Mode Matters: Matching Patient Goals with the Appropriate Exercise Regimen to Improve Diabetes Related Health Outcomes

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Modifiable Risk Factors for DM and CVD
• Physical Inactivity
• Overweight/Obesity
• High Blood Pressure
• Hyperlipidemia
• Healthy Eating
• Smoking

Physical inactivity increases risk of
• Coronary artery disease (by 45%)
• Stroke (by 46%)
• Hypertension (by 30%)
• Colon cancer (by 41%)
• Breast cancer (by 31%)
• Type 2 diabetes (by 58%)
• Osteoporosis (by 59%)

Statement of the Problem
• 39% are considered regularly active
• Ages 60 years and older are 2-3x more likely to report inability to walk ¼ mile, climb stairs, or do housework
• Receive less support, education and encouragement for physical activity compared to other aspects of diabetes care

Physical Inactivity & Sedentaryism:
The Greatest Health Threat of the 21st Century

Physical inactivity must be polygenic in multiple organ systems — Frank W. Booth, PhD


Physical Activity/ Exercise Promotion vs. Programming

Promotion
- Break up sitting time
- Use the stairs
- Park farther away
- Join a gym
- Increase your daily steps

Programming
- Apply structured sessions (FITT)
- Tailor to Goals
- Address Contraindications

Exercise Participation vs. MI Risk

AADE7 Self Care Behaviors

- Monitoring
- Taking Medications
- Healthy Eating

- Being Active
- Reducing Risks
- Problem Solving
- Healthy Coping

Creating an EFFECTIVE Exercise Program

Physical Activity Guidelines for U.S. Adults

Aerobic Activity:
- A minimum of 150 minutes of moderate intensity aerobic activity per week
- 75 minutes of vigorous intensity aerobic activity per week
- An equivalent combination of the two per week

Resistance Training:
- A minimum of 2 days per week of resistance training
No One Exercise Type is Created Equal

Patient Characteristics to Consider?

Physical and Body Composition
- Arthritis
- Sarcopenia
- Osteopenia/porosis
- Gait instability
- Bodyweight/ fat

Metabolic & Cardiovascular
- Glycemia
- Blood Pressure
- Cholesterol
- Triglycerides
- Insulin (resistance)

* Musculoskeletal functional capacity

Dose Response Curves

Matching Patient Goals to Exercise Associated Outcomes

1. Understand the Evidence of Modality Benefits
2. Review and Match Patient’s Goals (self and assisted) for Proper Exercise Programming
3. Consider Patient’s Functional Capacity using Objective Measures for Outcomes Assessment, Follow up, Program Tailoring and Reporting

Aerobic Exercise and Cardiac Stress

VO2 max (Cardiorespiratory Fitness measure)
- Central and peripheral adaptations
  - Increased Q, SV
  - Increased cardiac dimensions and blood volume
  - Changes in muscle fiber type
  - Increases in mitochondrial content
  - Increased capillary density

Aerobic Exercise lowers BP at fixed exercise workloads
Aerobic Exercise and Diabetes

Acute:
- Can improve insulin action by as much as 15-25%
- Mainly due to increases in GLUT 4 content and transport

Chronic:
- Can improve insulin sensitivity by as much as 60% aerobic
- Due to:
  - Increased type 1 fibers (highly oxidative for better fat and carb utilization)
  - Increased capillary perfusion
  - Increased glycogen storage needs and capacity
  - Increase muscle hypertrophy in type 1 fibers (and type 2) for glucose storage thereby reducing insulin requirements for improved glucose tolerance

The Typical Aerobic Response


Inactive vs. Active Days

The Diabetes Research in Children Network (DirecNet) Study Group

Cardiorespiratory Fitness (CRF) and A1C


Aerobic Exercise and Metabolic Parameters

**Exercise Outcomes**

<table>
<thead>
<tr>
<th>Aerobic Exercise</th>
<th>Directional Change</th>
<th>Average Change (mean or %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Weight</td>
<td>↓</td>
<td>3%</td>
</tr>
<tr>
<td>Body Composition</td>
<td>Fat mass</td>
<td>↓</td>
</tr>
<tr>
<td>Lean muscle mass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>&lt;0.4 to -0.89%</td>
<td></td>
</tr>
<tr>
<td>HbA1c</td>
<td>0.67 to 0.89%</td>
<td></td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>SBP</td>
<td>-3 to -11</td>
</tr>
<tr>
<td></td>
<td>DBP</td>
<td>-3 to -8</td>
</tr>
<tr>
<td>Total Cholesterol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDLc</td>
<td>NC to -5%</td>
<td></td>
</tr>
<tr>
<td>HDLc</td>
<td>NC to +8</td>
<td></td>
</tr>
<tr>
<td>Triglycerides</td>
<td>-12%</td>
<td></td>
</tr>
<tr>
<td>Total Daily Insulin Dosing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**When to Apply?**

