Physical Activity & Sedentary Behaviour in Relation to Type 2 Diabetes – New Insights and Current Perspectives

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Outline

• Part 1: Importance of regular physical activity in the management of people with T2DM
  – Metabolic benefits, role of resistance exercise

• Part 2: Sedentary behaviour research – an emerging area of public health
  – Paradigm shift, current evidence, implications
Acknowledgements

• Prof Neville Owen – Uni. of Queensland
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• A/Prof Marc Hamilton – Uni. of Missouri
A sign of the times?
Type 2 diabetes

- Pancreas: Impaired Insulin secretion
- Liver: Increased glucose production
- Muscle: Decreased glucose uptake
- Insulin resistance

Hyperglycaemia
Currently 1,500,000 Australians have type 2 diabetes
Major Goals of Therapy – Type 2 DM

• Reduce hyperglycaemia

• Reduce body fat

• Control heart disease risk factors (eg: lipids, blood pressure)
Physical Activity

“Any bodily movement produced by skeletal muscle that results in energy expenditure”

• **Exercise**: “planned, structured and repetitive bodily movement done to improve or maintain one or more components of physical fitness/health”
REGULAR PHYSICAL ACTIVITY

✓ Reduces risk of heart disease
✓ Improves blood fats
✓ Lowers risk of high BP
✓ Reduces risk of Type 2 diabetes
✓ Reduces risk of colon cancer
✓ Helps achieve/maintain healthy weight
✓ Reduces depression & anxiety
✓ Promotes psychological well-being
✓ Builds/maintains healthy bones, muscles & joints
✓ Helps maintain independence in older adults
Acute Exercise: Enhanced Insulin Action
Muscle Glucose Uptake – 3 Key Processes

- Delivery of glucose from the blood to the muscle
- Transport of glucose across the muscle membrane
- Phosphorylation of glucose within the muscle

Source: Sigal R et al. 2004 Diabetes Care
Major Types of Exercise

**Aerobic Exercise**

Rhythmic, repeated, and continuous movements of the same large muscle groups for at least 10 mins¹

**Resistance Exercise**

Activities that use muscle strength to move a weight or work against a resistive load¹

¹Sigal R et al. 2004 *Diabetes Care*
## Major Types of Exercise – Unique Health Benefits

<table>
<thead>
<tr>
<th></th>
<th>Aerobic Exercise</th>
<th>Resistance Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone mineral density</td>
<td>↑</td>
<td>↑↑↑</td>
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<tr>
<td>Body composition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat mass</td>
<td>↓↓</td>
<td></td>
</tr>
<tr>
<td>Muscle mass</td>
<td>↔</td>
<td>↑↑↑</td>
</tr>
<tr>
<td>Strength</td>
<td>↔</td>
<td>↑↑↑</td>
</tr>
<tr>
<td>Glucose metabolism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulin response to glucose challenge</td>
<td>↓↓</td>
<td>↓↓</td>
</tr>
<tr>
<td>Basal insulin levels</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Insulin sensitivity</td>
<td>↑↑</td>
<td>↑↑</td>
</tr>
<tr>
<td>Serum lipids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-density lipoprotein cholesterol</td>
<td>↑↔</td>
<td>↑↔</td>
</tr>
<tr>
<td>Low-density lipoprotein cholesterol</td>
<td>↓↔</td>
<td>↓↔</td>
</tr>
<tr>
<td>Resting heart rate</td>
<td>↓↓</td>
<td>↔</td>
</tr>
<tr>
<td>Blood pressure at rest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic</td>
<td>↓</td>
<td></td>
</tr>
<tr>
<td>Diastolic</td>
<td>↓</td>
<td></td>
</tr>
<tr>
<td>Physical endurance</td>
<td>↓↓↓</td>
<td>↓</td>
</tr>
<tr>
<td>Basal metabolism</td>
<td>↑↑↑</td>
<td>↑↑</td>
</tr>
</tbody>
</table>

↑ indicates increased; decreased; ↔ negligible effect

Glucose Disposal Sites

Source: De Fronzo *Diabetes* 37: 667-687, 1988
Rationale for Strength Training

• Advancing Age
  • Reduced muscle mass/quality (sarcopenia)
  • Prevalence of impaired glucose tolerance/type 2

Muscle Mass

Type 2 Diabetes


Dunstan et al. Diabetes Care 2002
Rationale for Strength Training – T2DM

• Advancing Age
  • Reduced muscle mass/quality (sarcopenia)
  • Prevalence of impaired glucose tolerance/type 2

