Type 2 Diabetes Mellitus alters the perception of Physical Effort during Exercise

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Objectives

- Recognize the importance of physical activity for people with type 2 diabetes mellitus
- Summarize how exercise effort predicts physical activity behavior
- Contrast the differences in exercise effort between sedentary and overweight people:
  - with type 2 diabetes
  - without diabetes
Why People Should be Physically Active

Performing 150 minutes of weekly physical activity improves:

• All-cause mortality
• CHD/Stroke
• Blood pressure
• Glycemic control in diabetes  
  • (↓ HbA1c by ~0.3-7%)
• Colon/Breast cancer
• Depression
• Functional health
• Falls
• Cognitive function

Boulé NG, et al., JAMA 2001
Avery L, et al., Diabetes Care, 2012
MacLeod SF, et al., Diab Metab Res Rev, 2013
People with Diabetes recall advice to be Physically Active

- Higher rates of advice from a health professional to be physically active

Morrato EH, Diabetes Care, 2006
People with Diabetes are not typically Physically Active

- Lower prevalence of regular physical activity (≥90 minutes/week)

Morrato EH, Diabetes Care, 2007
Why not move more?

- Affective barrier – Unpleasant response
  - Physical activity feels too hard
  - ↑Effort -> Unpleasant affective response
- Other barriers (beyond today’s talk)
  - Lack of social support
  - Pain during physical activity
  - Poor health

Huebschmann AG, et al., Diabetes Care, 2011
Conceptual Model: \( \uparrow \)Effort as Barrier

\( \uparrow \)Intensity -> \( \uparrow \)Effort -> Unpleasant affective response -> Avoid activity

Williams D., J Sport Exerc Psych, 2008
Colberg et al, ADA/ACSM Physical Activity Recommendations for DM, 2010
Conceptual Model: ↑Effort as Barrier

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Williams D., J Sport Exerc Psych, 2008
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Hypothesis

↑Exercise effort during low-intensity exercise in sedentary people with type 2 diabetes mellitus (DM2)
• as compared to normal weight people without DM2
• as compared to overweight people without DM2
Metric for Effort – Borg Rating of Perceived Exertion (RPE)

- RPE is the gold standard measure of exercise effort

- Subjective perception of objective physiological stimuli
  - Plasma Lactate levels
  - Heart rate
  - Cardiorespiratory fitness (Peak Oxygen Consumption (VO$_{2\text{peak}}$))

Noble BJ, Robertson RJ, Perceived Exertion, 1996
### RPE relates to Physical Activity Adherence

- **Preferred RPE range for physical activity:** 11-14

- **Lower adherence to physical activity for RPE ≥15**

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#### The Borg Scale

<table>
<thead>
<tr>
<th>RPE</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minimal exertion</td>
</tr>
<tr>
<td>2</td>
<td>Trace effort</td>
</tr>
<tr>
<td>3</td>
<td>Slight exertion</td>
</tr>
<tr>
<td>4</td>
<td>Slight to moderate</td>
</tr>
<tr>
<td>5</td>
<td>Moderate effort</td>
</tr>
<tr>
<td>6</td>
<td>Somewhat hard</td>
</tr>
<tr>
<td>7</td>
<td>Hard (heavy)</td>
</tr>
<tr>
<td>8</td>
<td>Very hard</td>
</tr>
<tr>
<td>9</td>
<td>Extremely hard</td>
</tr>
<tr>
<td>10</td>
<td>Maximal exertion</td>
</tr>
</tbody>
</table>

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Noble BJ, Robertson RJ, Perceived Exertion, 1996
Dishman, Med Sci Sports Ex, 1994
Affective Barrier to Activity in DM2: Higher RPE During Exercise

* $P < 0.05$

Huebschmann et al., APNM, 2009
Affective Barrier to activity in DM2: Higher RPE During Exercise

Huebschmann et al., APNM, 2009
Next step – measuring effort objectively

Hypothesis:

↑Plasma lactate levels during low-intensity exercise in DM2 than nondiabetic people

• 30 Watts
• Exercise intensity adjusted to individual fitness level
Affective Barrier to Activity in DM2: Worse Lactate Levels During Exercise

Figure 2c. Lactate concentrations

- Rest
- 30W
- 35% VO2 peak

Huebschmann et al., BMJ Open Diabetes Research and Care, 2015
Affective Barrier to Activity in DM2: Worse Lactate levels During Exercise

