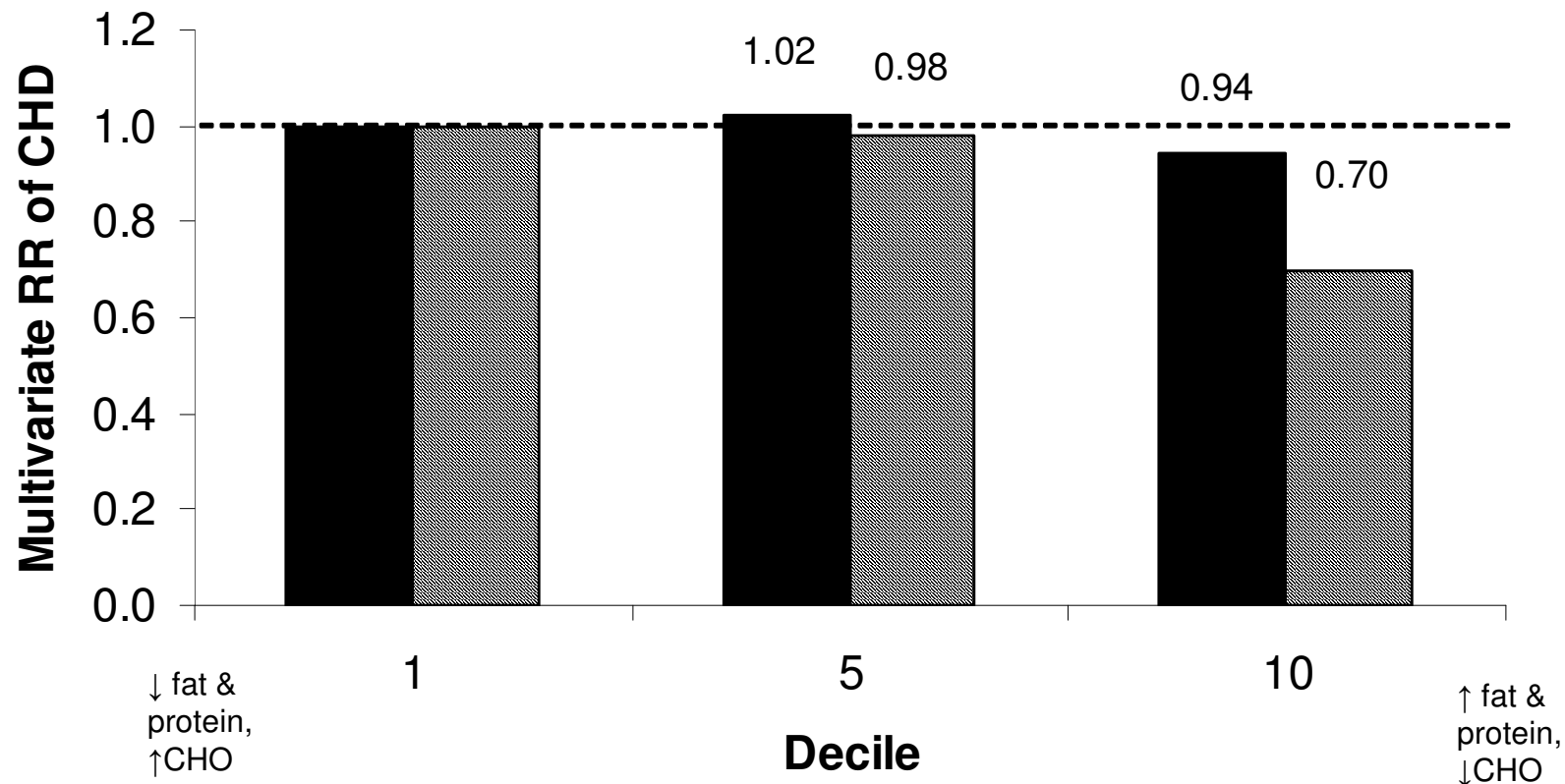


Low-Carbohydrate Diet and LDL-C

<u>Authors</u>	<u>Duration</u>	<u>LDL-C Effect</u>
Volek et al, 2000	8 wks	↑ LDL-C
Foster et al, 2003	52 wks	↑ LDL-C / ↔ LDL-C
Volek et al, 2003	4 wks	↑ LDL-C
Samaha et al, 2003	24 wks	↔ LDL-C
Meckling et al, 2004	10 wks	↔ LDL-C
Stern et al, 2004	52 wks	↔ LDL-C
Schaefer et al, 2005	52 wks	↑ LDL-C / ↔ LDL-C
Noakes et al, 2006	12 wks	↑ LDL-C

Vegetable Protein and Fat

Nurses' Health Study:
Low-CHO-Diet Score and Risk of CHD



- Intake of Carbohydrate, Animal Protein and Animal Fat
- ▨ Intake of Carbohydrate, Vegetable Protein and Vegetable Fat

Low-Carbohydrate Plant-Based Diet

- Animal protein → vegetable protein
 - Mainly from soy, gluten (seitan) and nuts
- Animal fat → vegetable oil
 - tree nuts, avocado
 - olive and canola oils (high MUFA)
- Promotion of weight loss



Objective

To assess the effectiveness of a low-carbohydrate, high protein plant-based diet on body weight and blood lipids under first **metabolic** and then **real-world conditions**.

