Physical Inactivity & Sedentary Behaviour as CVD risk factors

Professor Marie Murphy
Chair of Exercise & Health | Dean of Postgraduate Research

mh.murphy@ulster.ac.uk  @MarieHMurphy
12 Physical Fitness and Physical Activity: Effects on Risk of Cardiovascular Disease

Professor Marie Murphy, Professor Steven N. Blair, and Bridget Benelam
• Physical Activity (PA), Exercise, Fitness and Sedentary Behaviour (SB)

• Current PA and SB guidelines

• Evidence update/magnitude of risk

• Interventions to change behaviour
Definitions

- **Physical Activity** is any bodily movement produced by skeletal muscles that requires energy expenditure and can be undertaken for personal transport work, recreation and leisure or to carry out domestic tasks.

- **Exercise** is planned, structured physical activity designed to improve or maintain one of the components of physical fitness.

- **Physical Fitness** is a measure of the cardiovascular and musculoskeletal systems ability to cope with physical activity or exercise.

- **Sedentary Behaviour** refers to any waking activity characterized by an energy expenditure \( \leq 1.5 \) metabolic equivalents and a sitting or reclining posture.
Fig. 12.1  Schematic showing relationship between physical activity, physical fitness, exercise, and cardiovascular disease (CVD) risk.
Sedentary Behaviour

Physical Activity

Sleep  Sedentary  Light  Moderate  Vigorous

1.5  3  6

METS

Waking activity characterised by an energy expenditure $\leq 1.5$ METs and a sitting or reclining posture

Sedentary Behaviour Research Network (2012)
## Exercise intensity?

<table>
<thead>
<tr>
<th></th>
<th>Low Intensity</th>
<th>Moderate Intensity</th>
<th>Vigorous</th>
</tr>
</thead>
<tbody>
<tr>
<td>% VO&lt;sub&gt;2&lt;/sub&gt; max</td>
<td>&lt;50%</td>
<td>50-65%</td>
<td>&gt;65%</td>
</tr>
<tr>
<td>% HR max</td>
<td>&lt;55%</td>
<td>55-75%</td>
<td>&gt;75%</td>
</tr>
<tr>
<td>METs</td>
<td>1.5 – 2.9</td>
<td>3 - 6</td>
<td>&gt; 6</td>
</tr>
</tbody>
</table>

‘at least moderate intensity’

‘to improve fitness’
• Physical Activity (PA), Exercise, Fitness and Sedentary Behaviour (SB)

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2011 Guidelines
How much physical activity for health benefit?

“....at least 150 minutes per week of moderate intensity activity in bouts of 10 minutes or more”

“....activity to improve muscular strength on at least 2 days a week”

“....minimise time spent sedentary for extended periods”

Department of Health (2011) Start Active, Stay Active: a report on physical activity from the four home countries' Chief Medical Officers
Physical activity for children (5-16 years)

- Benefits Health
- Improves Sleep
- Maintains Healthy Weight
- Manages Stress
- Improves Quality of Life

What should children do?

Be Physical

For a healthy heart and mind

Be Active

Vigorous
- Jog
- Run
- Cycle

Moderate
- Walk
- Swim
- Skate

Sit less

Find ways to help all children at least 60 minutes every day

UK Chief Medical Officers’ Guidelines 2011

Physical activity for pregnant women

Throughout pregnancy aim for at least 150 minutes of moderate intensity activity every week

- Helps control weight gain
- Helps reduce high blood pressure problems
- Helps to prevent diabetes of pregnancy
- Improves fitness
- Improves sleep
- Improves mood

Not active?
- Start gradually

Already active?
- Keep going

Out and about

Every activity counts, in bouts of at least 10 minutes

- Do muscle strengthening activities twice a week
- Listen to your body and adapt
- Don’t bump the bump

Home

Every activity counts, in bouts of at least 10 minutes

- Do muscle strengthening activities twice a week
- Listen to your body and adapt
- Don’t bump the bump

Leisure

Every activity counts, in bouts of at least 10 minutes

- Do muscle strengthening activities twice a week
- Listen to your body and adapt
- Don’t bump the bump

UK Chief Medical Officers’ Recommendations 2017: Physical Activity in Pregnancy. bit.ly/2rTactveinfo
2011 UK Physical activity guidelines are currently under review - updates to incorporating scientific evidence from 2010-2017

In 2018, the UK guidelines on physical activity across the life course will be reviewed and revised in line with the latest scientific evidence.
• Physical Activity (PA), Exercise, Fitness and Sedentary Behaviour (SB)

• Current PA and SB guidelines

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• Interventions to change behaviour
World Health Organisation 2004

