Metabolic Efficiency Training: Health & Exercise Performance Benefits

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Sport Dietitian
Outline

• Metabolic efficiency concept
• Background
• Implementation methods
• Potential benefits on health and exercise performance
Metabolic Efficiency

What does it mean?
The body’s ability to utilize its endogenous stores of carbohydrate and fat at different intensities and durations.

Why do we care?
Enhance fat oxidation, preserve carbohydrate stores.

Who is it for?
Mostly athletes and active adults.
“Crossover” Concept → Metabolic Efficiency

Fat oxidation

Intense of exercise

Carb
Fat

Improve fat oxidation by
low intensity, aerobic training
Research

- Determination of the exercise intensity that elicits maximal fat oxidation.
- Maximal fat oxidation during exercise in trained men.
- Relation between plasma lactate concentration and fat oxidation rates over a wide range of exercise intensities.
- Optimizing fat oxidation through exercise and diet.
- Respiratory gas-exchange ratios during graded exercise in fed and fasted trained and untrained men.
- Mammalian fuel utilization during sustained exercise.
- Balance of carbohydrate and lipid utilization during exercise: the “crossover” concept.
- Glucose kinetics during high-intensity exercise and the crossover concept.
- Substrate utilization during endurance exercise in men and women after endurance training.
- Fat metabolism during high-intensity exercise in endurance-trained and untrained men.
- Lipid metabolism in skeletal muscle of endurance-trained males and females.
- Low-fat diet alters intramuscular substrates and reduces lipolysis and fat oxidation during exercise.
- Catecholamine response is attenuated during moderate intensity exercise in response to the lactate clamp.
- Endurance capacity and high-intensity exercise performance responses to a high-fat diet.
- Effects of exercise intensity and training on lipid metabolism in young women.
- Training-induced alterations of carbohydrate metabolism in women: women respond differently from men.
- Contributions of working muscle to whole body lipid metabolism vary with exercise intensity and training.
- Determinants of the variability in respiratory exchange ratio at rest and during exercise in trained athletes.
- Long-term fat diet adaptation effects on performance, training capacity, and fat utilization.
More Background
Testing Metabolic Efficiency

- Measurement of gas exchange
- Ratio of CO₂ produced to O₂ consumed (= respiratory exchange ratio)
Metabolic Efficiency Point (MEP)

Power: 175 watts
Heart rate: 135 beats per minute

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (watts)</td>
<td>100</td>
<td>120</td>
<td>140</td>
<td>160</td>
<td>180</td>
<td>200</td>
<td>220</td>
<td>240</td>
</tr>
<tr>
<td>Kcal burned/hr</td>
<td>450</td>
<td>552</td>
<td>618</td>
<td>696</td>
<td>786</td>
<td>864</td>
<td>954</td>
<td>1038</td>
</tr>
<tr>
<td>CHO burned (kcal/hr)</td>
<td>86</td>
<td>121</td>
<td>198</td>
<td>292</td>
<td>401</td>
<td>484</td>
<td>639</td>
<td>778</td>
</tr>
<tr>
<td>CHO burned (gr/hr)</td>
<td>21</td>
<td>30</td>
<td>49</td>
<td>73</td>
<td>100</td>
<td>121</td>
<td>160</td>
<td>195</td>
</tr>
<tr>
<td>FAT burned (kcal/hr)</td>
<td>364</td>
<td>431</td>
<td>414</td>
<td>397</td>
<td>377</td>
<td>380</td>
<td>305</td>
<td>249</td>
</tr>
<tr>
<td>FAT burned (gr/hr)</td>
<td>40</td>
<td>48</td>
<td>46</td>
<td>44</td>
<td>42</td>
<td>42</td>
<td>34</td>
<td>28</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>107</td>
<td>115</td>
<td>120</td>
<td>127</td>
<td>138</td>
<td>147</td>
<td>154</td>
<td>159</td>
</tr>
</tbody>
</table>
Effects of Efficiency

Metabolic "INEFFICIENCY"

- Carb: 52% 54% 57% 61% 65% 71% 83%
- Fat: 48% 46% 43% 39% 35% 29% 17%

Metabolic "EFFICIENCY"

- Carb: 90% 85% 80% 75% 70% 60% 55% 55% 55% 45% 45% 30% 30% 10%
- Fat: 10% 15% 20% 25% 30% 40% 45% 45% 45% 30% 30% 10%

Intensity

Rely on dietary carbs

Use internal fat for fuel
How much carb?

