Saturated Fat, Carbohydrates, & Metabolic Syndrome – Should We Be Changing Our Recommendations?

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Dr. Roussell's robust academic background coupled with his broad range of experience from consulting with pharmaceutical and food companies, medical schools, top rated fitness facilities, and individual clients give him the unique ability to translate scientific findings into relevant, understandable, and actionable strategies that get results. This has made Dr. Mike a sought after expert contributor to both national print publications and leading online fitness outlets such as Men's Health, Men's Fitness, Experience Life, Ironman, Health, Cooking Light, Muscle & Fitness magazines, LiveStrong.com, , Shape.com, espnW and Bodybuilding.com. Dr. Mike writes the weekly "Ask The Diet Doctor" column at Shape.com. He authored the books Your Naked Nutrition Guide (2007) and The 6 Pillars of Nutrition (2011) in addition to serving as the nutritionist for Power Training (Rodale, 2007), Strength Training Cardio (Rodale, 2010), and the Women's Health Big Book of Abs (2012). Dr. Mike is the Head of Nutritional Services at PEAK Performance in NYC.

Metabolic Syndrome Overview

- In 1988, a WHO consulting group working to define diabetes identified metabolic syndrome.
- Consists of a clustering of symptoms in which you need *3 of the 5* to be diagnosed.
- Metabolic syndrome statistics
  - 24% of US adults have metabolic syndrome
  - 5 fold increase in risk for diabetes
  - 2 fold increase in risk of cardiovascular disease

Metabolic Syndrome Characteristics

  - Large waist (cut points are country/region specific)
    - 40-46 inches for men
    - 35-40 inches for women
  - Elevated triglycerides
    - ≥ 150 mg/dL
  - Low high density lipoprotein cholesterol (HDL-C)
    - < 40mg/dL for men
    - < 50mg/dL for women
  - High blood pressure
    - ≥ 155/85 mm Hg or on blood pressure medication
  - Elevated fasting blood sugar
    - ≥ 100 mg/dL or higher

- Insulin resistance is believed by many to be the number one driving force behind metabolic syndrome.

What predisposes you to Insulin Resistance and Metabolic Syndrome?

  - Type 2 diabetes mellitus in first-degree relatives before age 60 years
  - Polycystic ovary disease
  - Fatty liver
  - C-reactive protein (CRP) >3 mg/L
  - Microalbuminuria
  - Elevated total apolipoprotein B

- The Metabolic Syndrome diagnosis does not take into account
  - Age
  - Sex
  - Smoking status
  - Low density lipoprotein cholesterol (LDL-C)

- Individuals with Metabolic Syndrome commonly have ***Atherogenic Dyslipidemia***, a clustering of lipoprotein abnormalities
    - **Elevated triglycerides**
    - Elevated apolipoprotein B
    - Increase small dense LDL
    - **Reduced HDL-C**

Metabolic Syndrome Treatment Recommendations

American Heart Association

- Eat Better, Get Active, Lose Weight, Take Medication
- "Adopt a diet rich in whole grains, fruits, vegetables, lean meats and fish, and low-fat or fat-free dairy products and avoid processed food, which often contains partially hydrogenated vegetable oils, and is high in salt and added sugar."
- American Heart Association (AHA) treatment of metabolic syndrome
    - The primary goal of clinical management in individuals with the metabolic syndrome is to reduce risk for clinical atherosclerotic disease. Even in people with the metabolic syndrome, first-line therapy is directed toward the major risk factors: LDL-C above goal, **hypertension**, and **diabetes**.

Adult Treatment Panel III

- **Option 1** – Address abdominal adiposity and insulin resistance via diet and increased activity.
- **Option 2** – Directly treat metabolic risk factors.

