The role of exercise in diabetes care
Energy balance

Changing rate of energy expenditure
Physical activity and exercise

Physical activity

- Occupational activity (business, work)
- Leisure activity (Recreational activities, sports)
- Travel to and from places

Exercise

- Planned, repeated physical activity to maintain or improve physical fitness
Forms of exercise

Aerobic exercise
- Exercise requiring oxygen for muscle activity
- Aerobic capacity ($\text{VO}_2\text{max}$ for 1 minute) increased
- Walking, jogging, bicycle riding, swimming, aquarobic, aerobic, dance, light trail walking

Resistance exercises
- Anaerobic exercises increasing muscle volume/mass.
- Bands, dumbbells, weightlifting equipments, etc.

Flexibility exercise
- Improves elasticity of muscle and myofascium
- Yoga, stretching, Tai Chi
WHO recommendation on physical activity for health

• Throughout a week, including activity for work, during transport, and leisure time, adults should do at least

  – 150 minutes of moderate intensity physical activity
    OR
  – 75 minutes of vigorous intensity physical activity
    OR
  – An equivalent combination of moderate and vigorous intensity physical activity achieving at least 600 MET-minutes per week
Physical activity

- **METs (Metabolic Equivalents)**
  - Intensity of physical activities
  - The ratio of a person’s working metabolic rate relative to the resting metabolic rate

1 MET : the energy cost of sitting quietly
  → a caloric consumption of 1 kcal/kg/hour

Estimated as compared to sitting quietly

Moderate active: 4 METs (50-70% Max HR)
Vigorous active: 8 METs (>70% Max HR)
FORMAL EXERCISE

- Intro Pilates class
  - 3.5
  - 105-131 cal / 30 min

- Walking 4.0 mph (very briskly)
  - 5.0
  - 150-188 cal

- Weightlifting (vigorous)
  - 6.0
  - 180-225 cal

- Swimming front crawl (slow pace)
  - 8.0
  - 240-300 cal

- Boot camp / Calisthenics (vigorous)
  - 8.0
  - 330-413 cal

- Running 9:00 / mile
  - 11.0

Better for lighter workouts and beginners

Better for harder workouts and experienced exercisers

whyiexercise.com
# Acute Effect of Exercise

**Fuel utilization during exercise**

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Anaerobic Glycolysis</th>
<th>Oxidative (aerobic) metabolism</th>
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</thead>
<tbody>
<tr>
<td>1st 5-10 seconds</td>
<td></td>
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<tr>
<td>~10 sec - ~10 min</td>
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<tr>
<td>~30 min.</td>
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<tr>
<td>~30 min onward</td>
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</tbody>
</table>

- **IM glucose**
- **Hepatic Glycogenolysis**
- **Hepatic Gluconeogenesis** (FFA)

- **Likelihood of Hypoglycemia:**
  - Very low
  - Low
  - High
  - Very high

- Scheiner, Gary, MS CDE

Acute Effect of Exercise
Postexercise glycemic control

Glucose uptake by muscle

At rest and postprandial \( \rightarrow \rightarrow \) insulin mediated

During exercise, muscle contraction \( \rightarrow \rightarrow \) insulin independent

Muscular glucose uptake remains elevated postexercise

Contraction mediated : Several hours

Insulin mediated : For longer

The effect of single bout of aerobic exercise

Increase insulin action and glucose tolerance for 2-72hr
Benefits of exercise in diabetics

• Increased sensitivity to insulin
• Improvements in blood glucose and chronic complications
• Reduced gluconeogenesis in the liver
• Reduced serum low density lipoprotein-cholesterol, fatty acid and increased high density-lipoprotein cholesterol
• Improvements in mild to moderate hypertension
• Calorie restriction and increased energy expenditure leading to weight loss
• Improved quality of life
Components of exercise planning

- **Type**
  - What kind of exercises are there?

- **Frequency**
  - How many exercise sessions per week?

- **Duration**
  - How long will each exercise session be?

- **Intensity**
  - How intense will the exercise be?
Recommended physical activity for persons with type 2 diabetes

• Aerobic exercise training
  – At least 150 min/week
  – Moderate to vigorous intensity
  – At least 3 days during the week
  – With no more than 2 consecutive days between activity
  – Physical activity achieving at least 600 MET-minutes/week (150 min of moderate-4MET or 75 min of vigorous-8MET)

• Resistance exercise training
  – 2-3 days per week on nonconsecutive days
  – Moderate to vigorous

Diabetes Care 33, e147-167, 2010
Recommended physical activity for persons with type 2 diabetes

• Combined aerobic and resistance training
  – May confer health additional benefit control of BG

• Flexibility exercise (stretching, yoga)
  – Have shown mixed results

• Daily movement (unstructured activity)
  – Gain additional health benefit
Exercise intensity

Moderate intensity
Vigorous intensity

There are two basic ways to measure exercise intensity

1. **How you feel:** Exercise intensity is a subjective measure of how hard physical activity feels to you while you're doing it — your perceived exertion

2. **Your heart rate.** Your heart rate offers a more objective look at exercise intensity. In general, the higher your heart rate during physical activity, the higher the exercise intensity
Gauging intensity by how you feel

• **Moderate exercise intensity**
  Moderate activity feels somewhat hard.
  – Your breathing quickens, but you're not out of breathe.
  – You develop a light sweat after about 10 minutes of activity.
  – You can carry on a conversation, but you can't sing

