Sedentary behaviour and adult health
Physical activity and health in the 1950’s

- Jerry Morris – compared heart attack incidence & severity in drivers vs conductors

Harvard Alumni Study

- 16,936 men who entered Harvard University between 1916-1950
- Questionnaires: specific physician diagnosed disease; socio-demographic characteristics including physical activity

1962/66 Baseline  ➔  1977 Follow-up 1  ➔  1985 Follow-up 2
Physical activity measures

- Flights of stairs climbed
  (1 flight = 70 stairs = 28 kcal)
- City blocks walked
  (6 blocks = 0.5 miles = 50 kcal)
- Type and amount of sport
  (light 5 kcal/min; vigorous 10 kcal/min; mixed 7.5 kcal/min)
- Physical activity index computed as an indicator of energy expenditure
Harvard alumni: physical activity and all-cause mortality

A relatively small increase in energy expenditure (equivalent to approx 30 minutes of walking per day) is associated with >30% reduced risk of early death

Prevention of diabetes

- Physical activity is protective against type 2 diabetes in the general population with a reduction in risk of 10-40%
- This is observed in men and women, across the BMI range and across ethnic groups
- Current physical activity guidelines are appropriate for prevention of type 2 diabetes

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Evidence</th>
</tr>
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<tbody>
<tr>
<td>Over a week, activity should add up to at least 150 minutes (2½ hours) of moderate intensity activity.</td>
<td>Strong</td>
</tr>
<tr>
<td>Comparable benefits can be achieved through 75 minutes of vigorous intensity activity spread across the week or a combination of moderate and vigorous intensity activity.</td>
<td>Strong</td>
</tr>
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</table>

Start Active, Stay Active (2011)
Moderate physical activity and prevention of chronic disease

Moderate physical activity reduces risk of

- Heart attack
- Stroke
- Type 2 diabetes
- High blood pressure
- Colon & breast cancer
- Depression
- Cognitive decline
The new science of sedentary behaviour

- Research over the past 30 years or so has focused on establishing the association between MVPA and health.
- Sedentary behaviours (e.g. sitting in a car, watching TV, using the computer) are ubiquitous.
- Sedentary behaviour research has taken off in the last decade - only in 2010 was sedentary behaviour recognised as a medical subject heading.
- The distinction between being sedentary and inactive has largely been overlooked.
What is sedentary behaviour?

• Sedentary: any waking sitting or lying behaviour with low energy expenditure (≤1.5 METs)

• Inactivity: failure to be sufficiently active (e.g. not meeting the recommended 30 minutes per day of MVPA), rather than the absence of movement

• 1 MET = resting energy expenditure = 3.5ml/min/kg O₂ consumption = 1kcal/kg/hr
Sedentary behaviour

• Up to 60% of adult waking time is spent in sedentary behaviours
• MVPA and markers of sedentary behaviour, such as TV viewing, are poorly correlated (r<0.03)
• Sedentary behaviour is strongly inversely associated with time spent in light physical activity such as standing
Measurement of sedentary behaviour/time

- Subjective
  - Questionnaires most commonly used (cf log, direct observation)
  - TV viewing time most common, then leisure time sitting
  - Majority self-report (cf personal/telephone interview)
  - Recall periods of 12 months and 7dy most common
  - Good reliability but limited validity data

Clark et al. (2009) Obesity Reviews 10, 7-16
PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the last 7 days, how much time did you usually spend sitting on a weekday?

______ hours per day
______ minutes per day

27. During the last 7 days, how much time did you usually spend sitting on a weekend day?

______ hours per day
______ minutes per day

This is the end of the questionnaire, thank you for participating.
Measurement of sedentary behaviour/time

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- **Objective**
  - Accelerometers
  - Threshold (commonly <100cpm) used to define sedentary time
Measuring physical activity with an accelerometer (Actigraph GT3x)

- Triaxial solid state accelerometer
- Samples 30-100 times per second
- Raw data can be re-integrated to a user defined epoch – e.g. 10sec: measure over 1-2 wks
- Allows volume and patterns of activity to be assessed
  - Counts/hour
  - MVPA/SED – cut points
  - Hourly (or less) patterns
- Problem: waist worn so poor for sedentary behaviour
Sitting time and all-cause mortality

- Representative sample of 17,013 Canadians, 18-90yrs; 12 year follow up; 1,823 deaths
- Daily sitting time (5 categories) and leisure time physical activity assessed at baseline
- Progressively higher risk of mortality across higher levels of sitting time from all-causes and CVD, but not cancer

Katzmarzyk (2009) MSSE 41: 998-1005
Sedentary time and diabetes, CVD and death (Meta analysis)

- Cross-sectional or prospective design, adults (≥18 years), self reported or objective measures of time spent sedentary
- 18 relevant studies: range of countries, age 38-63 years, men (2), women (3) the rest mixed, all used a self report measure of sedentary behaviour
- Compared least vs most sedentary
- Associating were largely independent of physical activity

Objectively measured sedentary time and metabolic health

- Cross sectional studies show sedentary time is deleteriously associated with metabolic markers including waist circumference, blood glucose, insulin (OGTT, HOMA) and triglycerides, and generally these associations were independent of MVPA.

- Further, data suggest that people who break their sedentary time more (by getting up) have a better metabolic profile than those who spend their sedentary time largely uninterrupted. Association with breaks was independent of both total sedentary time and MVPA.
Objectively measured breaks in sedentary time

Healy et al. (2008) Diabetes Care. 31(4), 661-666
What is the mechanism?