Dietary Approaches to Stop Hypertension: DASH Diet

- Macronutrient Breakdown (% of energy)
    - Carbohydrates = 55-57%
    - Protein = 18%
    - Fat = 25-27%
    - Saturated Fat = 6-7%
    - Monounsaturated Fat = 10-13%
    - Polyunsaturated Fat = 6-8%

Insulin Resistance

Insulin resistance is defined clinically as the inability of a known quantity of exogenous or endogenous insulin to increase glucose uptake and utilization in an individual as much as it does in a normal population. – Lebovitz, **Insulin Resistance: definition and consequences.** 2001

Basic Approaches to Treatment of Insulin Resistance

- Decrease circulating glucose
- Increase Insulin secretion/presence
- Increase insulin sensitivity (at the site of muscle cells)

Carbohydrate Restriction and Metabolic Syndrome

Varying Levels of Carbohydrate Restriction

Very Low Carbohydrates Diet/Ketogenic Diet

- Volek et al, 2009: Macronutrient Breakdown (% of energy)
  - Carbohydrates = 12%
  - Protein = 29%
  - Fat = 59%

Reduced Carbohydrate Diet

- Krauss et al, 2006: Macronutrient Breakdown (% of energy)
  - Carbohydrates = 40%
  - Protein = 25%
  - Fat = 35%

Moderate Carbohydrate Diet

- Ebbeling et al, 2007: Macronutrient Breakdown (% of energy)
  - Carbohydrates = 40%
  - Protein = 25%
  - Fat = 35%

Moderate/High Carbohydrate Diet

- Appel et al, 2005 (OmniHeart): Macronutrient Breakdown (% of energy)
  - Carbohydrates = 48%
  - Protein = 25%
  - Fat = 27%

Other Unifying Characteristics

- Increased Protein
- Increase Fat

Metabolic Syndrome – Target Therapy: Weight Loss

Meta-analysis of Randomized Controlled Trials – Low Fat vs. Low Carbohydrate (6-12 months)

- 6 months – Low carbohydrate elicits 9.2lbs more weight loss
- 1 year – Similar weight Loss

Effects of a Low Glycemic Load vs. Low Fat Diet

- Low Glycemic Load (% of energy)
  - Carbohydrates = 40%
  - Protein = 25%
  - Fat = 35%
- Low Fat (% of energy)
  - Carbohydrates = 40%
  - Protein = 25%
  - Fat = 35%

Changes in Body Fat Percentage

	6 Months		18 Months	
	Low Glycemic Load	Low Fat	Low Glycemic Load	Low Fat
All	-1.3	-1.4	-1.5	-1.1
Insulin Sensitive	-0.9	-2.2	-0.9	-1.4
Insulin Resistant	**-2**	**-0.4**	**-2.6**	**-0.9**

**Based on insulin concentration at 30 minutes following 75 gram dose of oral glucose*

A to Z Weight Loss Study

- Atkins, Traditional lower fat diet, Zone, and Ornish diets
- 12 months long
  - Diet results
    - **Aktins – 10.3lbs lost**
    - *Zone – 3.5lbs lost*
    - *LEARN/Traditional – 5.7lbs lost*
    - *Ornish – 4.8lbs lost*
  - Stratified by insulin resistance
    - Most insulin sensitive: Atkins vs. Ornish
      - No difference in weight loss (8.8-12lbs lost)
    - Most insulin resistant: Atkins (11lbs lost) vs. Ornish (3.9lbs lost)
  - **Side Note:** Most insulin resistant participants had the lowest adherence (changes % calories from carbohydrates and fat) to Ornish plan.

Saturated Fat and Carbohydrate Restriction

Potential Problem – Carbohydrate restriction usually leads to increase in dietary saturated fat. Reducing saturated fat has been a primary public health message for almost 3 decades. Carbohydrate restriction yields more favorable results in insulin resistant individuals.

- Current recommendations aim to lower saturated as much as possible
    - Step I >10% calories
    - DASH >7%
    - BOLD 6%
- Strong evidence to support the lowering of saturated fat below ~9% of calories is lacking
- Continuing to decrease saturated fat continues to reduced LDL-C

What is the treatment goal?