- High blood pressure
- Tobacco use
- High blood glucose
- Physical inactivity
- Overweight and obesity
- High cholesterol
- Unsafe sex
- Alcohol use
- Childhood underweight
- Indoor smoke from solid fuels
- Unsafe water, sanitation, hygiene
- Low fruit and vegetable intake
- Suboptimal breastfeeding
- Urban outdoor air pollution
- Occupational risks
- Vitamin A deficiency
- Zinc deficiency
- Unsafe health-care injections
- Iron deficiency

Mortality in thousands (total: 58.8 million)

% of CVD Deaths and DALYs attributable to risk factors in UK

<table>
<thead>
<tr>
<th></th>
<th>% Deaths (mortality)</th>
<th>% DALYs (morbidity)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Diet</td>
<td>49.5</td>
<td>38.4</td>
</tr>
<tr>
<td>Low Physical Activity</td>
<td>10.2</td>
<td>9.0</td>
</tr>
<tr>
<td>Smoking</td>
<td>11.8</td>
<td>10.3</td>
</tr>
<tr>
<td>High Blood Pressure</td>
<td>47.5</td>
<td>45.9</td>
</tr>
<tr>
<td>High Cholesterol</td>
<td>27.6</td>
<td>25.7</td>
</tr>
<tr>
<td>High Fasting Glucose</td>
<td>15.1</td>
<td>12.5</td>
</tr>
<tr>
<td>High BMI</td>
<td>17.8</td>
<td>12.6</td>
</tr>
</tbody>
</table>

- Blood Pressure
- Blood Lipids
- Weight/BMI
- Fat distribution
- Glucose control
- Endothelial function
- Inflammation
Population attributable risk for CHD


http://researchonline.lshtm.ac.uk/id/eprint/17972
What is the nature of the relationship and the magnitude of the effect of
- Physical inactivity (insufficient PA / little or no exercise)
- Low physical fitness
- Prolonged or uninterrupted sedentary behaviour
on cardiovascular disease risk?

Evidence since 2005

Exercise and CVD - Epidemiological Evidence

Jeremy N Morris CBE
1910-2009

London Transport
Conductors vs Drivers

Ralph Paffenbarger
1922-2007

San Francisco
Longshoremen
Physical Activity & Heart Attack Risk

Heart Attack Rate/1000

Drivers
Conductors

Heart Attack Rate

<table>
<thead>
<tr>
<th>Condition</th>
<th>Drivers</th>
<th>Conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angina</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Death</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

3 mos incidence

Morris JN, (1966) Lancet ii 553-559
Physical Activity & Heart Attack Risk

San Francisco Longshoremen

Ralph Paffenbarger 1922-2007

Table 1 Relative risks (RR) and population attributable risks (PAR%) for physical inactivity in Canada, Australia, and the USA.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Canada RR</th>
<th>PAR%</th>
<th>Australia RR</th>
<th>PAR%</th>
<th>USA RR</th>
<th>PAR%</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHD</td>
<td>1.45</td>
<td>19.4</td>
<td>1.5</td>
<td>18</td>
<td>2.0</td>
<td>22</td>
</tr>
<tr>
<td>Stroke</td>
<td>1.60</td>
<td>24.3</td>
<td>2.0</td>
<td>16</td>
<td>na</td>
<td>Na</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.30</td>
<td>13.8</td>
<td>na</td>
<td>na</td>
<td>1.5</td>
<td>12</td>
</tr>
<tr>
<td>Colon Cancer</td>
<td>1.41</td>
<td>18.0</td>
<td>1.5</td>
<td>19</td>
<td>2.0</td>
<td>22</td>
</tr>
<tr>
<td>Breast Cancer</td>
<td>1.31</td>
<td>14.2</td>
<td>1.1</td>
<td>9</td>
<td>1.2</td>
<td>5</td>
</tr>
<tr>
<td>Type 2 Diabetes</td>
<td>1.50</td>
<td>21.1</td>
<td>1.3</td>
<td>13</td>
<td>1.5</td>
<td>12</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>1.59</td>
<td>24.0</td>
<td>1.4*</td>
<td>18*</td>
<td>2.0</td>
<td>18*</td>
</tr>
</tbody>
</table>

Being active reduces risk of
- CVD by 33%
- Stroke by 31%
- Hypertension by 32%

Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy

I-Min Lee, Eric J Shiroma, Felipe Lobelo, Peska Puska, Steven N Blair, Peter T Katzmarzyk, for the Lancet Physical Activity Series Working Group

Summary

Strong evidence shows that physical inactivity increases the risk of many adverse health conditions, including major non-communicable diseases such as coronary heart disease, type 2 diabetes, and breast and colon cancers, and shortens life expectancy. Because much of the world’s population is inactive, this link presents a major public health issue. We aimed to quantify the effect of physical inactivity on these major non-communicable diseases by estimating how much disease could be averted if inactive people were to become active and to estimate gain in life expectancy at the population level.