The Effect of a Plant-Based Low-Carbohydrate (“Eco-Atkins”) Diet on Body Weight and Blood Lipid Concentrations in Hyperlipidemic Subjects

David J. A. Jenkins, MD; Julia M. W. Wong, RD; Cyril W. C. Kendall, PhD; Amin Esfahani, MSc; Vivian W. Y. Ng, RD; Tracy C. K. Leong, BSc; Dorothea A. Faulkner, PhD; Ed Vidgen, BSc; Kathryn A. Greaves, PhD; Gregory Paul, PhD; William Singer, MD

ARCH INTERN MED/VOL 169 (NO. 11), JUNE 8, 2009

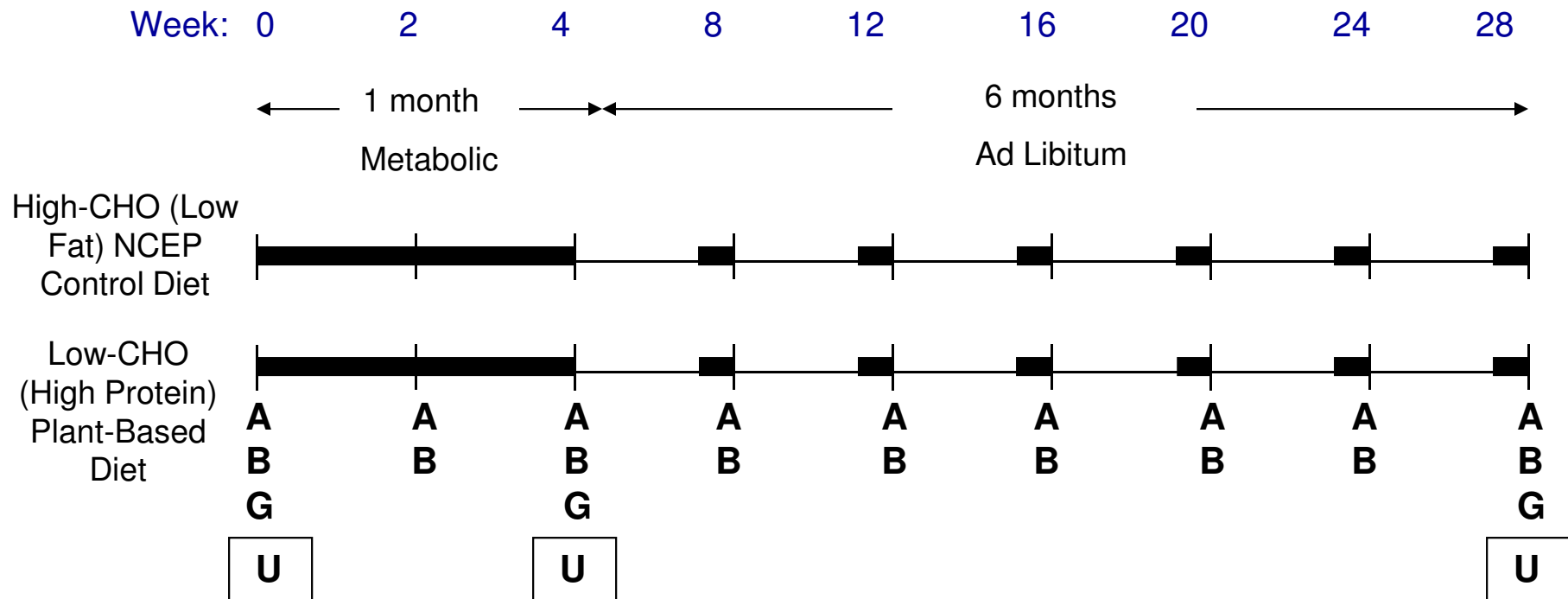
BMJ Open Effect of a 6-month vegan low-carbohydrate (‘Eco-Atkins’) diet on cardiovascular risk factors and body weight in hyperlipidaemic adults: a randomised controlled trial

David J A Jenkins,^{1,2,3,4,5} Julia M W Wong,^{1,3,6,7} Cyril W C Kendall,^{1,3} Amin Esfahani,^{1,3,8} Vivian W Y Ng,^{1,3} Tracy C K Leong,^{1,3} Dorothea A Faulkner,^{1,3} Ed Vidgen,^{1,3} Gregory Paul,⁹ Ratna Mukherjea,⁹ Elaine S Krul,⁹ William Singer^{1,2,3,4}

BMJ Open 2014;**4**:e003505. doi:10.1136/bmjopen-2013-003505

Study Design

2-phase randomized controlled parallel study



60% of energy requirements (Harris Benedict Equation).

