Carbohydrate restriction uniquely benefits metabolic syndrome (insulin resistance syndrome)

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That only a relatively small subset of adults has maintained a healthy weight in the context of current low fat guidelines implies that a majority of Americans may be metabolically and genetically programmed to benefit from alternative approaches.
The increase in calories during the obesity epidemic was due largely to carbohydrate intake.
The fate of carbohydrate...

Ingest Carbohydrate

Blood Sugar (~20 g)

Road to Health

Glycogen (~300-400 g)

Oxidation

Road to Metabolic Syndrome

Glycogen (~100 g)

Lipogenesis (fat synthesis)

↑16:0

↑16:1
Fasting and Carbohydrate Restriction

Carbohydrate restriction regulates the adaptive response to fasting

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- 84 hr of fasting or lipid infusion to meet REE
- Changes in plasma glucose, fatty acids, glycerol, ketones, insulin, epinephrine, as well as rates of lipolysis were similar

“Carbohydrate restriction, not the presence of a negative energy balance, is responsible for initiating the metabolic response to fasting.”

Am J Physiol. 262:E631-36, 1992
Decreases in insulin that occur on the Atkins diet result in large increases in fat breakdown and oxidation.
Impaired Glucose Tolerance

Insulin Resistance

Hyperinsulinemia

Early Diabetes

Late Diabetes

β-Cell Defect (↓ insulin secretion)

β-Cell Failure

Excessive carb intake is a slippery slope to diabetes

Progression from Insulin Resistance to Diabetes is not inevitable

Obesity (BMI ≥30) 2006 to 2008:
- 24% Non-Hispanic white
- 36% Non-Hispanic blacks
- 29% Black

Pre-Diabetes (2003 to 2006):
- IFG = 100 to 125 mg/dL
- 25.9% of adults ≥20 yr
- 35.4% of adults ≥60 yr

Diabetes (2007):
- 23.5 million (10.7%) adults
- Estimated Costs = $174 billion
Insulin Resistance:
Reduced ability of peripheral tissues to respond properly to insulin
Metabolic syndrome, insulin resistance, diabetes, and even many forms of obesity are all manifestations of carbohydrate intolerance.

How do we manage other food intolerances (lactose, gluten)?
### Features of MetS

- ✓ **Weight**
- ✓ **Fat**
- ✓ **TG**
- ✓ **HDL**
- ✓ **Glu**
- ✓ **Insulin**
- ✓ **BP**

### Improved by CHO Restriction

- ✓ **Weight**
- ✓ **Fat**
- ✓ **TG**
- ✓ **HDL**
- ✓ **Glu**
- ✓ **Insulin**
- ✓ **BP**
Low carbohydrate diets are more likely than low fat diets to effect global improvement in markers associated with insulin resistance.

Dietary carbohydrate restriction induces a unique metabolic state positively affecting atherogenic dyslipidemia, fatty acid partitioning, and metabolic syndrome.
Most reliable response to carbohydrate restriction
A CRD improves the postprandial lipemic & vascular response to a high fat meal

Volek et al. Metabolism. 2009 July 24

Volek et al. Lipids. 44:297-309, 2009
Dyslipidemia: HDL-C

- More effective than other lifestyle changes (exercise, smoking cessation, weight loss, n-3 PUFA)
- Not dependent on starting levels
- Stronger effect in women
- Dependent on the cholesterol content of diet

Size of LDL may be more important than Concentration!

High Carbohydrate/Low-Fat

Low Carbohydrate/High-Fat
A CRD improves qualitative features of LDL (increased particle size)


A CRD has anti-inflammatory effects

Treating any of the individual MetSyn markers w/ carbohydrate restriction holds promise to benefit the others.

Low carbohydrate diets preferred primary intervention when >1 sign of insulin resistance is observed.
“Limit your intake of saturated fat to <7% of energy.”
Saturated Fat & the Diet Heart Hypothesis

Renowned science writer Gary Taubes
“What if It’s All Been a Big Fat Lie?” - 2002
“Good Calories, Bad Calories” - 2007

Provocative articles exposing the lack of quality science behind low-fat diets.
### Conclusions

Over a mean of 8.1 years, a dietary intervention that reduced total fat intake and increased intakes of vegetables, fruits, and grains did not significantly reduce the risk of CHD, stroke, or CVD in postmenopausal women and achieved only modest effects on CVD risk factors, suggesting that more focused diet and lifestyle interventions may be needed to improve risk factors and reduce CVD risk.
If you decrease SFA, it matters what you replace it with!

Replacing 5% energy of SFA with **carbs** ↑ coronary events (HR 1.07)

**P** value, test for heterogeneity=0.51; combined hazard ratio (95% CI)=1.07 (1.01, 1.14)
Low Fat Diet
~1500 kcal/day

Low Carb Diet
~1500 kcal/day

Overweight Men and Women with Atherogenic Dyslipidemia (n=40)

Low Fat Low SFA

12 wk

Saturated Fat = 12 g

Saturated Fat = 36 g
Despite eating 3 times more SFA compared to low-fat, subjects showed significantly greater reductions in plasma SFA on a low carbohydrate diet.
Metabolic Processing of Saturated Fat

Processing of dietary SFA is more efficient when carbohydrate intake is low.

Low Fat Diet (208 g CHO/d)
- Saturated Fat Synthesis
- Saturated Fat Intake (12 g/d)

Low Carbohydrate Diet (45 g CHO/d)
- Saturated Fat Synthesis
- Saturated Fat Intake (36 g/d)

Saturated Fat Burned as Fuel

Saturated Fat
Does the quality of fat matter on a very low carbohydrate diet during iso-weight conditions?

<table>
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<th>Habitual</th>
<th>CRD-SFA</th>
<th>CRD-UFA</th>
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<tr>
<td><strong>PRO (%)</strong></td>
<td>25</td>
<td>29</td>
<td>30</td>
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<tr>
<td><strong>CHO (%)</strong></td>
<td>34</td>
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<td><strong>Fat (%)</strong></td>
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<td><strong>MUFA (g)</strong></td>
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<td><strong>PUFA (g)</strong></td>
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<td><strong>n-3 (%)</strong></td>
<td>0.7</td>
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<td><strong>n-6 (%)</strong></td>
<td>6.6</td>
<td>3.8</td>
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<tr>
<td><strong>Chol (mg)</strong></td>
<td>426</td>
<td>854</td>
<td>820</td>
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Low carbohydrate is a profound stimulus impacting the metabolic processing of ingested SFA.
A CRD decreases fat synthesis regardless of fat quality

Plasma 16:1 (%wt) in TAG
You are what you eat... 

...or you are what you do with what you eat!
Saturated fat has a totally different metabolic behavior when consumed in the context of a low carbohydrate diet.
Conclusions

Recent research showing rapid clearing of saturated fats, reduced inflammation and improvements in other biomarkers when consuming well-formulated low carbohydrate diets (Atkins Diet) should encourage us to re-examine their therapeutic value.

Immediate opportunity is to harness these benefits in the management of insulin resistance.