- Sedentary
- Low Cardiorespiratory stamina
- Cardiovascular Disease
- Cardiometabolic control
- Weight Management

**How Much?**

**FITT Principle:**
- **Frequency:** 3 - 7 days per week
- **Intensity:** moderate to vigorous
- **Time:** 150 - 300 moderate (75 - 150 vigorous)
- **Type:** rhythmic, multi-muscle activities

**Rate of Progression- Aerobic**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Frequency (per week)</th>
<th>Intensity (%HRR)</th>
<th>Time (minutes)</th>
<th>Min/ wk (minimum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial (sedentary)</td>
<td>1 - 4</td>
<td>&lt; 40 %</td>
<td>10 - 30</td>
<td>30 - 70</td>
</tr>
<tr>
<td>Improvement</td>
<td>5 - 24</td>
<td>40 - 60%</td>
<td>20 - 40</td>
<td>60 - 120</td>
</tr>
<tr>
<td>Maintenance</td>
<td>24+</td>
<td>60 - 90%</td>
<td>30 - 40</td>
<td>150 +</td>
</tr>
</tbody>
</table>

**Performance Measures for Tracking Outcomes- Aerobic**

- 6 minute walk test
  - Submax aerobic capacity
  - Monitor effort
    - HR, RPE, BP
    - Distance covered
  - Pre/ Post improvements

**Performance Measures for Tracking Outcomes- Aerobic**

- Step test
  - 2 minute
  - 5 - 8 inches (wall or step)
- Measure aerobic capacity
- Monitor efforts:
  - HR, RPE, steps rate (# steps/test), BP
- Pre/ Post Improvements
Resistance Exercise Benefits

- **Body Composition**
- **Musculoskeletal Fitness**
  - Strength and Endurance
  - Bone mineral density
- **Benefits for DM**
  - Muscle quality and quantity
  - Improves insulin action (20%)
  - Glycogen storage capacity
  - May reduce risk of exercise hypoglycemia

Loss of Muscle Strength with Aging

- 1-3% loss per year after age 30

Functional Limitations in Aging Adults

% adults 60 yrs. having any difficulty performing functional activities or unable to perform these activities by age: NHANES, 1999-2002

<table>
<thead>
<tr>
<th>Functional Activities</th>
<th>60-69 yrs</th>
<th>70-79 yrs</th>
<th>80-89 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking a mile</td>
<td>21</td>
<td>26</td>
<td>43</td>
</tr>
<tr>
<td>Walking 50 steps without resting</td>
<td>18</td>
<td>26</td>
<td>43</td>
</tr>
<tr>
<td>Dressing, undressing, or shaving</td>
<td>43</td>
<td>53</td>
<td>64</td>
</tr>
<tr>
<td>Lifting or carrying as heavy as 10 pounds</td>
<td>22</td>
<td>20</td>
<td>46</td>
</tr>
<tr>
<td>Going out to shop, movies, or events</td>
<td>13</td>
<td>21</td>
<td>29</td>
</tr>
<tr>
<td>Personal care tasks</td>
<td>14</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>Lifting up from an armless chair</td>
<td>17</td>
<td>26</td>
<td>45</td>
</tr>
</tbody>
</table>

Resistance Training (RT) Intensity

<table>
<thead>
<tr>
<th>Training goal</th>
<th>Strength</th>
<th>Power</th>
<th>Hypertrophy</th>
</tr>
</thead>
<tbody>
<tr>
<td>+20</td>
<td>+20</td>
<td>+20</td>
<td>+20</td>
</tr>
<tr>
<td>+10</td>
<td>+10</td>
<td>+10</td>
<td>+10</td>
</tr>
<tr>
<td>+5</td>
<td>+5</td>
<td>+5</td>
<td>+5</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>-5</td>
<td>-5</td>
<td>-5</td>
<td>-5</td>
</tr>
<tr>
<td>-10</td>
<td>-10</td>
<td>-10</td>
<td>-10</td>
</tr>
<tr>
<td>-20</td>
<td>-20</td>
<td>-20</td>
<td>-20</td>
</tr>
</tbody>
</table>

