Controversy:

How much fat is best for the optimal performance of athletes?
Low fat intake and injury in female runners

Purpose:
- To determine relationship between energy intake, dietary fat & injury risk in female runners.

Methodology:
- Recruited female runners (n=86)
- Subjects ran minimum of 20 miles/week.
- FFQ used to assess diet at study start
- Year long study (athletes assessed at 3, 6, 9, 12 months)
- Training schedule, changes health status, injury of lower limb
Low fat intake and injury in female runners

Results:

● 47 reported running injury
● Subjects w/fat consumption <30% were 2X likely to report injury
● Correlation between fat & injury could be contributed to polyunsaturated fatty acids (PUFAs)
● PUFAs aid in inflammation response reducing injury risk
### Table 2: Daily dietary intake of total sample, injured, and non-injured runners.

<table>
<thead>
<tr>
<th></th>
<th>Total Sample (n = 86)</th>
<th>Injured (n = 47)</th>
<th>Non-Injured (n = 39)</th>
<th>p value (injured vs. non-injured)</th>
<th>Goal</th>
<th>p value (injured vs. DRI)</th>
<th>p value (all runners vs. DRI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Intake (kcal/d)</td>
<td>2120 ± 861</td>
<td>2002 ± 547</td>
<td>2262 ± 1123</td>
<td>.083</td>
<td>2567–2807</td>
<td>&lt;.005**</td>
<td></td>
</tr>
<tr>
<td>Energy Intake (kcal/kgFFM/d)</td>
<td>45 ± 18.2</td>
<td>43 ± 11.8</td>
<td>47 ± 23.7</td>
<td>.138</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Balance (kcal/kgFFM/d)</td>
<td>-20 ± 17.5</td>
<td>-22 ± 13.1</td>
<td>-16 ± 21.6</td>
<td>.073</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Availability (kcal/kgFFM/d)</td>
<td>32 ± 17.8</td>
<td>29 ± 13.3</td>
<td>35 ± 21.8</td>
<td>.070</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Protein</td>
<td>16 ± 3.0</td>
<td>16 ± 2.6</td>
<td>16 ± 3.4</td>
<td>.824</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Carbohydrates</td>
<td>54 ± 7.2</td>
<td>56 ± 6.5</td>
<td>53 ± 7.8</td>
<td>.111</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Fat</td>
<td>29 ± 6.4</td>
<td>27 ± 5.1</td>
<td>30 ± 7.6</td>
<td>.021**</td>
<td>.240</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>296 ± 119</td>
<td>288 ± 90</td>
<td>305 ± 147</td>
<td>.507</td>
<td>130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat (g)</td>
<td>71 ± 38</td>
<td>63 ± 20</td>
<td>80 ± 50</td>
<td>.016**</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Low fat intake and injury in female runners

Conclusions: Lower fat & lower kcals consumed increases risk of injury in runners
  ◦ Specific types of dietary fat (i.e. PUFAs & inflammation) need to be assessed

Limitations:
  ◦ Short duration
  ◦ Small sample size
  ◦ FFQ used to assess diet (3 or 7-day food records more accurate)
High Fat/Ketogenic Diets

Overview:

- Majority of caloric intake are fats, rather than carbohydrates
- Fat intake range from 45-60% of diet; carbohydrate intake falls in favor of fats and protein
- Free fatty acids are primarily used for fuel over glucose for athlete which is hypothesized to increase endurance performance.
Ketogenic Diet Effects in Off-Road Cyclists

Purpose:
- To see effects of ketogenic diet on body composition and aerobic performance in endurance athletes.

Methods:
- Sample of male off-road cyclists (n=8)
- 8-week cross-over study with 1 week washout period between diets; 4 weeks each (Keto vs. SAD)
- Ketogenic diet - 15% CHO, 70% FAT, 15% PRO
- SAD - 50% CHO, 30% FAT, 20% PRO
- After 4 weeks, testing phase lasting 3 days - body composition and respiratory tests
Ketogenic Diet Effects in Off-Road Cyclists

Results:

- Athlete’s body fat % decreased on keto vs. SAD
- The VO$_{2\text{max}}$ and lactate threshold increased during exercise with keto diet
- Free fatty acids were used as fuel more in keto diet than SAD
- Concentration of lactic acid (showing use of glucose) lower in keto diet

![Figure 1](Image1.png) The concentration of free fatty acids (FFA) during the exercise protocol, after a mixed and ketogenic diet. * Statistical significance with $p < 0.05$.