• Co-morbidities
  • Obesity
  • Complications

• Functional decline
  • Accelerated strength decline\textsuperscript{1}
  • Increased risk – functional limitations\textsuperscript{2}

\textsuperscript{1}Park et al. (2007) Diabetes Care 30:1507-1512
\textsuperscript{2}De Rekeneire et al. (2003) Diabetes Care 26: 3257-3263
## Resistance Training in T2DM - RCTs

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Study Length</th>
<th>Intensity</th>
<th>Sets/Reps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tessier et al. (2000)</td>
<td>39</td>
<td>3/wk – 20 wks</td>
<td>Moderate</td>
<td>2/10</td>
</tr>
<tr>
<td>Maiorana et al. (2002)</td>
<td>16</td>
<td>3/wk - 8 wks</td>
<td>Moderate</td>
<td>3/15</td>
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<tr>
<td>Baldi et al. (2003)</td>
<td>18</td>
<td>3/wk - 10 wks</td>
<td>Moderate</td>
<td>2/12</td>
</tr>
<tr>
<td>Brandon et al. (2003)</td>
<td>31</td>
<td>2-3/wk - 104 wks</td>
<td>Moderate</td>
<td>3/8-12</td>
</tr>
<tr>
<td>Sigal et al. (2007)</td>
<td>127</td>
<td>3/wk - 22 wks</td>
<td>Mod/High</td>
<td>3/8-12</td>
</tr>
</tbody>
</table>
High-intensity resistance training improves glycaemic control in older patients with type 2 diabetes


<table>
<thead>
<tr>
<th>Setting:</th>
<th>Clinical</th>
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<tbody>
<tr>
<td>Duration:</td>
<td>24 weeks</td>
</tr>
<tr>
<td>Frequency:</td>
<td>3 x per week</td>
</tr>
<tr>
<td>Groups:</td>
<td>RT &amp; WL (16) vs WL (13)</td>
</tr>
<tr>
<td>Progressive Resistance Training:</td>
<td>8-10 exercises; free-weights/machines 3 sets, 8-10 reps; 75-85% of 1RM 88% adherence</td>
</tr>
</tbody>
</table>
Resistance Training Improves Glycemic Control in Older Adults with T2DM

# Changes in Blood Glucose Control with RT

<table>
<thead>
<tr>
<th>Source</th>
<th>Intensity</th>
<th>Change in HbA$_{1c}$ from baseline vs Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunstan et al. (1998)</td>
<td>Moderate</td>
<td>No change</td>
</tr>
<tr>
<td>Tessier et al. (2000)</td>
<td>Moderate</td>
<td>No change</td>
</tr>
<tr>
<td>Maiorana et al. (2002)</td>
<td>Moderate</td>
<td>-0.6%</td>
</tr>
<tr>
<td>Baldi et al. (2003)</td>
<td>Moderate</td>
<td>No change</td>
</tr>
<tr>
<td>Brandon et al. (2003)</td>
<td>Moderate</td>
<td>Not reported</td>
</tr>
<tr>
<td>Sigal et al. (2007)</td>
<td>Mod/High</td>
<td>-0.4%</td>
</tr>
<tr>
<td>Dunstan et al. (2002)</td>
<td>Mod/High</td>
<td>-0.8%</td>
</tr>
<tr>
<td>Castaneda et al. (2002)</td>
<td>Mod/High</td>
<td>-1.0%</td>
</tr>
</tbody>
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**Aerobic**
- 150 min/week moderate intensity &/or 90 min/wk vigorous intensity activity
- Larger volumes of exercise 7h/wk for long-term weight loss

**Resistance**
- 3 times per week
- All major muscle groups
- Progressing to 3 sets of 8-10 reps at a weight that cannot be lifted more than >8-10 times (8-10RM)
Lift for Life®

• Evidence-based national strength training program for people with or at risk of developing type 2 diabetes

www.liftforlife.com.au
Coming Soon: The Healthy Lifestyle Research Centre @ Baker IDI Heart and Diabetes Institute

- Epidemiology Research: Identify health issues
- Biomedical/Clinical Physiology Research: Test and/or Refine Interventions
- Behavioural Research: Apply Interventions
- Translational Research: Evaluate for effectiveness
- Applied Research
  - Fundamental Research
    - Underpinning Research Platforms
      - NUTRITION
      - PHYSICAL ACTIVITY

- Influence Health Policy
- Nutrition and exercise programs and guidelines
- OH&S workplace legislation
- Implementation of programs
- Increased community awareness eg leverage press and other outlets

Baker IDI
HEART & DIABETES INSTITUTE
But there is more to the story than just exercise............