<table>
<thead>
<tr>
<th></th>
<th>Coronary heart disease</th>
<th>Type 2 diabetes</th>
<th>Breast cancer</th>
<th>Colon cancer</th>
<th>All-cause mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence of inactivity in population (%)†</td>
<td>35.2% (22.3–40.5)</td>
<td>35.2% (22.3–40.5)</td>
<td>38.8% (23.3–44.3)</td>
<td>35.2% (22.3–40.5)</td>
<td>35.2% (22.3–40.5)</td>
</tr>
<tr>
<td>Prevalence of inactivity in people eventually developing the outcome (%)‡</td>
<td>42.2% (23.0–56.2)</td>
<td>43.2% (23.6–57.6)</td>
<td>40.7% (22.5–56.7)</td>
<td>42.9% (23.4–57.1)</td>
<td>42.9% (23.4–57.1)</td>
</tr>
<tr>
<td>RR, unadjusted‡</td>
<td>1.33 (1.18–1.49)</td>
<td>1.63 (1.27–2.11)</td>
<td>1.34 (1.25–1.43)</td>
<td>1.38 (1.31–1.45)</td>
<td>1.47 (1.38–1.57)</td>
</tr>
<tr>
<td>RR, adjusted‡</td>
<td>1.16 (1.04–1.30)</td>
<td>1.20 (1.10–1.33)</td>
<td>1.33 (1.26–1.42)</td>
<td>1.32 (1.23–1.39)</td>
<td>1.28 (1.21–1.36)</td>
</tr>
<tr>
<td>PAF with unadjusted RR (%)§</td>
<td>10.4% (7.2–13.4)</td>
<td>18.1% (10.8–22.8)</td>
<td>11.6% (6.8–15.5)</td>
<td>11.8% (6.8–15.1)</td>
<td>14.2% (8.3–18.0)</td>
</tr>
<tr>
<td>PAF with adjusted RR (%)§</td>
<td>5.8% (3.2–7.8)</td>
<td>7.2% (3.9–9.6)</td>
<td>10.1% (5.6–14.1)</td>
<td>10.4% (5.7–13.8)</td>
<td>9.4% (5.1–12.5)</td>
</tr>
</tbody>
</table>
What is the relationship between physical activity and cardiovascular disease incidence?

1 systematic review 9 meta-analysis (each 12-43 studies)
CHD (n=6) , stroke (n=5) heart failure (n=3)

- Any amount of PA has greater benefit than none
- Meeting current guidelines will result in about 75 percent of the maximal benefit
- More physical activity results in greater benefit, although the incremental benefit is less;
- No evidence risk of PA 3-5 times the current guidelines.
- Insufficient evidence is available to determine whether these relationships vary by age, sex, race, ethnicity, socioeconomic status, or weight status
Health benefits accrue even for those with pre-existing conditions

Figure C-2. Risk of Cardiovascular Mortality Among People with Type 2 Diabetes by Dose of Physical Activity

Source: Adapted from data found in Sadarangani et al., 2014.22

Department of Health and Human Services (2018)
Physical Activity Guidelines Advisory Committee Scientific Report
Walking and CVD risk

Figure 1  The association between walking and cardiovascular risk in men and women. The referent group refers to the lowest walking (volume/intensity) group and hazard ratios of less than 1.0 suggest benefits of walking. MET, metabolic equivalent.

http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0089909
The effect of walking on cardiovascular risk: An updated systematic review and meta-analysis of randomised control trials

- 32 RCT conducted 1971-2012,
- Inactive participants > 18 yrs, walking intervention > 4 wks
- CVD risk factors pre- and post-intervention (or Δ) reported
- 1508 participants (30-83y); 16 F only, 3 M only, 14 both

**Intervention**
- Length: mean 18.7 weeks (range: 8–52 weeks)
- Duration: 20–60 min at 2–7 days per week

Weighted Mean Treatment Effects

Effects of frequency, intensity, duration and volume of walking interventions on CVD risk factors: a systematic review and meta-regression analysis of randomised controlled trials among inactive healthy adults

Pekka Oja, Paul Kelly, Elaine M Murtagh, Marie H Murphy, Charlie Foster, Sylvia Titze

ABSTRACT
Objective. Walking interventions in healthy populations show clinically relevant improvements for many cardiovascular disease (CVD) risk factors. We aimed to assess the changes in CVD risk factors and the dose-response relationship between frequency, intensity, duration and volume of walking and cardiovascular risk factors based on randomised controlled trials (RCTs).

What are the findings?
- Walking interventions have clinically significant effect on cardiovascular disease risk factors including body mass, body mass index, body fat, systolic and diastolic blood pressure, fasting glucose and an increase in VO₂ max.
- Even modest amounts of walking appear to provide health benefit.
- There is insufficient evidence on the exact volume and pace of walking required for benefit.