Repetition maximum continuum

Resistance Training to Reduce Lows

- Exercise 1
- Exercise 2
- Recovery

(max. dashed line) (min. solid line)
Resistance Training to Reduce Lows

When to Apply?
- Sedentary
- Cardiometabolic control
- Post bariatric surgery
- Older adults
- Musculoskeletal integrity
- Functional limitations
- Fall risk?
- Hypo risk with Aerobic Exercise

How Much?

FITT Principle:
- Frequency: 2 – 7 days per week
  - At least 48 hrs between same muscle sessions
- Intensity: moderate to vigorous (8-12 reps)
  - 1-4 sets per muscle group
  - 2-3 minute rest intervals
- Time: variable
- Type: Major muscle groups (upper/ lower)
  - Dynamic

Rate of Progression - Resistance Training

Performance Measures for Tracking Outcomes - Resistance
- Timed Sit to Stand (5 reps or 30 sec)
- Muscular strength/ balance test
  - Chair
  - Stopwatch
- Monitor: stability, form, # of stands, time (sec)
  - Stop at 12 seconds (5 rep)

Performance Measures for Tracking Outcomes - Resistance
- Grip strength
Performance Measures for Tracking Outcomes - Resistance

- Variable strengths
- Monitor: effort
  - # reps to volitional fatigue
  - Form, uni/ bi lateral
- Pre/ Post improvements

Balance and Flexibility

Balance:
- The ability to control the body in a certain position vastly changes across the life span
  - Sensory input: Vision, Proprioception, Vestibular System
- Slips and trips from unstable balance count for 30% to 50% of falls for community-dwelling older adults.

Flexibility:
- The range of motion (ROM) in a joint or series of joints
- Increased ROM improves functional ability
- May reduce injury
- May improve glucose control (mode specific)
- Not a strong single mode program for:
  - Weight loss
  - Cardiometabolic control

Structured Balance and ROM Modes

Combination Training:
- Tai Chi + RT
  - Cochrane Review: reduce falls by ~30%
- Yoga
  - Reduce A1c as much as .5%
  - Reduce lipids, improve body composition

Fall Prevention (Use of RT)

- About 90% of all hip fracture falls actually occurred in the standing position prior to the fall
- Only ~ ½ of older adults who suffer from a hip fracture are able to regain independence
- 60-70% 1 RM good at the start (~12-20 reps)
- 50-85% 1 RM (6-12 reps)
- Closer to 80% (~ 8 reps) for bone mineral increases and optimal training adaptations
  - Light resistance bands and soup cans show little benefit in comparison

When to Apply?

- Limited joint mobility
- Aging
- Onset of Peripheral Neuropathy
  - Other balance related issues
- Fall Prevention
  - Balance/ Stability concerns

How Much?

FITT Principle:
- Frequency: 2-3 days per week
- Intensity: to slight discomfort (ROM) and loss of stability
- Time: variable
- Type: static vs. dynamic
  - Involve all major muscle tendon units
    - Shoulder girdle, chest, neck, trunk, lower back, hips, legs, ankles
Performance Measures for Tracking Outcomes - Balance/Strength

- Timed up and Go test
  - Chair
  - 10 feet
- Muscle strength and mobility test
  - Monitor: ability/stability, time to finish

Performance Measures for Tracking Outcomes - Balance/Strength

- Static Tests
  - Single leg stance
    - <10 sec balance impaired
    - <5 sec fall risk
  - Tandem stance
    - <10 sec fall risk
- Monitor:
  - Stability, time

Performance Measures for Tracking Outcomes - Flexibility

- Shoulder girdle
  - Distance between hands
- Sit and Reach
  - (lower back, hips and legs)
    - Feet 12 inches apart
    - Heels placed on 15 inch mark
      - ROM needed if don’t reach the tape line