A = Anthropometrics, symptom diaries, exercise logs

B = Blood

G = Breath Gases

█ = 7 day food record

U = 24h Urine

Nutrient Profiles of Prescribed Control and Test Diets (based on 2000 kcal diet)

	High CHO (Control) Diet	Low CHO (Test) Diet
Energy (kcal/d)	2001	2002
Total Protein (g/d)	82.2 (16.4)	152.3 (30.4)
Soy Protein (g/d)	0	34.5 (6.9)
Available Carbohydrate (g/d)	290.7 (58.3)	130.3 (26.2)
Total Dietary Fiber (g/1000kcal)	21.1	28.8
Total Fat(g/d)	56.2 (25.3)	96.6 (43.4)
SFA (g/d)	10.1 (4.6)	14.2 (6.4)
MUFA (g/d)	18.4 (8.3)	56.6 (25.5)
PUFA (g/d)	21.2 (9.5)	21.1 (9.5)
Dietary Cholesterol (mg/1000kcal)	27.5	0

Expressed as % of energy.

Study Foods

All study foods provided to participants (metabolic) and readily available in supermarkets (ad libitum).

High-CHO Control Diet

Non-Viscous Fiber

Whole wheat bread, bran flakes, wheat crackers, celery, tomato

Dairy & Egg Protein

Skim milk, fat-free cheese & yogurt, egg substitute, egg whites

Other Carbohydrates

noodles/pasta

Low-CHO Plant-Based Diet

Viscous Fiber

Oat bran cereal, barley, eggplant, okra

Vegetable Protein

Soy, gluten (seitan)