Carbohydrate Restriction Modifies Saturated Fat Metabolism

Low Density Lipoprotein Cholesterol Metabolism and Production

- Decreasing saturated fat increases LDL receptors (facilitating improved clearance of LDL-C particles)
- Carbohydrate restriction decreasing HMG-CoA reductase expression

Plasma Saturated Fat, Carbohydrate Restriction, and Insulin Sensitivity

- In a carbohydrate restricted (13%) environment saturated fat intake is not associated with plasma saturated fat levels
- Individuals with metabolic syndrome have increased levels of plasma saturated fatty acids
- Insulin Resistance
    - Replacing unsaturated fat with saturated fat impairs insulin sensitivity (-10%) in healthy individuals
    - A carbohydrate restricted diet (containing elevated intakes of saturated fat) leads to improvements in insulin sensitivity independent of weight loss.
        - 29.6% reduction in intrahepatic TG
        - 23.4% reduction in basal glucose
        - In first 48 hours.
    - Nonoxidative glucose disposal
        - In Higher carb, higher fat (a.k.a. traditional American diet) the increase in fatty acids impairs insulin's action on glucose uptake in the muscles.
        - Changing the carbohydrate to fat ratio (to favor higher fat, lower carbohydrate) modifies this relationship and nonoxidative glucose disposal is increased.
            - This occurs do to a shifting in carbohydrate usage from oxidation to storage.
            - *Impaired storage <u>is</u> insulin resistance*.

Carbohydrate Restriction, Saturated Fat, and Atherogenic Dyslipidemia

Macronutrient Composition of Diets

	Control	Carb Restricted / Low SFA	Carb Restricted / High SFA
Carbohydrate	54	26	26
Protein	16	29	29
Total Fat	30	46	45
Saturated Fat	7	9	15
Monounsaturated Fat	13	27	20
Polyunsaturated Fat	8	5	6

**% of total energy*

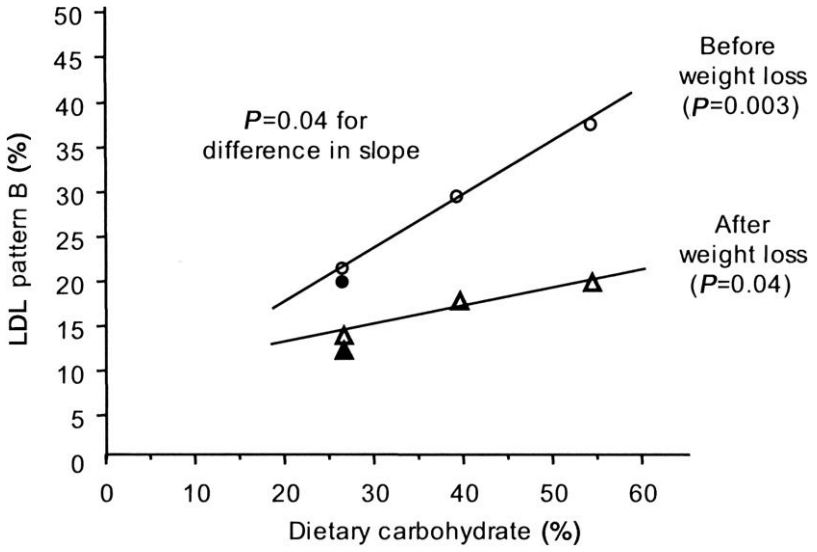
How does carbohydrate restriction impact the biochemical effects of saturated fat intake?

- Increases in saturated fat on carbohydrate restricted diets did not follow predictive equation estimates
    - Changing from Control diet to Carb Restricted/High SFA diet should yield a **5.4 mg/dL** increase in LDL-C
- There was a linear relationship between carbohydrate intake and prevalence of LDL Pattern B
- LDL-C reduction on the carbohydrate restricted diets was from small dense LDL particles
    - Reductions in small dense LDL particles were similar between low and high saturated fat carbohydrate restricted diets.
- Higher saturated fat diet yielded slight increases in larger LDL particles.
- With weight Loss, the higher carbohydrate diet yielded more beneficial reductions in CVD risk factors.

