Top Sports Nutrition Concerns Seen in Adolescent Sports Medicine

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CHOC RD’s in Practice: Pediatric Sports Nutrition
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Disclosures

• I do receive royalties for SLACK Publications from my textbook
Goals and Objectives

• Case-based presentation
  – Identification and management tips for the anemic athlete
  – Compare and contrast the roles of water vs. sports beverages
  – Explore strategies for athletes suffering from Female Athlete Triad and/or Relative Energy Deficit
  – Review contributions of protein and creatine to recovery

• Practical recommendations

• Whole food based to maximize collateral benefits
Case One

SHOULD I TAKE EXTRA IRON TO BOOST MY PERFORMANCE?
Role of Iron in Oxygen Transport

- **Hemoglobin** - transports oxygen in blood
- **Myoglobin** - accepts, stores, and releases oxygen in muscle
- About 70% of body iron in hemoglobin or myoglobin
Iron Storage

- **Ferritin**: intracellular protein that stores iron
  - Acute Phase Reactant
  - Levels may rapidly fluctuate due to stressors
Anemia

- Decreased hematocrit (amount of red cells in blood) and/or hemoglobin able to transport oxygen
- Results in decreased aerobic performance
  - Fatigue
  - Poor recovery
  - Slower race times
Causes of Anemia in Athletes

- Gastrointestinal Losses
- Foot Strike Hemolysis
- Larger Bruises, Contusions or Hematomas
- Menstrual Losses
- Athletic Psuedo-Anemia
- Excessive Sweat Losses (pretty rare)
- Insufficient Iron Intake
Gastrointestinal Losses

• Non-steroidal Anti-inflammatory Use
• Reflux esophagitis
  – Cyclists and runners
• Higher *reticulocyte* count
• Occult blood positive stools
Foot Strike Hemolysis

• Break down of red cells due to impact of foot with ground
  – Distance Runners
• **Peripheral Smear:** fragmented, irregular cells
• **Mean Corpuscular Volume (MCV):** higher due to larger immature cells released into blood
Larger Bruises, Contusions or Hematomas

- Acute trauma
- Relatively rapid decrease in hematocrit/hemoglobin
- Serial measurements recommended
Menstrual Losses

- Heavier menstrual flow
- Higher number of days of menstrual flow
- Actual trend toward longer or absent menstrual cycles in active female athletes
Athletic Pseudo-Anemia

• Increased plasma volume relative to increase in red cell counts
  – Less viscosity allows more efficient red cell transport

• Red Blood Cell Counts (RBC), Red Cell Sizes (MCV/MHCH) and Ferritin all normal
Insufficient Iron Intake

<table>
<thead>
<tr>
<th>Hematocrit and Hemoglobin</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Corpuscular Volume (MCV) and</td>
<td>Low</td>
</tr>
<tr>
<td>Mean Corpuscular Hemoglobin Concentration (MCHC)</td>
<td>Low</td>
</tr>
<tr>
<td>Total Iron Binding Capacity (TIBC)</td>
<td>High</td>
</tr>
<tr>
<td>Iron Saturation</td>
<td>Low</td>
</tr>
<tr>
<td>Ferritin</td>
<td>Low</td>
</tr>
</tbody>
</table>

Little doubt in professional literature that classic iron deficiency anemia can contribute to diminished aerobic performance, and that supplementing iron stores is indicated.
NORMAL RED CELL COUNTS AND IRON STORES, SHOULD I STILL TAKE EXTRA IRON?
OR EVEN BETTER, SHOULD ALL ENDURANCE ATHLETES TAKE EXTRA IRON?
Hereditary Hemochromatosis

• Excessive Iron Affinity
• Increased Iron Deposition
  – Early organ damage
  – Bronze color to skin
• Tends to run in families
• More common and presents sooner in males
  – Menstruation in females delays clinical onset
Hereditary Hemochromatosis
Screening and Confirmation

• Screen:
  – Iron (Transferrin) Saturation
    >45% in males
    >45-50% in females
    (high serum ferritin higher risk factor)
  – Many suggest screen any male before iron supplementation

• Confirm:
  – Blood genetic testing for C282Y and H63D mutations
Normal red cells, normal ferritin

Prevailing thought is that supplemental iron intake is not needed and may actually have risks (organ damage, higher risk of liver cancer) that outweigh any benefits to performance.
Now, Where It Gets Really Interesting

ROLE OF IRON SUPPLEMENTATION WITH LOW FERRITIN AND NORMAL OR LOW NORMAL HEMATOCRIT/HEMOGLOBIN
Things to Consider

Unique Demands of Endurance Athletes

• Athletic individuals have different oxygen transport and muscle function demands.