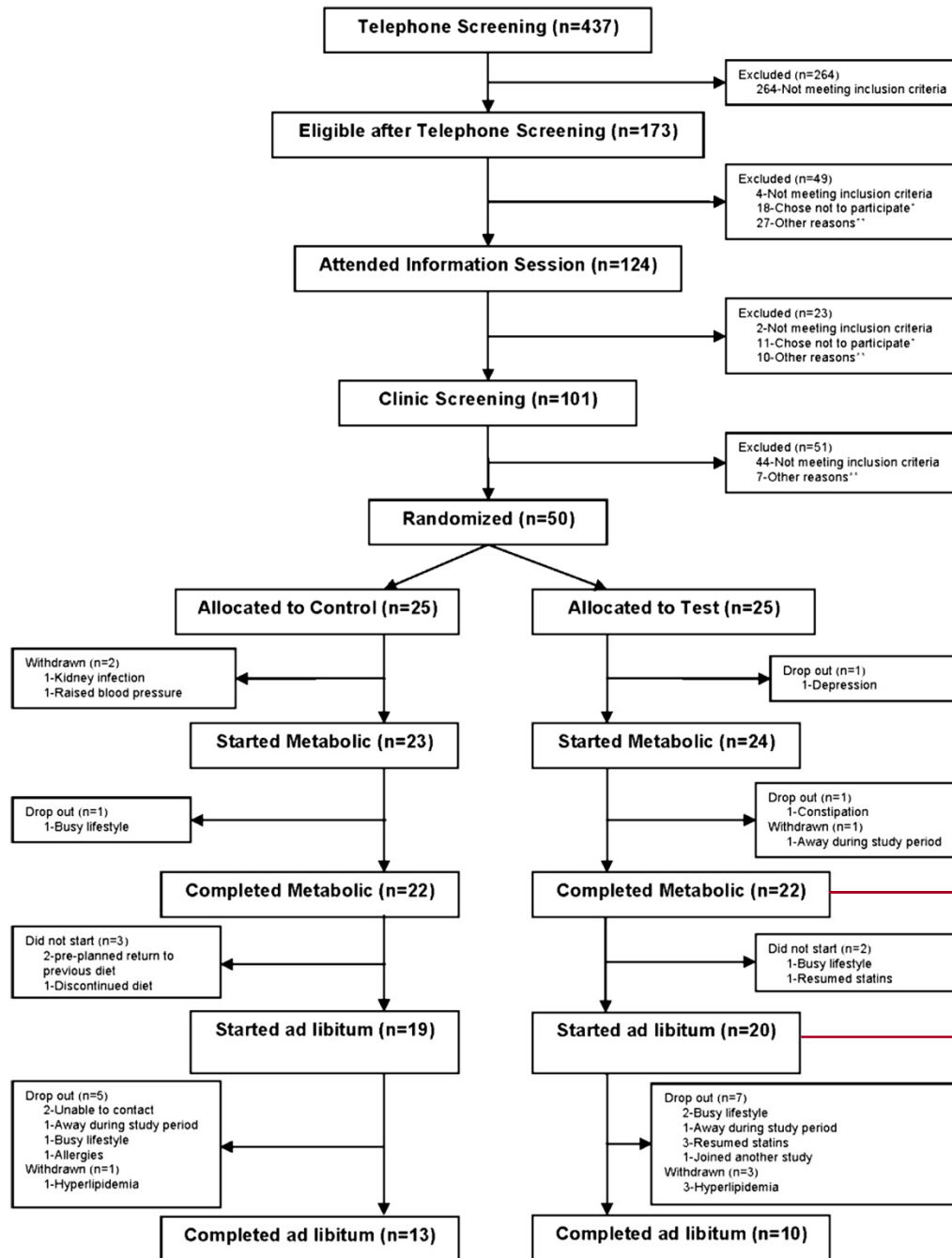
Nuts

Almond, hazelnut, pecan, cashew, macadamia, pistachio

Volunteers

Participant Characteristics

- 50 overweight hyperlipidemic subjects randomized
- Mean Age: 56.9 ± 7.3 y
- BMI: 30.8 ± 2.6 kg/m²
- Baseline LDL-C: 4.07 ± 1.21 mmol/L