Changes in Markers of Atherogenic Dyslipidemia

	Weight Stable			Weight Loss		
	Control	Carb Restricted / Low SFA	Carb Restricted / High SFA	Control	Carb Restricted / Low SFA	Carb Restricted / High SFA
LDL Cholesterol	-2.6 ± 3.1	-11.2 ± 2.7	-0.7 ± 3.9	-8.9 ± 2.5	4.3 ± 2.7	1.1 ± 2.7
HDL Cholesterol	-1.3 ± 0.7	0.4 ± 0.9	3.0 ± 1.0	1.9 ± 0.7	2.4 ± 0.8	2.5 ± 0.9
Triglycerides (log)	-0.05 ± 0.02	-0.19 ± 0.03	-0.2 ± 0.03	-0.07 ± 0.02	0.01 ± 0.02	-0.03 ± 0.02
Apolipoprotein B	-4.9 ± 2.0	-15.8 ± 1.7	-12.5 ± 1.9	-6.4 ± 1.8	2.3 ± 0.8	-1.4 ± 2.0
LDL Particle Diameter	0.2 ± 0.8	3.6 ± 0.9	5.1 ± 1.1	-3.9 ± 1.0	0.9 ± 0.7	1.9 ± 0.8

**LDL-C, HDL-C, TG, and ApoB are in mg/dL. TG are log transformed. LDL Particle Diameter is in angstroms*



The above graph illustrates how both weight loss and carbohydrate restriction impact prevalence of LDL pattern B

Summary & Conclusions

- Insulin resistance may be **the** driving force behind metabolic syndrome.
- Weight loss is universally recommended.
- Dietary recommendations are not currently specific to metabolic syndrome or the concurrent atherogenic dyslipidemia.
- Carbohydrate restriction leads to more effective weight loss in insulin resistant individuals.
- Levels of carbohydrates restriction varies but it usually leads to increased protein and fat intakes.
- Carbohydrate restriction modifies lipid response.
    - Increased saturated fat intake does not yield predicted response.
- Dietary approaches for the treatment of metabolic syndrome should focus on carbohydrates restriction (and compliance) and less on saturated fat restriction (below 9-10% of energy).
- Working with a client who has metabolic syndrome to reduce carbohydrate content from 55% to 40% of energy from carbohydrates will be more efficacious than 10% to 7% of calories from saturated fat.

Selected & Highlighted References

1. Accurso A, Bernstein R, Dahlqvist A, et al. Dietary carbohydrate restriction in type 2 diabetes mellitus and metabolic syndrome: time for a critical appraisal. Nutrition & Metabolism 2008;5(1):9.

2. Adult Treatment Panel III Final Report. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Circulation 2002;106(25):3143-421.

3. Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. Diabetic medicine : a journal of the British Diabetic Association 1998;15(7):539-53. doi: 10.1002/(sici)1096-9136(199807)15:7<539::aid-dia668>3.0.co;2-s.

4. Alberti KGMM, Eckel RH, Grundy SM, et al. Harmonizing the Metabolic Syndrome. Circulation 2009;120(16):1640-5. doi: 10.1161/circulationaha.109.192644.

5. Al-Sarraj T, Saadi H, Calle MC, Volek JS, Fernandez ML. Carbohydrate Restriction, as a First-Line Dietary Intervention, Effectively Reduces Biomarkers of Metabolic Syndrome in Emirati Adults. The Journal of Nutrition 2009;139(9):1667-76. doi: 10.3945/jn.109.109603.

