EXERCISING WITH DIABETES
--ACROSS THE AGE SPAN

Sherry Barkley, Ph.D., FACSM, RCEP

Outline

- What is exercise?
- General guidelines for the exercise prescription
- Exercise guidelines and strategies for persons with diabetes
- Special considerations and precautions
- Lessons from the athletes

What is Exercise?

- Activities that promote...
  - Cardiovascular Endurance
  - Muscular Fitness
  - Flexibility
  - Balance

Benefits of Exercise

- Physical
  - Energy
  - Fitness
  - Weight control*
  - Risk factor reduction*
  - Immunity
  - Sleep
  - Fall prevention
  - Blood sugar control*

- Mental
  - Concentration
  - Memory
  - Self-confidence

- Social
  - Time with friends

- Emotional
  - Stress management
  - Self-esteem

General Guidelines for Exercise

- Follow the FITT Principle
  - Frequency
  - Intensity
  - Time
  - Type

- Use good SENSE
  - Start
  - Exercise
  - Nice and SLOW
  - Every time

American College of Sports Medicine, 2014

Guidelines for Adults

- Cardiorespiratory Endurance Exercise
  - Moderate intensity exercise for ≥ 30 min/day on ≥ 5 d/week (≥ 150 min/week), OR...
  - Vigorous intensity exercise for ≥ 20 min/day on ≥ 3 d/week (≥ 75 min/week), OR...
  - A combination of moderate and vigorous exercise

- Resistance Exercise
  - 2-3 days/week for each major muscle group, (intensity depends on goals)

- Flexibility
  - 60 sec/exercise, ≥ 2 days/week, gentle stretch
Guidelines for Older Adults

- **Cardiorespiratory Endurance Exercise**
  - Moderate intensity exercise for ≥ 30 min/day on ≥ 5 d/week (≥ 150 min/week), OR...
  - Vigorous intensity exercise for ≥ 20 min/day on ≥ 3 d/week (≥ 75 min/week), OR...
  - A combination of moderate and vigorous exercise (at least 10 min/exercise bout)
- **Resistance Exercise**
  - 2 or more days/week for each major muscle group
- **Activities for Balance and Fall Prevention**
  - ≥ 3 days/week

Guidelines for Children & Adolescents

- 60 minutes (1 hour) or more of daily physical activity
  - **Aerobic**: most of the 60 min should be moderate-or vigorous-intensity, with vigorous PA ≥ 3 d/week
  - **Muscle-Strengthening**: include as part of 60 min of daily activity at least 3 d/week
  - **Bone-Strengthening**: include as part of 60 min of daily activity at least 3 d/week

Guidelines for People with Diabetes

- **Pre-Exercise Screening**
  - Consider cardiovascular risk factors
  - Determine goals: health vs. fitness, weight loss, blood glucose control
- **F: Frequency of Exercise**
  - Cardiorespiratory
    - 3-7 days/week
    - no more than 2 days between bouts
  - Resistance
    - 2-3 days/week, non-consecutive
  - Flexibility
    - Can be done daily—but NOT as a substitute for Aerobic or Resistance exercises

Guidelines for Diabetes (cont.)

- **I: Intensity of Exercise**
  - Cardiorespiratory
    - Moderate intensity
    - RPE = 11-13
  - Resistance
    - Sub-maximal
    - Avoid breath-holding
  - Flexibility
    - Mild stretching
    - Resistance, not pain

Guidelines for Diabetes (cont.)

- **T: Time (duration/volume) of Exercise**
  - Cardiorespiratory
    - 150 – 300 min/week
    - At least 10 min/exercise bout
  - Resistance
    - 1-3 sets of 8-15 repetitions
  - Flexibility
    - Hold stretch for 10-60 seconds

Guidelines for Diabetes (cont.)