Data presented from Metabolic Phase

Data presented from Ad Libitum Phase



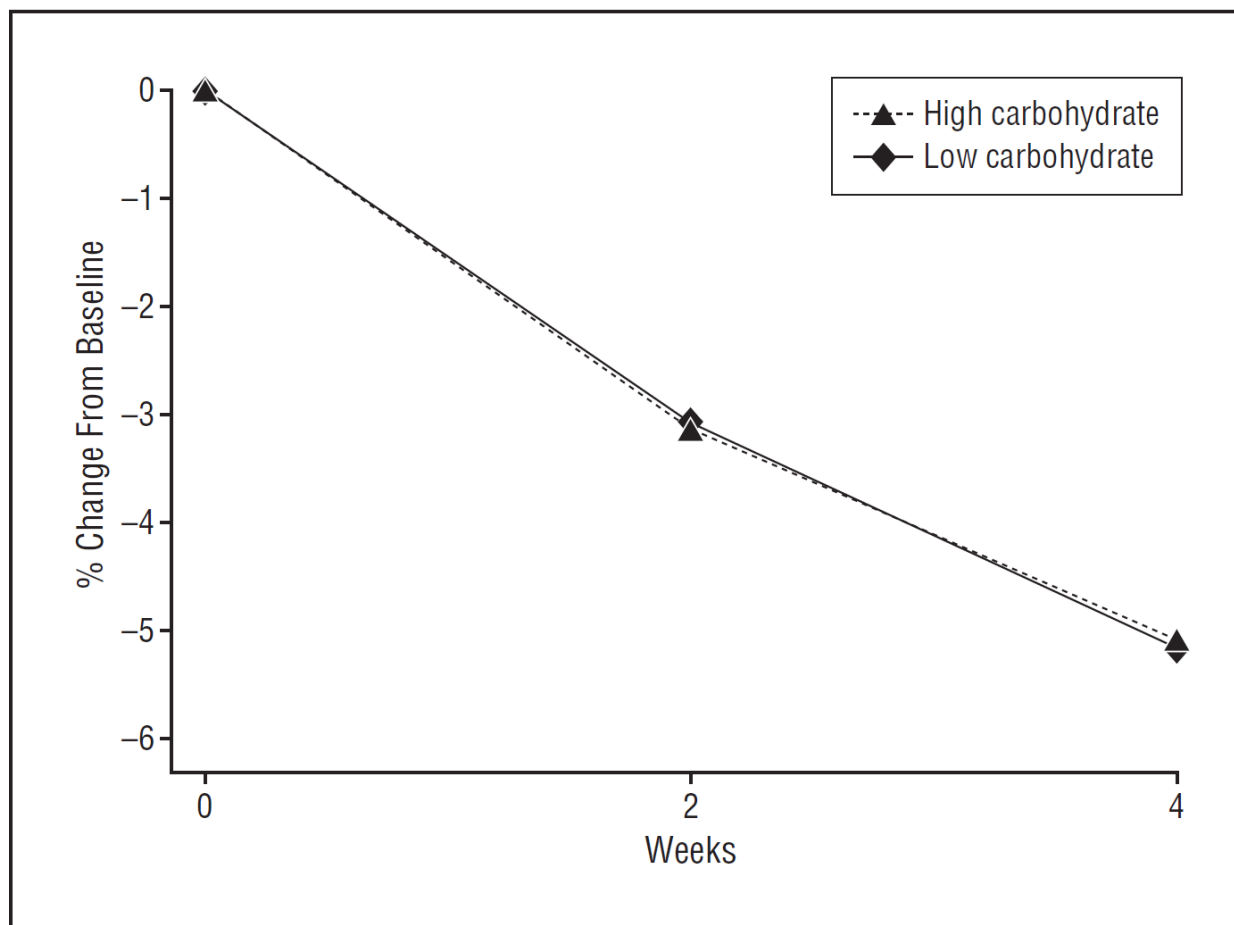
4-Week Metabolic Phase

Nutrient Profiles During Metabolic Phase

Variable	High-Carbohydrate Control Diet	Low-Carbohydrate Test Diet	<i>P</i> Value ^a
→ Calories, mean (SE), kcal	1488.2 (48.1)	1451.4 (47.3)	.59
→ Calorie compliance, % (SE)	94.2 (1.3)	94.8 (1.4)	.76
Total calories, % (SE)			
→ Available carbohydrate	58.2 (0.4)	26.8 (0.3)	<.001
→ Protein	16.8 (0.1)	30.0 (0.3)	<.001
Vegetable protein	7.0 (0.1)	29.9 (0.3)	<.001
Soy protein	0.2 (0.0)	6.8 (0.1)	<.001
→ Fat	24.5 (0.4)	43.1 (0.2)	<.001
Saturated	4.6 (0.0)	6.3 (0.1)	<.001
Monounsaturated	7.9 (0.2)	25.0 (0.2)	<.001
Polyunsaturated	9.1 (0.2)	9.6 (0.1)	.02
Alcohol	0.3 (0.2)	0.0 (0.0)	.15
Dietary fiber, mean (SE), g/1000 kcal	21.3 (0.2)	28.3 (0.2)	<.001
Dietary cholesterol, mean (SE), mg/1000 kcal	30.1 (1.4)	0.4 (0.3)	<.001

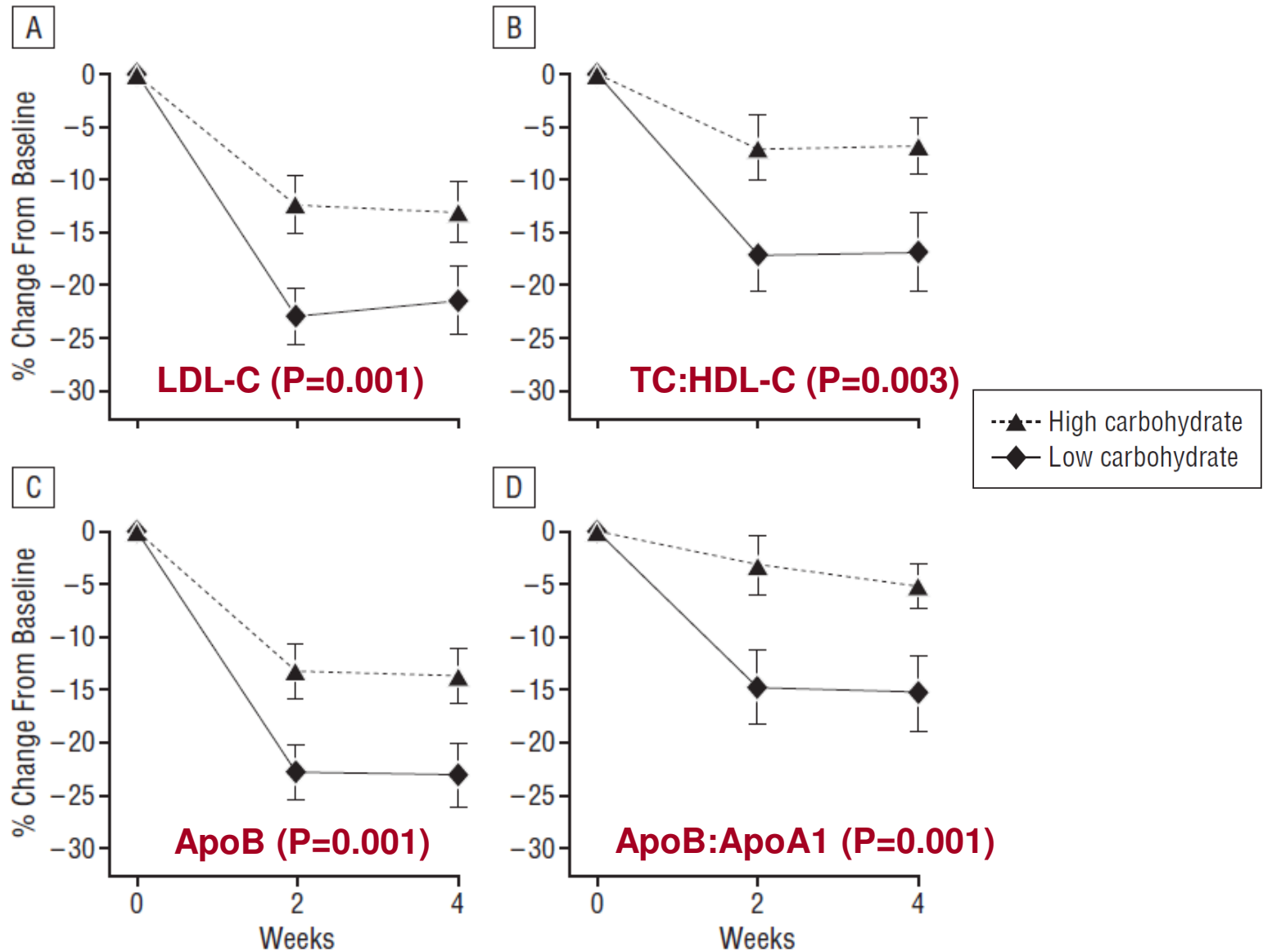
^a Calculated using the 2-sample *t* test between high- vs low-carbohydrate diets.