• What many of us consider as "normal" hemoglobin values for less active individuals may not be so acceptable for intense endurance or team sports athletes.

• Many athletes may strive for hemoglobin levels at least 2-3 points above the lowest range of normal.
Things to Consider
The Perplexing Role of Ferritin

• Ferritin levels can be influenced by illness or even total body inflammation, so often sick or over-trained and under-performing athletes mistakenly appear to be "doing better" with iron intake based solely on higher ferritin levels.

• If you "trust" ferritin, then deciding on acceptable levels is yet another concern. In many athletes, keeping levels in the 20-30 range is a challenge during period of heavier training or competition.
Is There Something Better Than Ferritin?

- **Soluble Transferrin Receptor:** may be more accurate in measuring iron stores
  - Not an acute phase reactant
Bottom Line?

• The results of a recent meta-analysis lend additional support that iron supplementation for low iron stores without frank anemia can improve iron status and aerobic capacity.
• Higher doses of iron supplementation over a shorter period of time were suggested to be more effective than smaller doses over longer periods with effect on iron stores to be diminished with a treatment period over 80 days.
• Optimal dosing amounts, protocols, and routes (oral versus injected) require more study.
Food Sources of Iron

- Best Absorbed: Red meat, Red fish, Dark poultry, Veal
  - Also supply protein and creatine
- Leafy Green Vegetables, Raisins, Nuts
  - Need almost astronomical amounts for sufficient effect
- Vitamin C enhances absorption
- Cooking with Cast Iron pan/skillet
# US RDA for Elemental Iron

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Daily Dose of Elemental Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-8</td>
<td>10 mg/day</td>
</tr>
<tr>
<td>8-13</td>
<td>8 mg/day</td>
</tr>
<tr>
<td>&gt;13 years</td>
<td></td>
</tr>
<tr>
<td>MALES</td>
<td>11 mg/day</td>
</tr>
<tr>
<td>FEMALES</td>
<td>15 mg/day</td>
</tr>
</tbody>
</table>
Liquid or Pill Iron Supplement Doses
Ferrous Sulfate, Ferrous Gluconate, Ferrous Fumarate, Ferrous bis-glycinate chelate

• 3-6 mg **elemental iron/kg/day**
  – Liquid forms contain 20% elemental iron
  – Dried forms (monohydrate) have 30-33%
  – BID to TID
  – Many recommend nightly dosing for GI upset
  – Compliance is major issue
  – Recommend taking until next scheduled blood draw (2-3 months)
Liquid or Pill Iron Supplements
Ferrous Sulfate, Ferrous Gluconate, Ferrous Fumarate, Ferrous bis-glycinate chelate

• Indications
  – Insufficient Food Intake
  – Vegetarian/Vegan
  – Prolonged Insufficiency
  – Ferritin <20

• Issues
  – Liquid: Staining of teeth
    • Use a straw
  – Constipation
    • Stool softener is a must
    • Ferrous fumarate may be better tolerated
    • Ferrous bis-glycinate chelate requires lower dosing, may be better tolerated
Goals

• Increase Hemoglobin by at least 1 point
• Increase Ferritin over 20
• Reduce impact of side effects
Unique Challenges

• Iron Supplementation not an overnight success
  – Takes at least 100 days to increase red cell production

• Anti-inflammatory diet may increase absorption
  – Less processed carbohydrates/foods
  – Increased ginger, turmeric, berries/cherries, omega-3 fatty acids
Role of Intramuscular or Intravenous Iron?

- Few studies in elite athletes
- Failed diet and oral supplementation
- Risks:
  - Anaphylaxis
  - Skin/muscle necrosis
  - Iron toxicity
- Certain IM/IV administrations may be banned for elite athletes
Why Isn’t it Working?