Majority of current sports nutrition guidelines:
• Train the gut to handle as much carbohydrate as possible
  ➢ Upwards of 90 grams per hour (360 kcals)

But…

“the occurrence of gastrointestinal disturbances has been related to carbohydrate intake during exercise” and is “dependent on the intensity and duration of exercise” (GSSI, 2008)
Consequences of Metabolic Inefficiency during exercise

- Poor utilization of fat stores
  - Increased reliance on carbohydrate stores
    - (have to) eat more carbs
      - Battle: working muscle vs. stomach
        - GI distress
  - Increased blood flow to working muscles
    - Blood shunted from digestive tract
      - cramping
      - bloating
      - diarrhea
      - vomiting
      - gas
Why Metabolic Efficiency (Nutrition) Training?

Main benefits:
1. Improves nutrient partitioning for energy use
2. Athletes have decreased risk for GI distress
3. Improves body composition and body weight
4. Improves health profile
Metabolic Efficiency Training: Implementation Methods
Metabolic Efficiency: How to get there

1. Proper physical (aerobic) training – we already know this
3. Control blood sugar / insulin
4. Nutrition periodization
Your assessment?
Athlete “Mike” #1

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>Large bowl of cereal, Banana, Juice</td>
<td></td>
</tr>
<tr>
<td>Pre-workout</td>
<td>Gel</td>
<td></td>
</tr>
<tr>
<td>During workout</td>
<td>Sports drink</td>
<td></td>
</tr>
<tr>
<td>Post-workout</td>
<td>Energy bar</td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td>Ham sandwich, Pretzels</td>
<td></td>
</tr>
<tr>
<td>Snack</td>
<td>Orange</td>
<td></td>
</tr>
<tr>
<td>Snack</td>
<td>Cookies</td>
<td></td>
</tr>
<tr>
<td>Dinner</td>
<td>Spaghetti, Marinara sauce, French bread</td>
<td></td>
</tr>
<tr>
<td>Snack</td>
<td>Sorbet</td>
<td></td>
</tr>
</tbody>
</table>
What about this one?
Athlete “Mike” #2

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal</th>
</tr>
</thead>
</table>
| Breakfast    | Egg white - veggie omelet with avocado  
Mixed fruit             |
| Post-workout | Greek yogurt, blueberries, walnuts       |
| Lunch        | Big salad with olive oil vinaigrette  
Grilled chicken breast  
Apple                |
| Snack        | Cottage cheese with tomatoes             |
| Dinner       | Salmon  
Asparagus  
Roasted cauliflower  
Brown rice  
Dark chocolate       |
Why control blood sugar?

High carbohydrate intake = higher carbohydrate oxidation

Elevated blood glucose $\rightarrow$ high insulin levels $\rightarrow$ insulin inhibits lipolysis

Insulin response and fat oxidation
Eat to support stable blood sugar

- Protein + fiber (fruits, veg)
- Healthy fats
- Whole grains – depending on health goals and training cycle
- “Misses” – can be included but should be <10%
Nutrition Periodization

**Qualitative Model:**
Periodization Plates

- **Preparatory Phase:** Focus on Metabolic Efficiency
- **Competition Phase:** Energy expenditure
- **Taper Phase:** Preparation for the next phase
- **Transition Phase:** Transition to a new phase

**Nutrient Distribution:**
- **LP/HF:** Lean Protein and Healthy Fats
- **FV:** Fruits and Vegetables
- **WG:** Whole Grains
- **SNP:** Sports Nutrition Products
Implementation of Periodization Plates

“Foodlists”

<table>
<thead>
<tr>
<th>Lean Proteins / Healthy Fats</th>
<th>Vegetables / Fruits</th>
<th>Healthy Starches / Whole Grains</th>
<th>Misses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken</td>
<td>Leafy greens</td>
<td>Quinoa</td>
<td>Dark chocolate</td>
</tr>
<tr>
<td>Eggs</td>
<td>Tomatoes</td>
<td>Brown rice</td>
<td>Red wine</td>
</tr>
<tr>
<td>Salmon</td>
<td>Blueberries</td>
<td>Barley</td>
<td></td>
</tr>
<tr>
<td>Avocado</td>
<td>Bell pepper</td>
<td>Sweet potato</td>
<td></td>
</tr>
<tr>
<td>etc.</td>
<td>etc.</td>
<td>etc.</td>
<td>etc.</td>
</tr>
</tbody>
</table>

SIMPLE and SUSTAINABLE
Extra Strategy: Examine Ratios

Basic rule: look at carbohydrate to protein ratio and consider fiber content

<table>
<thead>
<tr>
<th>Level</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal</td>
<td>1 : 1</td>
</tr>
<tr>
<td>Good</td>
<td>2 : 1</td>
</tr>
<tr>
<td>Okay</td>
<td>3 : 1</td>
</tr>
<tr>
<td>Pushing it</td>
<td>4 : 1</td>
</tr>
<tr>
<td>Skip it</td>
<td>5 : 1</td>
</tr>
</tbody>
</table>