Global Corporate Challenge
Active = ≥150mins moderate-intensity activity / wk
Inactive = 0-149 mins moderate-intensity activity / wk
How times have changed

Then

Transport

Work

Domestic

Now
Sedentary behaviour: what is it?

Sitting (or lying down), involving < 2 MET (metabolic equivalent)

**Sedentary**
- 1.0: Sitting quietly (TV viewing)
- 1.5: Sitting (talking)
- 1.8: Sitting (desk work)
- 2.0: Standing
- 2.5: Slow walking
- 3.0: Moderate
- 3.8: Brisk walking
- 4.0: Public Health Physical Activity Guidelines: time spent in moderate-vigorous activity

Physical Activity

Sedentary Behaviour
Physically Inactive ‘Sedentary Lifestyle’

Too little moderate-intensity physical activity (< 150 mins per week)

Sedentary Behavior¹,² ‘Sedentary Time’

Sitting too much

Our modern ‘sitting orientated’ society

- **Awake 7 am**
  - Breakfast 15 mins
  - Transport to work 45 mins

- **Sleep 11 pm**
  - Watch TV 4 hrs

- **Transport From work 45 mins**
  - Lunch 30 mins
  - Work on computer 3.5 hrs

- **Evening meal 30 mins**
  - Work on computer 4 hrs
  - Evening meal 30 mins

- **Walk – 30 min**

**Sitting Opportunities 15.5 hrs**
Sitting induces muscular inactivity

Measuring sedentary time

**Accelerometers**

- Small, lightweight, unobtrusive
- Record the time, duration, frequency, & **intensity** of walking or running movements
How Australian adults’ overall daily behaviour patterns are distributed between physically-active and sedentary time

- **Sedentary time**: 9.3 hrs/day (60%)
- **Light-intensity**: 6.5 hrs/day (35%)
- **Moderate-vigorous activities**: 0.7 hrs/day (5%)

Mean mod-to-vigorous time = 31 mins/day
% Waking hours spent in Sedentary = 71%
Ground-Breaking Findings

• Sedentary time – associated with risk factors for CVD and type 2 diabetes (independent of physical activity levels)\(^2\)

Healy GN, Dunstan DW et al. *Diabetes Care* 2008; 31: 369-371
Ground-Breaking Findings

• ‘Breaking-up’ sedentary time (frequent transitions from sitting to standing) has beneficial associations with health outcomes (independent of sedentary time)

Healy GN, Dunstan DW et al. Diabetes Care 2008; 31: 661-666
Stand Up Australia
Sedentary behaviour in workers
August 2009

- Research into office-based, call centre and retail employee behaviours revealed that 77 percent of the working day is spent sitting.
- Individuals who spend high amounts of time sitting at work also tend to spend high amounts of time sitting on non-work days.
- Participants in the study perceived they had much higher levels of physical activity than they did when measured objectively.
- Prolonged sitting time in the workplace is an adverse health risk.

Moving to Clinical/Experimental Studies

Project Grant: 2009-2011

“Understanding the acute and cumulative metabolic effects of prolonged sitting in adults”

‘The IDLE Breaks study’
IDLE Breaks: Contacts

- Miriam Clayfield – Baker IDI (Tel: 9076 2948)

<table>
<thead>
<tr>
<th>INCLUSION</th>
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<tbody>
<tr>
<td>Age: 45-65 years</td>
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<tr>
<td>Overweight/obese: BMI &gt; 25 ≤ 45 kg/m²</td>
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</table>

http://www.bakeridi.edu.au/sedentary_behaviour_heart_disease_risk/
Reducing sitting time during the workday

- Stand whilst on the telephone
- ‘Standing’ progress meetings
- Walking progress meetings
- Incorporate breaks into prolonged meetings
- Support standing and movement during meetings
- ‘Standing’ hot desks
- Stand up and move around during TV commercial breaks
Walking (standing) the talk.....
Is this where we are heading??
Take Home Message
Reducing and/or breaking up sitting time must now be seen as a public health priority

This is in addition (and not an alternative) to engaging in regular aerobic and strength-developing physical activities