- Confirm Diagnosis
- Eliminate other causes of anemia
- Discuss compliance
- Absorption Issues
  - Carbonation
  - Concurrent Calcium intake
  - Equivocal data if Helicobacter infection reduces iron absorption
Other Things to Consider

• Other causes of fatigue/underperformance
  – Emotional/physical overtraining and burnout
  – Insufficient sleep
    • Less than 8.5 hours a night in high school population
  – Relative energy availability concerns
    • Insufficient overall intake for level of physical demand
The Fluid Battle

WATER VS. SPORTS BEVERAGES
Indications for Sports Beverages

American Academy of Pediatrics Councils on Sports Medicine and Fitness and Nutrition

http://pediatrics.aappublications.org/content/early/2011/05/25/peds.2011-0965.full.pdf

• Sports drinks have a specific limited function
  – More rapid replenishment of carbohydrates and/or electrolytes in combination with water during prolonged sports

• Concerns over excessive sugar intake
  – Dental Erosion
  – Caloric Intake
  – Carbohydrate/sugar load
  – Weight Issues
Pre-Activity

• The Winner: **WATER**

• **WHY?**
  
  – Inexpensive, readily accessible and low-calorie option
  
  – Cold water better absorbed
  
  – For kids who won't drink water and prefer a flavored beverage, then sports drinks right before exercise are a sensible option.
Guidelines for Pre-Exercise Hydration


• Drink 16-20 fluid ounces of water or sports beverage at least four hours before exercise.

• Drink 8-12 fluid ounces of water 10-15 minutes before exercise.
Other Pre-Exercise Hydration Thoughts

- Dehydration can affect quality of exercise, ability to maintain body temperature, and may lead to early fatigue and cramping.
- Keep an eye on body weight, especially in hot or humid environments, and in multiple exercise sessions with short recovery periods.
- More than 2% weight loss from regular weight suggests dehydration and requires adequate fluid intake (usually with water)
During Activity

- The winner: **Kinda Depends**
- **WHY?**
  - For most exercise *under an hour*, water is a very sensible
  - If the exercise *over an hour*, water is still a solid selection, but there is increased role for sports beverages to help replace carbohydrates and electrolytes
  - For those *salty sweaters* (white salt rings on headgear and uniforms, sweat has a distinct salt taste), sports beverages can help replace those sweat salt losses.
## Maintaining Fluid Balance

"depending on tolerance"

<table>
<thead>
<tr>
<th>Exercising for</th>
<th>Drink 3-8 fluid ounces of water every 15-20 minutes depending on tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 60 minutes</td>
<td></td>
</tr>
<tr>
<td>greater than 60 minutes</td>
<td>Drink 3-8 fluid ounces of a sports beverage or water (5-8 percent carbohydrate with electrolytes) every 15-20 minutes depending on tolerance</td>
</tr>
</tbody>
</table>
Risks of Over-Hydration

• Excessive water ingestion without adequate salt intake can lead to low serum sodium levels (hyponatremia) with risks of seizures, brain swelling and even death.

• Thus, many authorities recommend against rigid or forced consumption of water especially during ultra-endurance events such as marathons or triathlons.
Post-Activity

• The Winner: **Neither**

• **WHY?**
  
  – Cannot go wrong with water or measured amounts (again to reduce sugar/calorie burden) of sports drinks
  
  – **But** if the ultimate goal is optimizing immediate (first 30 minutes) recovery including rehydration....
Chocolate Milk

- Adequate fluids for rehydration, but also scientifically supported ratios of carbohydrate to protein that enhance muscle repair and recovery
- Delivers calcium and Vitamin D especially with indoor sport athletes that have reduced opportunity for Vitamin D absorption
- Almond, rice or soy-based chocolate milk can be used for those who don't tolerate or are allergic to cow's milk.
- Usually isn't much objection to the sweet taste.
Tart Cherry Juice


• Provides necessary fluid intake with collateral benefits of anti-inflammatory properties that could reduce both immediate and delayed muscle soreness and stiffness

• Might actually be able to reduce perceived need for non-steroidal anti-inflammatory medications after exercise
Guidelines for Use

- One 8-12 ounce serving of chocolate milk or tart cherry juice within 30 minutes of completing activity.
- Can use similar amount of sports beverage.
- Measure weight after activity- for every one pound of weight loss, recommend consumption of 16-24 ounces of fluid, of which water should be the primary component.
RELATIVE ENERGY DEFICIT (REDS) AND FEMALE ATHLETE TRIAD ISSUES
What is the Female Athlete Triad?