↑ Intensity of Exercise in Type 2 Diabetes Mellitus

Huebschmann et al., BMJ Open Diabetes Research and Care, 2015
Summary

- ↑Effort during Exercise - barrier to physical activity in DM2
  - Counseling strategies may mitigate this barrier
    - Recommending enjoyable activities
    - Self-pacing intensity by effort rather than heart rate
  - Other behavioral strategies and interventions warrant investigation
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  • Irene Schauer, MD, PhD

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Questions?
Conceptual Model of RPE in Type 2 Diabetes

**↑Objective RPE predictors**
- ↓VO$_2$peak
- ↑Tau$_2$
- ↑Lactate
- ↑Heart Rate

**↑Dysmetabolic environment**
- ↑Insulin Resistance
- ↑Hemoglobin A1c
- Hypertension
- ↑BP during exercise
- ↑Arterial Stiffness

**Behavioral RPE predictors**
- ↑Depressive symptoms
- ↑Self-efficacy

**↑Rating of Perceived Exertion (RPE)**

**↓Physical Activity**

**↑Disability**
- ↑CV Morbidity
- ↑CV Mortality
Lactate increased in T2D vs. control pre-menopausal women

<table>
<thead>
<tr>
<th>Workrate</th>
<th>Normal Weight Control</th>
<th>Overweight control</th>
<th>Type 2 Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Watts</td>
<td>0.45 ± 0.19</td>
<td>0.69 ± 0.45</td>
<td>1.09 ± 0.68*</td>
</tr>
<tr>
<td>30 Watts</td>
<td>0.50 ± 0.21</td>
<td>0.84 ± 0.39</td>
<td>1.96 ±1.82†</td>
</tr>
<tr>
<td>80 Watts</td>
<td>1.88 ± 1.10</td>
<td>2.08 ± 1.31</td>
<td>4.56 ± 1.98</td>
</tr>
</tbody>
</table>

Reproduced from Regensteiner et al., 1998\textsuperscript{34}; Values are mean ± SD; *P<0.05 difference between T2D and normal weight controls; †P<0.05 difference between T2D and both control groups
What are the key ingredients for behavioral interventions?

High-impact moderators of effective interventions

- Accountability:
  - Behavior log - pedometer or other tracking
  - Intervention staff review behavior log periodically

- Goal setting: outcome/behavior

- Barrier identification/problem-solving

- Planning social support

Avery L., et al., Diabetes Care, 2012
Online resources

- American Diabetes Association
  - Describes benefits of physical activity for people with diabetes

- Physical activity guidelines for Americans
  - Information and case examples on how to reach guidelines
  - Stratified by children, adults, and older adults
  - Recommendations may still appear too intense for very sedentary individuals

- Exercise Is Medicine
  - Handouts on how patients should start an exercise program
  - Exercise prescription forms
  - [http://exerciseismedicine.org/documents/StartingExProgram.pdf](http://exerciseismedicine.org/documents/StartingExProgram.pdf)
Benefits of “moving more”

• Calories burned by walking periodically through 8-hour day:
  • 2 minutes/hour = 16 minutes = 49 kcal
  • 5 minutes/hour = 40 minutes = 132 kcal
• Glycemic benefits of 2-minute walking breaks every 20 minutes
  • Lowers postprandial glucose by ~20%
• Glycemic benefits of stationary biking x 60 minutes in a day
  • Lowered hyperglycemia by 50% over next 24 hours

Impact of Type 2 Diabetes (T2D) in the United States

- Prevalence: 29.1 million people in 2014

- Cardiovascular disease risk equivalent

- Linked with ↑ rates of disability and institutionalization

- Annual medical costs in 2012: $176 billion – over 2 times higher than for patients without T2D

Diabetes Fact Sheet, Centers for Disease Control and Prevention, 2014
Pros of Physical activity

- Personally experiencing an effect of activity
  - Short-term health benefits
    - T2D-specific: improved blood glucose or BP
    - Other: better mood and sleep
  - Long-term health benefits for T2D
    - Avoid additional medications
    - Avoid CV disease
    - Avoid complications of diabetes
- Social support to be active

Health concerns are Major Barriers to Physical Activity in T2D

- Fear of injury
  - Among sedentary adults, reported by 61% with DM vs. 44% without DM

- Pain during exercise
  - Major barrier for people with T2D due to osteoarthritis and neuropathy
  - Non-weight bearing activity or shorter bouts of activity are possible solutions

Huebschmann AG, et al., Diabetes Care, 2011