• **Vigorous exercise intensity**
  Vigorous activity feels challenging
  – Your breathing is deep and rapid.
  – You develop a sweat after only a few minutes of activity.
  – You can't say more than a few words without pausing for breathe.
Gauging intensity using your heart rate

- **Moderate intensity**: 50 to 70 percent of your maximum heart rate
- **Vigorous intensity**: 70 to 85 percent of your maximum heart rate

How to determine your target zone

**Maximum heart rate**: 220-age (220-50)

**Resting heart rate**: Heart beats for 1 min (70)

**Heart rate reserve**: Maximum HR - resting HR (170-70=100)

**Target zone**

**Moderate intensity**: Heart rate reserve x 0.5~0.7 + resting HR
100 x 0.5~0.7 + 70 = 120~140

**Vigorous intensity**: Heart rate reserve x 0.7~0.85 + resting HR
100 x 0.7~0.85 + 70 = 140~155
Exercise with non-optimal blood glucose control

• **Hyperglycemia**
  
  – Type 1 diabetes
  
  Hyperglycemia can be worsened by exercise in patients with insulin deficient and ketotic.

  – Type 2 diabetes
  
  Generally, do not need to postpone exercise, if they are feeling well

  – When undertaking strenuous exercise with high blood glucose, make sure that they are hydrated and feeling well.

Diabetes Care 33, e147-167, 2010
Exercise with non-optimal blood glucose control

- Hypoglycemia is the greatest concern
- Hypoglycemia
  - Persons with type 2 diabetes not using insulin or insulin secretagogue (sulfonyurea)
    Unlikely to experience hypoglycemia related to exercise
  - Persons using insulin or insulin secretagogue
    1. Preexercise blood glucose <100mg/dl
    2. Late onset hypoglycemia (High intensity exercise)
      - Consumption of carbohydrate during and within 30min after exercise

Diabetes Care 33, e147-167, 2010
Medication Effects on Exercise Response

• Persons using insulin or insulin secretagogue (sulfonyurea and meglitinide)
  – Require medication dosage adjustment
  – before planned exercise
    ➔ Especially, rapid and short acting insulin

– Need to monitor blood glucose level before, during, and after exercise

Diabetes Care 33, e147-167, 2010
Pre-exercise Evaluation

- For exercise more vigorous than brisk walking
- Sedentary and older diabetic individuals with long history of diabetes

  - Assess for conditions that
    - Risk of CVD
    - Contraindicate certain activities
    - Predispose to injuries
      - Known or suspected CAD, cerebrovascular disease, peripheral vascular disease (PAD), high risk of CAD
      - Severe peripheral neuropathy, severe autonomic neuropathy, proliferative retinopathy, advanced nephropathy
Exercise With Long-term Complication of Diabetes: Vascular disease

• Known CVD is not an absolute contraindication to exercise.

• Peripheral arterial disease (PAD)
  – Exercise enhance mobility, functional capacity, pain tolerance, and quality of life
  – Low to moderate walking, cycling, lower extremity resistance training

Diabetes Care 33, e147-167, 2010
Exercise With Long-term Complication of Diabetes: Peripheral Neuropathy

- Stop weight-bearing exercises if there is loss of feet sensation
- Repeated exercise on foot with sensual loss ultimately results in ulcer and fracture
- Recommended: Swimming, aquarobic, water exercise
- Contraindicated: Long walking, step climbing
- Precautions: Wear socks and athletic shoes to protect feet. Observe and manage feet before/after exercise.
Exercise With Long-term Complication of Diabetes: Autonomic neuropathy

- Loss of perception of hypoglycemia: always be alert on the signs and symptoms.
- Impaired temperature regulation: must not exercise in hot or cold setting. Always adequately hydration to prevent dehydration.
- Hyper/hypotension frequent after vigorous exercise.

Nature Reviews Endocrinology 8, 405–416 (July 2012)
Exercise With Long-term Complication of Diabetes: Retinopathy

- Exercise with intermediate or lower intensity is safe
- Recommended: Light walking
- Contraindicated: Weightlifting, vigorous intensity sports
Exercise With Long-term Complication of Diabetes: Nephropathy

Later Stage Kidney Disease

- BP increase
- CV mortality
- Reduced muscle function
- Reduced aerobic capacity

Diabetes Care 33, e147-167, 2010
Rules of exercise – 1

• Exercise at a time between 1 to 3 hours after meal.
• No exercise if fasting glucose > 240mg/dL or < 70mg/dL
• Wear socks and shoes appropriate for activities
• Bring emergency snacks for hypoglycemic events and keep diabetes recognition card.
• Avoid exercise if too hot or cold
• Stop exercise in case of chest pain, vomiting, dizziness, etc.
Rules of exercise—2

• Consult medical teams for insulin dose adjustment on day of exercise
  • Reduce short-acting insulin by 30-50%, decrease of total insulin amount by 10%
Exercise

Prevention and control

Insulin resistance, Prediabetes, GDM

Type 2 diabetes, and diabetes complication

Both aerobic and resistance training

Acutely and Chronically Effective
insulin action, BP, lipid, CV risk,
mortality, QOL

Must be undertaken

Regularly and Continued

Diabetes Care 33, e147-167, 2010