Body Weight



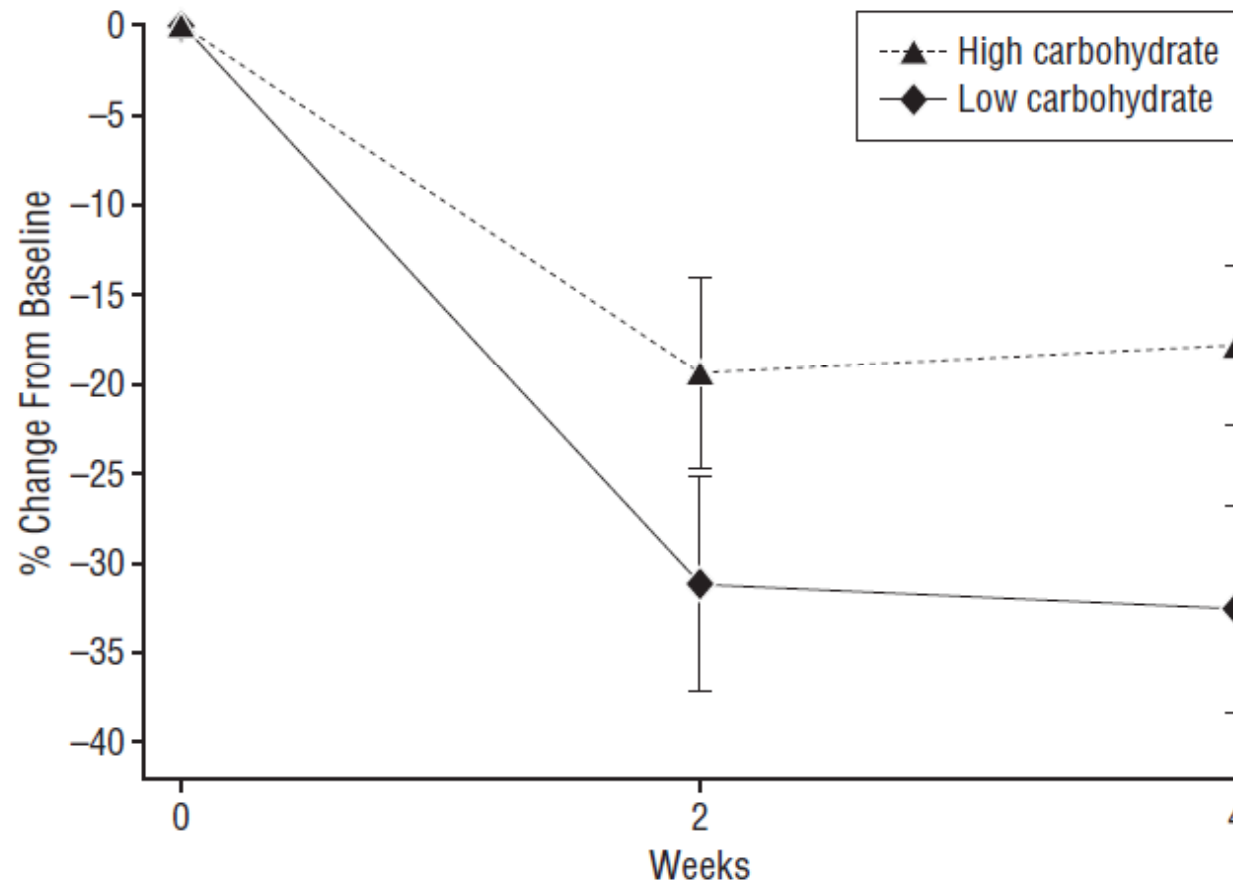
Weight loss from both diets during the 4 weeks of the study ($P=.98$) for completers.

Blood Lipids



Blood Lipids

Triglycerides (P=0.02)