Sedentary physiology

- Enforced immobility in rats leads to reduction in postural muscle lipoprotein lipase activity
- Reduced LPL has been associated with reduced plasma HDL-C levels and CVD
- MVPA has little effect on LPL activity
- In diabetes
  - Immobility quickly leads to significant peripheral insulin resistance
  - Interrupting prolonged sitting with bouts of light intensity improves glucose metabolism

Hamilton et al. (2007) Diabetes. 56(11), 2655-2667
**What is the role of sedentary behaviour in the management of T2DM?**

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<td>Persons with type 2 diabetes should undertake at least 150 min/week of moderate to vigorous aerobic exercise spread out over at least 3 days of the week</td>
<td>B</td>
</tr>
<tr>
<td>In addition to aerobic training, persons with type 2 diabetes should undertake moderate to vigorous resistance training at least 2–3 days/week</td>
<td>B</td>
</tr>
<tr>
<td>Supervised and combined aerobic and resistance training may confer additional health benefits</td>
<td>B/C</td>
</tr>
</tbody>
</table>

ADA/ACSM guidelines (2010) Diabetes Care 33: e147-167
Intervention in patients with type 2 diabetes

- 593 patients with newly diagnosed T2DM
- 3 groups:
  - Usual care
  - Diet
  - Diet + exercise
- 1 year intervention delivered in 2° care
- Home based exercise intervention
- Primary outcome: HbA1c

Participant visits in Early ACTID

Usual care (n=110)
- 6-month measurements x2
- Clinical review x1
- 10 visits

Diet only (n=320)
- 6-month measurements x2
- Clinical review + Dietician x1
- 12-month measurements x2
- Dietician + Nurse x1
- Nurse only x2
- 19 visits

Diet + exercise (n=320)
- 6-month measurements x2
- Clinical review + Dietician x1
- 12-month measurements x2
- Dietician + Nurse x1
- Nurse only x4
- 19 visits
Participants – consort diagram

Reply slip/phone
1634

Eligible screening
700

Baseline measures

Randomisation
593

N Care
99

Diet
248

Diet & Ex
246

6 month measure
587 (99%)
97
247
243

12 month measure
579 (98%)
93
246
240

596 not interested; 326 not eligible
12 declined/DNA
107 excluded
Change in physical activity & weight in Early ACTID

**MVPA**

- **T1**
- **T2**
- **T3**

**Weight**

- **T1**
- **T2**
- **T3**

Compliance: 579 (98%) of participants still in study at 12 months and 71% of visits attended
Change in HbA1c

<table>
<thead>
<tr>
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<th>6 months</th>
<th>Difference</th>
<th>P value</th>
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</thead>
<tbody>
<tr>
<td>D vs D+E</td>
<td>-0.05</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>D vs U</td>
<td>-0.28</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>D+E vs U</td>
<td>-0.33</td>
<td>&lt;0.001</td>
<td></td>
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<table>
<thead>
<tr>
<th></th>
<th>12 months</th>
<th>Difference</th>
<th>P value</th>
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<tr>
<td>D vs D+E</td>
<td>-0.08</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>D vs U</td>
<td>-0.26</td>
<td>0.005</td>
<td></td>
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What type of exercise is effective in people with diabetes?

- 23 trials of structured exercise and 24 of exercise advice
- Supervised aerobic & resistance exercise, and both combined, had a similar magnitude of effect (overall \(-0.67\%\))
- Advice alone is of limited value and should be combined with dietary intervention
- How much change is possible?

Physical activity & sedentary time in people with diabetes
Sedentary time and metabolic factors in type 2 diabetes

- Greater time sedentary associated with poorer metabolic profile independent of physical activity
- Little change in sedentary time as a result of the intervention, indicates specific interventions needed

Daily pattern of physical activity at baseline (Early ACTID)
Employment and physical activity pattern (Early ACTID)
Daily pattern of sedentary time and MVPA
Relationship between MVPA, sedentary time and metabolic risk factors (Early ACTID)

Predicted Clustered Metabolic Score
adjusted by: age, sex, drugs & weartime

P value = 0.033

-1 -.5
0
.5
1
1.5
Mean Clustered ... (LOW) 2 3 4 (HIGH)
Quintiles of Sedentary time
Below median MVPA Above median MVPA
Predicted Clustered Metabolic Score
**ActivPAL: measuring sedentary behaviour**

- Comparison with Actigraph suggests a 30-50% over estimate of sedentary time by the waist worn accelerometer.
Simultaneous behaviours - diet

- TV viewing may exert negative effects on food consumption
  - Associated with increased meal frequency, food intake and snacking (regardless of hunger)
  - 20-25% of daily energy is consumed in front of the TV
  - Watching TV increases simultaneous intake of high density, palatable foods
  - TV viewing may act as a “distractor” at meal times, inducing an increase in caloric intake

Chaput et al. (2011) Obesity Reviews 12, e12-e20
Public health – what to do?

• Understand determinants of sedentary behaviour:
  • Personal & demographic attributes
  • Biological attributes
  • Pattern of behaviours
  • Knowledge of health risks
  • Social and cultural factors which make some sedentary choices easy
  • Physical environmental factors
  • Policies, rules, regulations
Summary

• In people with diabetes exercise can improve glucose control but the “best” prescription is unclear.
• Sedentary behaviour is a novel intervention target but we know very little about the nature of sedentary behaviour, especially in people with type 2 diabetes.
• Work within the BRU will explore the potential for manipulating sedentary time: how to measure accurately (volume, pattern), other behaviours, sit/stand transitions.