![Figure 2](Image2.png) The concentration of LA during the exercise protocol, after a mixed and ketogenic diet. * Statistical significance with $p < 0.05$. 
Ketogenic Diet Effects in Off-Road Cyclists

Limitations:
- Small sample size (n=8)
- Short in duration

Conclusions:
- Increase of fat intake increases free fatty acids that are used for fuel over CHO
- Confirms idea that fatty acids are used during moderate exercise and CHO are used during intense exercise as preferred fuel sources
- More research is needed with larger sample size/longer study duration
Ketogenic Diet Effects in Elite Gymnasts

Purpose:
● To see effects of ketogenic diet on body composition and strength performance in strength/weight class athletes.

Methods:
● Sample of male gymnasts (n=9)
● 60-day cross-over study with 3 month washout period between diets; 30 days each (Keto vs. SAD)
● Ketogenic diet - 5% CHO, 55% FAT, 40% PRO
● SAD - 47% CHO, 38% FAT, 15% PRO
● Strength tests and body comp measurements taken before and after each 30 day period
Ketogenic Diet Effects in Elite Gymnasts

Results:

- No difference in performance strength tests between the 2 diet types
- Decrease in total body fat and fat percentage, and overall weight
- Increase in lean body mass percent

Table 4 Performance, anthropometric and body composition results befor and after diet intervention

<table>
<thead>
<tr>
<th></th>
<th>VLCKD start</th>
<th>VLCKD end</th>
<th>WD start</th>
<th>WD end</th>
</tr>
</thead>
<tbody>
<tr>
<td>performance results</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SJ</td>
<td>0.42 ± 0.04</td>
<td>0.42 ± 0.05</td>
<td>0.41 ± 0.04</td>
<td>0.40 ± 0.04</td>
</tr>
<tr>
<td>CMJ</td>
<td>0.45 ± 0.04</td>
<td>0.43 ± 0.05</td>
<td>0.43 ± 0.06</td>
<td>0.43 ± 0.05</td>
</tr>
<tr>
<td>reverse grip chins</td>
<td>17 ± 4.2</td>
<td>16.6 ± 4.6</td>
<td>15.2 ± 3.4</td>
<td>15.2 ± 5.8</td>
</tr>
<tr>
<td>push-ups</td>
<td>36 ± 6.3</td>
<td>38.8 ± 4.7</td>
<td>37 ± 11.8</td>
<td>43.5 ± 18.1</td>
</tr>
<tr>
<td>legs closed barrier</td>
<td>19.2 ± 4.96</td>
<td>21.7 ± 6.35</td>
<td>17.2 ± 5.0</td>
<td>16 ± 4.77</td>
</tr>
<tr>
<td>parallel bar dips</td>
<td>25.8 ± 8.35</td>
<td>28.2 ± 9.31</td>
<td>23 ± 12.19</td>
<td>27 ± 10.61</td>
</tr>
<tr>
<td>Anthropometric and body composition results</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>muscle Kg</td>
<td>37.6 ± 3.9</td>
<td>37.9 ± 4.5</td>
<td>38.4 ± 4.1</td>
<td>38.6 ± 4.5</td>
</tr>
<tr>
<td>Fat Kg</td>
<td>5.3 ± 1.3</td>
<td>3.4 ± 0.8 **</td>
<td>5.1 ± 1.3</td>
<td>4.9 ± 1.1</td>
</tr>
<tr>
<td>fat %</td>
<td>7.6 ± 1.4</td>
<td>5.0 ± 0.9 **</td>
<td>8.0 ± 1.3</td>
<td>7.7 ± 1.2</td>
</tr>
<tr>
<td>Lean body mass Kg</td>
<td>64.2 ± 6.5</td>
<td>63.1 ± 7.1</td>
<td>61.5 ± 4.3</td>
<td>61.8 ± 4.6</td>
</tr>
<tr>
<td>lean body mass %</td>
<td>92.4 ± 1.4</td>
<td>95.0 ± 1.0 **</td>
<td>92.0 ± 1.3</td>
<td>92.3 ± 1.2</td>
</tr>
<tr>
<td>Weight</td>
<td>69.6 ± 7.3</td>
<td>68.0 ± 7.5 **</td>
<td>70.1 ± 6.2</td>
<td>70.0 ± 6.3</td>
</tr>
</tbody>
</table>