6-Month Ad Libitum Phase

Nutrient Profiles During Ad Libitum Phase

High carbohydrate Low carbohydrate

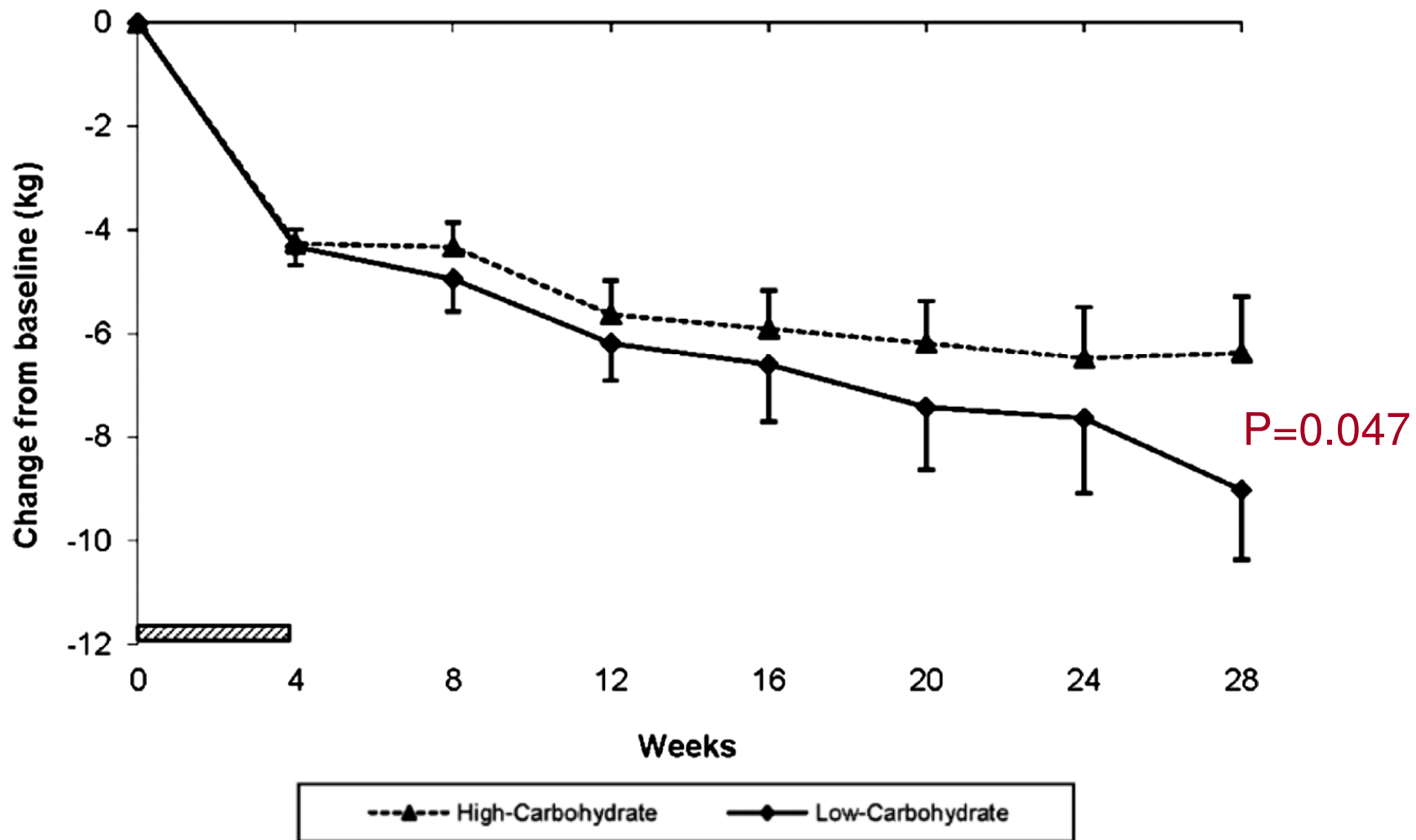
	Week 0*	Ad Libitum*	Week 0*	Ad Libitum*	Between-treatment difference†	p Value‡
→ Calories (kcal)	1598	1347	1840	1388	-248	0.001
Percentage of total calories						
→ Available carbohydrate	46.3	53.9	43.8	39.6	-10.5	<0.001
→ Protein	20.6	18.4	20.1	22.7	5.9	<0.001
Vegetable protein	5.6	6.7	5.7	15.0	8.2	<0.001
Soy protein	0	0.2	0	4.7	3.6	<0.001
→ Fat	30.8	27.5	34.4	36.0	5.2	<0.001
Saturated	10.8	7.6	11.8	7.5	-0.4	0.401
Monounsaturated	12.3	10.4	13.0	14.8	4.6	<0.001
Polyunsaturated§	5.2	6.3	6.6	8.4	0.4	0.350
Alcohol	2.2	1.9	1.6	1.1	-0.5	0.160
Dietary fibre (g/1000 kcal)	10.9	18.2	12.1	21.3	1.5	0.127
Dietary cholesterol (mg/1000 kcal)	149	87	157	117	11	0.954
Adherence with 'Eco-Atkins' components¶						
Viscous fibre (of 33.3%)	-	-	-	14.0	-	-
Vegetable protein (soy and gluten; of 33.3%)	-	-	-	14.7	-	-
Nuts (of 33.3%)	-	-	-	6.3	-	-
→ Total adherence (of 100%)	-	-	-	33.6	-	-

*Values represent multiple imputation (mean of 5 sets of randomly imputed values) to generate data for those who dropped out or had missing values.