• Menstrual Function
  – Primary Amenorrhea
    • No period after age 15
  – Secondary Amenorrhea
    • Absence of menses for 3 cycles or 6 months after established normal cycles

• Bone Mineral Density
  – Stress Injuries

• Energy Availability
  – Disordered Eating
How about Relative Energy Deficiency?


- “inadequacy of energy to support the range of body functions involved in optimal health and performance”
- Involves males
- Considered a syndrome that impairs physiologic and/or psychologic function
Who is at risk?

- Weight class athletes
- Disciplines that favor leanness
- Activities with subjective scoring
Why Athletes Will Get Referred....

- Amenorrhea
- Bone Stress Injuries
  - More than one
  - Higher risk stress fractures
  - Complicated healing
- Under-performance
- Injured athletes
  - Fear of weight gain while inactive
- Family discord or history of abuse
Particular Food-based Behaviors

• Restrictive Diet
  – Inadequate caloric intake
  – Ignorance rather than disease
• Pre-occupation with weight or food
• Won’t eat in front of teammates
• Meticulous counting of calories or fat grams
• Regimented “extra” exercise
• Use of laxatives or diuretics
Team-Based Collaborative Evaluation

• Follow Height, Weight and BMI
• Calculate Energy Availability
  – 3 Day Food and Activity Diary
  – Accelerometer
• Consider EKG in syncope/presyncope or bradycardia
• Consider DEXA scan
  – Persistant amenorrhea > 6 months
  – Multiple or high risk stress fractures
• Psychological Support
Goals and Outcomes

• Evidence suggests that keeping BMI >28%ile contributes to regular menstrual function

• Modify activity levels to “match” energy intake

• Liberalize activity as energy intake levels increase
Elements of a Treatment Contract


- **Frequency of follow-up appointments**: Usually once per week until weight stabilizes
- **Frequency of labs**: Initial visit and then every 6-8 weeks until steady weight gain is established
- **Names of practitioners who will evaluate the athlete**: Nutritionist, Psychologist, Physician
- **Expected weight gain per week**: 0.5 to 1 lb
- **Minimum acceptable weight**: < 85% of expected weight for height/age is DSM IV TR criteria for AN
- **Goal Body Mass Index (BMI)**: < 18.5 or < 5th percentile on a growth chart considered underweight
- Weight at which the athlete must stop physical activity or that requires hospitalization
- Statement that failure to comply will result in restriction from sport
- Statement that the athlete’s family may be contacted as necessary if condition worsens
- All initial labs and screening tests must be completed in certain time frame-usually 1-2 weeks.
<table>
<thead>
<tr>
<th>Metric</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>Decreased in poor nutrition, increased in insulin deficiency</td>
</tr>
<tr>
<td>Sodium</td>
<td>Decreased with increased water intake or laxative use</td>
</tr>
<tr>
<td>Potassium</td>
<td>Decreased in vomiting, laxative or diuretic use, refeeding syndrome</td>
</tr>
<tr>
<td>Chloride</td>
<td>Decreased in vomiting, increased with laxative use</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>Increased in vomiting, decreased in laxative use</td>
</tr>
<tr>
<td>BUN</td>
<td>Increased in dehydration</td>
</tr>
<tr>
<td>Creatinine</td>
<td>Increased in dehydration or renal dysfunction, falsely elevated due to low muscle mass</td>
</tr>
<tr>
<td>Calcium</td>
<td>Decreased or normal in poor nutrition with bone breakdown</td>
</tr>
<tr>
<td>Phosphate</td>
<td>Decreased in poor nutrition or refeeding</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Decreased in poor nutrition, laxative use, refeeding syndrome</td>
</tr>
<tr>
<td>Total protein/Albumin</td>
<td>Increased in early malnutrition due to muscle breakdown</td>
</tr>
<tr>
<td>Aspartate aminotransaminase (AST)</td>
<td>Increased in liver dysfunction</td>
</tr>
<tr>
<td>Alanine aminotransaminase (ALT)</td>
<td>Increased in vomiting and pancreatitis</td>
</tr>
<tr>
<td>Amylase</td>
<td>Increased in pancreatitis</td>
</tr>
</tbody>
</table>