Data are expressed as mean and SD. Symbols: ** = p < 0.001 significant difference from baseline; * = p < 0.05 significant difference from baseline.
Ketogenic Diet Effects in Elite Gymnasts

Limitations:
- Small sample size (n=9)
- Short in duration
- Conflict of interest - partial funding by company supplying supplements used

Conclusions:
- Ketogenic diet may not affect performance in strength exercises
- Might be used in weight class sports for safe weight loss compared to other methods
- More research is needed with larger sample size/longer study duration/no supplements included
Introduction to Omega 3s

- Athletes: oxidative damage/inflammation
  - Soreness, fatigue, immune function
  - Affects overall performance
- Omega-3s act as antioxidant/anti-inflammatory
  - EPA and DHA
  - Ratio of 2:1
  - Athlete recommendations 1-2 grams
- High intakes detrimental
  - Decreased immune function/Increased bleeding time
Omega-3s reduce exercise-induced inflammation

Purpose:
- Determine effects of omega-3s on eccentric exercise induced inflammation

Inflammation:
- muscle soreness, muscle swelling, and body temperature

Exercise:
- eccentric bicep curls, 1 rep max
Omega-3s reduce exercise-induced inflammation

Methods:
- Sample size (n=11)
- 2-week omega-devoid diet
- 1-week omega supplemented (2:1)
- Exercise induced inflammation assessed after each diet
Omega-3s reduce exercise-induced inflammation

Results:
- Reduced muscle soreness w/omega-3s, No differences in body temperature/muscle swelling

Limitations:
- Small sample size
- Short in duration
- Single eccentric exercise used

Conclusions:
- Omega-3 supplementation reduces post-exercise muscle soreness
Omega-3s supplementation on resting & exercise induced inflammation & oxidative stress

Purpose: Determine effects of DHA/EPA supplementation vs. placebo on resting and exercise induced inflammatory and oxidative stress biomarkers

Methods:
- Subjects (n=11) men
- Inflammation: blood samples and muscle soreness
- Measured pre/post exercise for 6 weeks
- Aerobic exercise: treadmill w/weighted vest
Omega-3s supplementation on resting & exercise induced inflammation & oxidative stress

Results:

- Daily supplementation (DHA 2,209 mg + 2,224 mg) lowered resting inflammatory biomarkers and increased fatty acids in blood.
- No differences observed post exercise.
- Potentially due to exercise routine (not hard enough to solicit inflammatory response).
Omega-3s supplementation on resting & exercise induced inflammation & oxidative stress

Limitations:
- Small sample size
- Varied exercise (aerobic vs. strength)
- Increased duration

Conclusions: High intakes of omega-3 supplementation decrease inflammatory biomarkers and oxidative stress pre-exercise.
DHA supplementation and complex reaction time in elite female soccer players

- High concentration of DHA in the frontal cortex
  - Region of the brain where responses to stimuli are planned and perceptual information is integrated
  - DHA may improve the perceptual motor processes that lead to lower complex reaction time and higher accuracy

Purpose:
- Analyze the effects of DHA supplementation on perceptual motor processes, such as complex reaction time, accuracy, and efficiency in elite female soccer players
DHA supplementation and complex reaction time in elite female soccer players

Methods:

- Four week, double blind study
- Sample: 34 elite professional female soccer players from Spain
- Players randomly received either 3.5g/day of DHA or a placebo
- Recorded food intake and daily routines and habits as a control
- Measured complex reaction efficiency
  - Computerized task presented visual and auditory stimuli, measured consequent responses
  - Generated successes, failures, and complex reaction times
  - Test requires a behavioral decision between several possibilities, reflects perceptual motor and cognitive activity required in athletic performance
  - Athletes completed at beginning and end of season
DHA supplementation and complex reaction time in elite female soccer players

Results:
- No significant differences in diet between groups based on food intake records
- No significant difference between beginning versus end of season
- Significant differences between the DHA supplementation group and control group
  - Decreased complex reaction time
  - Increased accuracy
  - Increased complex reaction efficiency

Conclusion:
- Supplementation with DHA produced perceptual motor benefits which may benefit athletes in sports where decision making and reaction time efficiency are important
- Future studies with larger sample size and testing while playing
References

Academy of Nutrition and Dietetics. Position of the American Dietetic Association, Dietitians of Canada, and the American

docosahexaenoic acid on resting and exercise-induced inflammatory and oxidative stress biomarkers: A randomized, placebo controlled,
cross-over study. *Lipids in Health and Disease*, 8(1), 36.


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