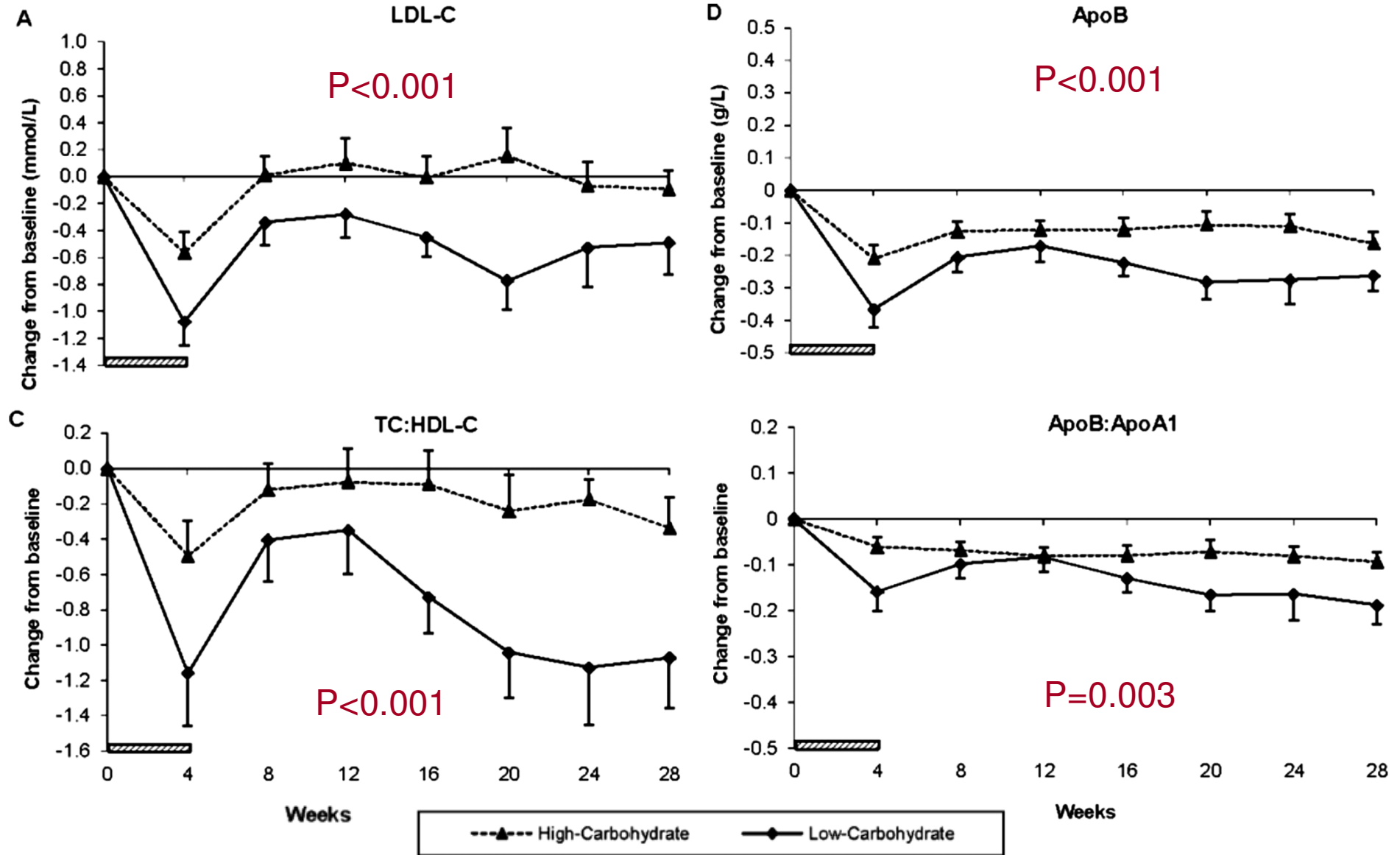
†Between-treatment difference, change from baseline between the two diets using all available data.

‡p-Values assessed using all available data and a repeated measures mixed model accounting for time of assessment. The response variable was change from baseline, with diet and week as fixed effects and subject ID nested in diet. There was no adjustment for baseline.

Body Weight



Blood Lipids



Future Direction

- Test diets for a longer duration in a larger sample
- Examine surrogate markers of CVD in addition to risk factors
- Focus on strategies to increase and maintain adherence in “real-world” conditions
 - especially to the cholesterol-lowering components (all bear US FDA health claims for CVD risk reduction)
- Collaborate with food industry in addressing concerns of availability, variety, and ease of food preparation

Conclusions

- Under **metabolic conditions**, a low-carbohydrate plant-based diet improved the blood lipid profile compared to a conventional high-carbohydrate diet despite similar weight reductions.
- Under **real-world conditions**, a self-selected low-carbohydrate plant-based diet resulted in a modestly greater body weight reduction and a sustained and favorable blood lipid profile compared to a high-carbohydrate diet.
- A low-carbohydrate plant-based diet may be another dietary option for treatment of hyperlipidemia and obesity.