6. Appel LJ, Sacks FM, Carey VJ, et al. Effects of Protein, Monounsaturated Fat, and Carbohydrate Intake on Blood Pressure and Serum Lipids: Results of the OmniHeart Randomized Trial. JAMA 2005;294(19):2455-64. doi: 10.1001/jama.294.19.2455.

7. Astrup A, Dyerberg J, Elwood P, et al. The role of reducing intakes of saturated fat in the prevention of cardiovascular disease: where does the evidence stand in 2010? The American journal of clinical nutrition 2011;93(4):684-8. doi: 10.3945/ajcn.110.004622.

8. Bisschop PH, de Metz J, Ackermans MT, et al. Dietary fat content alters insulin-mediated glucose metabolism in healthy men. The American journal of clinical nutrition 2001;73(3):554-9.

9. Chokkalingam K, Jewell K, Norton L, et al. High-Fat/Low-Carbohydrate Diet Reduces Insulin-Stimulated Carbohydrate Oxidation but Stimulates Nonoxidative Glucose Disposal in Humans: An Important Role for Skeletal Muscle Pyruvate Dehydrogenase Kinase 4. Journal of Clinical Endocrinology & Metabolism 2007;92(1):284-92. doi: 10.1210/jc.2006-1592.

10. Ebbeling CB, Leidig MM, Feldman HA, Lovesky MM, Ludwig DS. Effects of a Low–Glycemic Load vs Low-Fat Diet in Obese Young Adults. JAMA: The Journal of the American Medical Association 2007;297(19):2092-102. doi: 10.1001/jama.297.19.2092.

11. Feinman RD, Volek JS. Carbohydrate restriction as the default treatment for type 2 diabetes and metabolic syndrome. Scandinavian Cardiovascular Journal 2008;42(4):256-63. doi: doi:10.1080/14017430802014838.

12. Forsythe C, Phinney S, Feinman R, et al. Limited Effect of Dietary Saturated Fat on Plasma Saturated Fat in the Context of a Low Carbohydrate Diet. Lipids 2010;45(10):947-62. doi: 10.1007/s11745-010-3467-3.

13. Kirk E, Reeds DN, Finck BN, Mayurranjan MS, Patterson BW, Klein S. Dietary Fat and Carbohydrates Differentially Alter Insulin Sensitivity During Caloric Restriction. Gastroenterology 2009;136(5):1552-60.

14. Krauss RM, Blanche PJ, Rawlings RS, Fernstrom HS, Williams PT. Separate effects of reduced carbohydrate intake and weight loss on atherogenic dyslipidemia. Am J Clin Nutr 2006;83(5):1025-31.

15. Lien LF, Brown AJ, Ard JD, et al. Effects of PREMIER Lifestyle Modifications on Participants With and Without the Metabolic Syndrome. Hypertension 2007;50(4):609-16. doi: 10.1161/hypertensionaha.107.089458.

16. Nordmann AJ, Nordmann A, Briel M, et al. Effects of Low-Carbohydrate vs Low-Fat Diets on Weight Loss and Cardiovascular Risk Factors: A Meta-analysis of Randomized Controlled Trials. Arch Intern Med 2006;166(3):285-93.

17. Vessby B. Dietary fat, fatty acid composition in plasma and the metabolic syndrome. Curr Opin Lipidol 2003;14(1):15-9.

18. Vessby B, Uusitupa M, Hermansen K, et al. Substituting dietary saturated for monounsaturated fat impairs insulin sensitivity in healthy men and women: The KANWU Study. Diabetologia 2001;44(3):312-9.

19. Volek J, Phinney S, Forsythe C, et al. Carbohydrate Restriction has a More Favorable Impact on the Metabolic Syndrome than a Low Fat Diet. Lipids 2009;44(4):297-309.

20. Volek JS, Ballard KD, Silvestre R, et al. Effects of dietary carbohydrate restriction versus low-fat diet on flow-mediated dilation. Metabolism: clinical and experimental 2009;58(12):1769-77.