- **T: Type of Exercise**
  - Cardiorespiratory
    - Walking, water exercises, cycling, etc.
  - Resistance
    - Body weight, resistance bands, dumbbells, machines, free weights
    - Pick exercises to focus on 6-10 major muscle groups
  - Flexibility
    - Static stretching

Center for Disease Control and Prevention, 2008
Exercise Strategies—know your fuel

**Anaerobic Energy Pathways**
- **ATP-PCr** – immediate needs
  - ATP → ADP + Pi + energy, PCr → Cr + Pi + energy
  - lasts about 15-20 seconds
- **Anaerobic Glycolysis** – short term needs
  - glucose (glycogen) → → pyruvic acid (→ lactate)
  - lasts less than 2 minutes

**Aerobic Energy Pathways**
- **Aerobic Glycolysis** – long term needs
  - glucose (glycogen) → → pyruvic acid → acetyl CoA → Krebs Cycle → ETC
  - Provides ATP for up to 2 hours (depending on glucose availability)
- **β-oxidation** – long term needs
  - triglycerides → glycerol + FA → → → acetyl CoA → Krebs Cycle → ETC
  - Fat stores can provide fuel for hours (but with insufficient CHO will produce ketones)

Exercise Strategies

**Avoid hypo/hyperglycemia**
- Optimize fuel delivery to the muscles
  - Start exercise with adequate blood sugar levels
- Be aware of Energy Pathways
- Balance glucose levels during exercise
  - Impacted by insulin and exercise
  - Regular exercisers may need less insulin
- Balance glucose levels during recovery
  - Pre- and post-exercise nutrition both play a role
  - Cool-down is important

### Recommended Pre-Exercise CHO Intake Based on Blood Glucose Levels

<table>
<thead>
<tr>
<th>GLUCOSE PRE-EXERCISE</th>
<th>INTENSITY AND DURATION OF EXERCISE</th>
<th>EXTRA FOOD NEEDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 100 mg/dl</td>
<td>Low (&lt;30 minutes) Moderate (30-60 minutes) Strenuous (&gt;1 hour)</td>
<td>10 - 15 gm carbohydrate 30 - 45 gm carbohydrate 45 - 60 gm carbohydrate</td>
</tr>
<tr>
<td>101-180 mg/dl</td>
<td>Low Moderate Strenuous</td>
<td>No extra food needed 15 - 30 gm carbohydrate 45 - 60 gm carbohydrate</td>
</tr>
<tr>
<td>181-300 mg/dl</td>
<td>Low Moderate Strenuous</td>
<td>No extra food needed 15 - 30 gm carbohydrate</td>
</tr>
<tr>
<td>Over 300 mg/dl</td>
<td>Don’t begin exercise until BG under better control.</td>
<td>No extra food needed</td>
</tr>
</tbody>
</table>

***If BG > 250, athlete should check ketones—avoid exercise if ketones are present.

American Association of Diabetes Educators, 2011

CHO Options to Treat Hypoglycemia

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>AMOUNT (for 15 gm carbohydrate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit Juice</td>
<td>½ cup</td>
</tr>
<tr>
<td>Milk (Skim preferred)*</td>
<td>1 cup</td>
</tr>
<tr>
<td>Regular Soda Pop</td>
<td>½ cup (4 oz)</td>
</tr>
<tr>
<td>Glucose Tablets</td>
<td>3-4 (depends on brand)</td>
</tr>
<tr>
<td>Glucose Gel</td>
<td>Check package info for amount equal to 15 gm</td>
</tr>
</tbody>
</table>

*Note: High fat foods/drinks slow gastric emptying and CHO absorption, taking longer to raise blood glucose levels, but may help in preventing hypoglycemia.

Balancing Glucose During Exercise

- **Insulin** is used to move blood glucose into cells
- **Muscle contraction** causes an insulin-like response
- **Exercise hormones** (epinephrine, nor-epi, glucagon, cortisol) increase blood glucose

**Imbalance of insulin, other hormones and exercise can lead to hypoglycemia**
**Insulin Dosing**

- Goal: match insulin levels with physiological needs
- Mixed/split doses of insulin
- Insulin pump

<table>
<thead>
<tr>
<th>TYPE</th>
<th>NAME</th>
<th>ONSET</th>
<th>PEAK</th>
<th>DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid-acting</td>
<td>Aspart (NovoLog)</td>
<td>5-15 min</td>
<td>30-90 min</td>
<td>&lt; 5 hours</td>
</tr>
<tr>
<td></td>
<td>Glulisine (Apidra)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lispro (Humalog)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-acting</td>
<td>Regular</td>
<td>30-60 min</td>
<td>2-3 hours</td>
<td>5-8 hours</td>
</tr>
<tr>
<td>Intermediate-acting</td>
<td>NPH</td>
<td>2-4 hours</td>
<td>None</td>
<td>10-16 hours</td>
</tr>
<tr>
<td>Long-acting</td>
<td>Detemir (Levemir)</td>
<td>2-4 hours</td>
<td>None</td>
<td>24 hours</td>
</tr>
<tr>
<td></td>
<td>Glargine (Lantus)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