Take Home Message

- Not all Exercise Modes (or amounts) will Produce Needed Results
- All patients should be counseled on effective exercise behaviors
- Tailoring Exercise Modalities to Patient Goals and Needs Provides Appropriate and Predicted Outcomes
- Assessment can be informative, quick, easy, cheap and effective

The Educator’s Exercise Toolbox

<table>
<thead>
<tr>
<th>Strength Assessment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bands ($5-$40)</td>
</tr>
<tr>
<td>Grip dynamometer ($30)</td>
</tr>
<tr>
<td>Standard Chair (no arms)</td>
</tr>
<tr>
<td>Aerobic Assessment:</td>
</tr>
<tr>
<td>Standard Step or Chair (may also indicate strength needs)</td>
</tr>
<tr>
<td>Stopwatch/cadence</td>
</tr>
<tr>
<td>($0 (phone app) - $10)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Body Composition:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bodyweight Scale</td>
</tr>
<tr>
<td>BIA device ($30-$50)</td>
</tr>
</tbody>
</table>

General Resources:
- Technique
- FITT advice
- ADL, home exercises
- etc.
- Resources - community fitness centers

Patient Scenario 1:

Medical Profile:
- Sedentary
- Age = 74 years
- Type 2 Diabetes (5 years)
  - Metformin (1,000 mg)
- A1c = 8.5%
- BMI = 23 kg/m²
- Osteopenia of spine and femur
- Sarcopenia
- Controlled HTN (ARB), HLD (statin)
- No known micro/macrovessels concerns

Patient Goals:
- Reduce A1c
- Prevent Osteoporosis
  - Fear of falling and breaking hip
  - Improve ADL stamina

Leisure Activities:
- Gardening, cleaning house, playing with toddler grandchildren
Exercise Considerations?

Mode?
- Resistance Training
- Maybe incorporate balance training

FIT?
- 2-3 days per week
- Light to moderate (Start) progress to moderate to Vigorous
- 1-3 sets, 8-20 reps, rest or continuous between sets
- Major muscle groups
  - Specifically? Load spine and femur
  - Upper body:
    - Lower body:

Follow up?

Assessment/ Devices:
- TUG test
- Grip strength
- Resistance used vs. baseline (or # of reps produced)

Patient Scenario 2:

Medical Profile
- Age = 42
- Type 1 diabetes (35 years)
- BMI = 29 kg/m²
- Pump therapy with CGM
- A1c = 6.8%
- 3-4 hypoglycemic events/wk (<70 mg/dl)
- Cardiac autonomic neuropathy
- Mild non-proliferative retinopathy
- Exercises 1-3 days/wk
  - Combo (AT, RT) sessions

Patient Goals
- Increase exercise frequency
- Determine intensity goals to run faster for longer periods and increase upper body muscle hypertrophy
- Reduce typical hypoglycemic events post exercise

Exercise Considerations?

Mode?
- Combo with RT last
- HIIT
  - Reduce basal rates
  - Don’t exercise with bolus on board (esp. peaking)

FITT:
- Aerobic: RPE scale (due to CAN) to determine METS, speed, etc. on treadmill
- Resistance: mod-vig 6-12 reps, 3-6 sets, major muscle groups, 30-90 second rest periods
- Duration variable

Follow up?

Assessment/ Devices
- # of hypoglycemic events
- Running distance over time
- Muscle girth measures
- Body comp (BIA, skinfolds)

Patient Scenario 3:

Medical Profile
- Age = 55 years
- Type 2 diabetes (12 years)
  - Metformin, DPP4, SGLT2
  - A1c = 10.2%
- BMI = 42 kg/m²
- Sedentary
- HTN (ACEi; BB), HLD (statin; niacin), SA, GERD (PPi)
- No known micro/macrovascular concerns

Patient Goals
- Improve stamina
- Weight Loss
- A1c reduction
- BP reduction
Exercise Considerations?

Mode?
• Aerobic Training
FITT?
• 3 (minimum) – 7 days per week
• Light to moderate (Start) progress to moderate to Vigorous (if appropriate)
  – RPE, Fitbit, etc.
• 10 (minimum) to 90 minutes/ day
  – 150-300 minutes per week

Follow up?

Assessment/ Devices
• Blood work
• Bodyweight
• Quality of Life
• CRF improvements
  – Assess duration, distance, HR, BP, etc. during and post

Thank You