![Nutrition Facts](Image)
Key Metabolic Efficiency Implementation Messages

1. Control blood sugar
2. Protein + fiber foods
3. Daily nutrition
   • considers food preferences
   • education on quality of foods
4. Periodize carbohydrates to match energy needs
5. The New “KISS”
Metabolic Efficiency Training:

Health Benefits
Controlling blood sugar

- Reduces cravings
- Feed less frequently
- Weight loss
- Loss of body fat
- Steady energy levels
- Decreased risk of chronic diseases
A Few Other Benefits

• Rob, 48 y/o male with type 1 diabetes on insulin pump
  In 3 months:
  - 4% body weight loss
  - 30% reduction in basal insulin
  - A1c 7.5% $\rightarrow$ 6.4%

• Ann, 36 y/o female, ht: 5’9”, dx: hypothyroidism
  In 6 months:
  - 175# $\rightarrow$ 160#
  - 8.5% body weight loss

• Relief of perimenopausal symptoms such as night sweats and hot flashes

• Freedom from calorie counting

• Improved relationship with food
Impact of poor blood sugar control

- Weight gain
- Frequent feedings
- Energy fluctuations
- Increased risk for chronic diseases
  - Insulin resistance, diabetes
  - CVD, inflammation, cancer
  - Obesity
“An overwhelming body of scientific work has connected meal-induced elevations in blood sugar with adverse consequences (e.g., insulin resistance, impaired antioxidant status, inflammation, oxidative damage, vascular dysfunction) ultimately increasing risk of many diseases including diabetes, cardiovascular disease, and cancer.”

--- Jeff Volek, PhD, University of Connecticut
In the United States

- 35% of adults have pre-diabetes
- 8% of adults have type 2 diabetes  
  (Centers for Disease Control and Prevention, 2011)
- 35.7% of adults are obese  
  (CDC, 2012)
- 34% of adults meet criteria for metabolic syndrome  
  (CDC, 2009)
Metabolic Syndrome

Diagnosed with $\geq 3$ or more of the following:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated triglycerides</td>
<td>$\geq 150$ mg/dl</td>
</tr>
<tr>
<td>Low HDL-C</td>
<td>$&lt; 40$ mg/dl men</td>
</tr>
<tr>
<td></td>
<td>$&lt; 50$ mg/dl women</td>
</tr>
<tr>
<td>Hypertension</td>
<td>$\geq 130/85$ mm Hg</td>
</tr>
<tr>
<td>Elevated fasting blood glucose</td>
<td>$\geq 100$ mg/dl</td>
</tr>
<tr>
<td>Large waist circumference</td>
<td>$&gt; 40$” men</td>
</tr>
<tr>
<td></td>
<td>$&gt; 35$” women</td>
</tr>
</tbody>
</table>
Lower CHO and Triglycerides

Feinman R and Volek J. 2006
Nutrition and Metabolism
Lower CHO and HDL

Feinman R and Volek J. 2006
Nutrition and Metabolism
Metabolic Efficiency Training:
Exercise Performance Benefits
Physical Performance

- Lower body weight
- Less body fat
- More muscle mass

→
- Improved speed
- Improved strength
- Better stamina
- Better agility
Hypoglycemia and Mental Performance

- Blood sugar spikes are short-lived energy bouts
- Hypoglycemia often follows = reduction in mental performance
  - Focus and concentration decreases
  - Auditory and visual information processed more slowly
35 y/o male ultrarunner 50km distance

- **Pre-metabolic efficiency:**
  275 kcals consumed per hour, with GI distress

- **Post-metabolic efficiency:**
  65 kcals consumed per hour, no GI distress
Benefits for Athletes

40 y/o female marathoner

- Pre-metabolic efficiency: 3:45
  95 kcals consumed per hour, with GI distress
- Post-metabolic efficiency: 3:25
  26 kcals consumed per hour, no GI distress
Benefits for Athletes

50 y/o male Ironman athlete

- St. George 2010, 11:13
  73 kcals consumed per hour, no GI distress

- St. George 2011, 10:20
  37 kcals consumed per hour, no GI distress
Metabolic Efficiency Training: Some key points

• **Not** a fad diet
• KISS!
• Application is mostly with athletes but can be useful for any level of active individual
• Requires a paradigm shift
• Improves health - (your own!)
Take Home Points

1. Controls blood sugar
2. Improves the body’s ability to use fat
3. Positive effects on body weight / composition
4. Decrease reliance on supplemental carbohydrates (athletes)
5. Decreased risk for GI distress (athletes)
6. Various health benefits for everyone
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