American Association of Diabetes Educators, 2011

**Muscle Contractions and Blood Glucose**

- Exercise has an “insulin-like” response
  - Effect is independent of and in addition to the effects of insulin
  - Stopping/decreasing exercise decreases the effect
  - Implications for travel, taper and cool-down

**Hormones and Blood Glucose**

- Stress hormones are released during exercise
  - Epinephrine/norepinephrine
  - Cortisol
  - Glucagon
- Excitement of competition may increase blood glucose—or maybe not!
  - But hormone surge may mimic hypoglycemia

**Glucose Response to Exercise Type**

- HIIT vs. Moderate Exercise
  - n = 7 individuals with T1DM
  - 30 min protocol: MOD (60% VO2) vs. HIIT (40% VO2 with 4s sprints every 2 min)
  - Blood glucose higher during and after HIIT
    --Guelfi et al., 2005.
- Aerobic vs. Resistance Training
  - n = 12 adults with T1DM
  - 90 min protocol: 45 min each type, RA vs. AR
  - Blood glucose drops more during Aerobic activities (but some nocturnal hypoglycemia after resistance exercise)
    --Yardley et al., 2013.

**Balancing Glucose During Recovery**

- Monitor blood glucose and refuel accordingly
  - Typical re-fuel regimen calls for CHO + protein within 45 min of exercise cessation (2:1 to 4:1 ratio)
  - Importance of cool-down
  - Appropriate pre-fueling decreases late onset hypoglycemia
    - Study: Impact of Beverages on LOPEH
    - n = 7 adults with T1DM
    - whole milk/skim milk/commercial beverages
    - beverages with fat and protein better for preventing LOPEH
      --Hernandez et al., 2000

**Special Considerations/Precautions**

- Monitor blood sugar before, during, and after exercise
- Adjust CHO/insulin to meet the demands of exercise
- Avoid injecting insulin into exercising muscles
- Be aware of symptoms and treatment for hypoglycemia
- Carry fast-acting sugar in case of hypoglycemia
Considerations/Precautions (cont.)

- Including cool-down may decrease risk for hypo/hyperglycemia
- Be aware of effects of heat and hydration
- Exercise with a partner
- Practice foot care
- Carry medical ID

Lessons from Athletes

Diabetes Risk?

- Weight cycling and risk for T2DM
  - n = 58 college males (28 wrestlers, 30 non-wrestlers)
  - Tested in-season vs. post season weight and FPG
  - W: significant weight fluctuation
  - W: in-season FPG (80.6 mg/dL) and post-season FPG (82.4 mg/dL) different than N-W: 76.5 mg/dL
  - Weight cycling cannot be ruled out as contributor to increased FPG values

---Nelson and Barkley, 2015

Lessons from Athletes

- Professional athletes with diabetes...
  - Bobby Clarke: Ice Hockey – NHL center
  - Will Cross: Mountain Climber
  - Jay Cutler: Football – NFL quarterback
  - Chris Dudley: Basketball – NBA
  - Missy Foy: Ultramarathon – US Olympic team
  - Kris Freeman: Cross Country Skiing – US Olympic team (15K to 30K)
  - Sam Fusa: Baseball – MN Twins outfilder
  - Gary Hall, Jr.: Swimming – US Olympic Team (sprints)
  - Kevin Hanson: Volleyball – US National Team, World League
  - Kati Kuehn: Golf – LPGA
  - Ryan Reed: NASCAR – driver
  - Team Novo Nordisk: Cycling, running, triathlon

- Non-professional athletes with diabetes...
  - Emily (HS student): Volleyball, Basketball, Track
  - Hayley (middle school student): Softball
  - Jay (HS student): Hockey
  - Karl (college professor): Fitness walking and weightlifting
  - Matt (college student): Tennis
  - Sarah (entering HS): Horseback riding, marching band

The Take-Home Message:

- Exercise is for Everyone!
  - An exercise prescription is individualized
  - Blood sugar control must be individualized as well

References

- Giurati, Jones, Fournier: The Decline in Blood Glucose Levels Is Less With Intermittent High-Intensity Compared With Moderate Exercise in Individuals With Type 1 Diabetes. Diabetes Care, 28(6), 1289-1294; 2005.