CONCLUSIONS

Walking is known to benefit health. Assuming causal relationships, these analyses suggest that increasing walking pace could be linked with lower risk for all-cause and CVD mortality. Walking pace should be emphasised in public health messages, especially in circumstances when increase in walking volume or frequency is less feasible.
Physical Fitness

Cardiorespiratory - the ability of the cardiovascular and respiratory systems to supply oxygen to skeletal muscles for use during physical activity

Musculoskeletal – the ability of muscles to produce force (muscle strength) and to repeat or sustain a contraction (muscle endurance)
Cardiorespiratory Fitness & Mortality

All-Cause Death Rates by CRF Categories – 3,120 Women and 10,224 Men followed for 8 years

Cardiorespiratory Fitness & CVD Risk

24 studies
84,323 participants and 4485 cases

Pooled RRs CHD/CVD per 1-MET higher level of CRF = 0.85 (95% CI, 0.82-0.88),

Each 1-MET higher level of mean aerobic capacity was associated with 15% decrease in CVD risk

This is comparable to
• 7 cm decrease waist circumference,
• 5 mmHg reduction in BP
• 1 mmol/L reduction in triglyceride or fasting glucose,
• 0.2-mmol/L increase in HDL cholesterol

Physical fitness and activity as separate heart disease risk factors: a meta-analysis

Paul T. Williams
Life Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720

38 Cohorts reporting
- total physical activity (30) or
- physical fitness (8)

Relative risks ranked from
- least fit/active to most fit/active across 20 categories

Figure 4.
Relative risk for CHD or CVD in 8 physical fitness (317,908 person-years of follow-up) and 30 physical activity cohorts (2,286,806 person-years of follow-up) for studies cited in, and subsequent to, the Report of the Surgeon General. [57]
What about strength training?

What about strength training?

Women's Health Study
- 35,754 women
- 10 year follow-up
- 1742 cases of CVD

Women who did strength training had 17% reduced risk of CVD (hazard ratio = 0.83, 95% confidence interval = 0.72, 0.96)

Sedentary Behaviour

Dunstan et al. 2010 Too Much Sitting and Metabolic Risk-Has Modern Technology Caught Up with Us? European Endocrinology, Vol. 6, p. 20,
Sitting Time and All-Cause Mortality

n= 53,440 men 97,776 women followed 14 years

Even if you exercise enough to meet the guidelines

Sitting Time, Physical Activity and CVD in Women

Womens Health Study n=71,018 women aged 50-79 followed 12-17 years

Sedentary Behaviour and CVD morbidity and mortality

18 studies (16 prospective, 2 cross-sectional)

High levels of SB associated with

- 147% increase in the risk of cardiovascular disease (RR 2.47; 95% CI 1.44, 4.24)

- 90% increase in the risk of cardiovascular mortality (HR 1.90; 95% CI 1.36, 2.66)
Can the health effects of sedentary behaviour be cancelled by being very active?

Review of 16 studies

- >1m participants followed between 2 and 18 years
- Self reported sitting, TV viewing and physical activity
- All cause mortality

Ekelund, Ulf et al. (2016) Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women The Lancet, Volume 388, Issue 10051, 1302 - 1310
High levels of moderate intensity physical activity (i.e., about 60–75 min per day) may eliminate the increased risk of death associated with high sitting time. (only a very small proportion of the population do this amount of PA)
• Physical Activity (PA), Exercise, Fitness and Sedentary Behaviour (SB)

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Changing PA and SB what works (moderate to strong evidence)?

- Community design
- Access to facilities
- Point of decision prompts
- Built environment for active transport
- Multicomponent
- Community-wide delivery
- Worksite intervention (SB)
- Behaviour Change Techniques
- Family/School support
- Peer-led
Take home messages

• Physical activity (meeting current UK guidelines) reduces risk of CVD by 15-35% depending on baseline PA, gender and disease endpoint

• Physical fitness, is associated with a reduced risk of CVD by similar magnitude to PA. Strong independent association for cardiorespiratory fitness, emerging evidence for association with musculoskeletal fitness.

• For both Physical Activity and Physical Fitness the greatest population benefit is derived from moving from low to moderate levels of activity and fitness

• Prolonged and/or uninterrupted sedentary behaviour increases CVD risk even in those meeting current PA guidelines. Only very high levels of physical activity attenuate this increase in risk

• PA and SB are complex behaviours. Changing these behaviours is likely to require interventions at the individual, community, environmental and policy level
Physical Inactivity & Sedentary Behaviour as CVD risk factors

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mh.murphy@ulster.ac.uk  @MarieHMurphy