Adapted from Eating Disorders: Critical Points for Early Recognition and Medical Risk Management in the Care of Individuals with Eating Disorders, www.aedweb.org
Mechanisms for Modifying Behavior

• Shift obsession from calories to portions

• Create concrete changes
  – Adding 100 kcal/week
  – Adding avoided food group

• Address underlying issues
  – Family/individual therapy
  – Medications
Contraindications for Participation

- BMI < 17
- Weight that goes down 2 lines on growth chart
- Failure to meet targeting weight gain goals
- Hospitalization
  - dehydration
  - severe/symptomatic bradycardia
  - electrolyte abnormalities
Protein and Creatine

I WANT TO GET BIGGER AND STRONGER!
Protein

• Made up of amino acids
• Can assist in building muscle when combined with resistance training
• Common types
  – Whey
  – Casein
• Big fan of Whole Food based sources
• Supplements no better than food sources
What are Protein Requirements?

- **USA RDA**
  - 0.8 gm/kg/day (adult)
- **Endurance Athletes**
  - 1.2-1.4 gm/kg/day
- **Strength Athletes**
  - 1.2-1.7 gm/kg/day
Amount is Usually Not the Issue

• “Standard American Diet”
  – Most males get sufficient amounts of protein
  – Excessive protein tends to be excreted in the urine

• Who might not get adequate amount?
  – Restricted/limited/no animal based food product intake
  – Malabsorption
Timing of Protein Intake

• Best: within 30 minutes after finishing athletic activity
  – Up to 30 grams
  – Simultaneous ingestion of carbohydrate may enhance absorption

• Some evidence suggests another protein load 2 hours after exercise
Chocolate Milk

• 4:1 gram ratio of carbohydrate to protein
• Collateral benefits
  – Calcium (300 mg/8 oz)
  – Vitamin D (100 IU)
  – Sodium (150 mg)
  – Potassium (425 mg)
  – Tastes good
  – Relatively inexpensive
  – Easy to obtain
Evidence Supporting Chocolate Milk

• Consuming chocolate milk immediately after exercise and again at 2 h post-exercise appears to be optimal for exercise recovery and may attenuate indices of muscle damage

• Chocolate milk may be as effective as or superior to (commerical recovery beverages) in promoting recovery

• The effects of consumption of MILK after endurance exercise on muscle protein fractional signal rate, signaling molecules of skeletal muscle protein turnover, leucine kinetics, and performance measures suggest unique benefits of milk compared with a CHO-only beverage
Other Easy to Access Food-based Protein Sources

• Yogurt
  – Especially Greek Yogurt
• Peanut or Almond Butter
• Nuts and seeds
  – Trail mix
• Cruciferous Vegetables
  – Broccoli, Cauliflower, Carrots
How About Protein Drinks, Shakes and Powders?

• **Benefits**
  – Condensed delivery
  – Taste good
  – Appealing
  – Collateral elements

• **Potential Downsides**
  – Cost
  – Overload on urinary system
  – Dependence
  – Unwanted collateral elements
  – Bridge to other supplements?
Creatine Monohydrate

• Phosphate donor
  – ATP resynthesis from ADP
  – Primary energy source for short-duration (10 second) anaerobic high-intensity exercise

• Use to enhance muscle hypertrophy and recovery
Food Sources of Creatine

• Wild Game
• Domestic Meats
  – Free Range richer than Commercially Prepared
• Wild Caught Fish
• Milk (rather small amount)
• Cranberries (rather small amount)
Why Supplement?

• Supplementation can increase muscle phosphocreatine stores by 20%
  

• Common Forms
  
  – Liquid
  – Powder
Potential Creatine Side Effects

- Gastrointestinal Discomfort
- Diarrhea
- Weight Gain
- Muscle Cramping
- Muscle Strains
- Renal Dysfunction
Opinions on Creatine

• Most US-based national sports medicine medical bodies do not recommend creatine supplementation in athletes < 18 y/o
  – American Academy of Pediatrics
  – American College of Sports Medicine
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Our Present and Future Athletes Thank You!