Physical activity, cognitive function and decline in an ageing population

British Nutrition Foundation
Physical Activity Conference
October 2011
London

Professor Ken Fox
Exercise, Nutrition and Health Sciences
Physical activity and health outcomes:  
Chief Medical Officer’s Report  
At least 5 a week (2004)  

www.dh.gov.uk/publications

<table>
<thead>
<tr>
<th></th>
<th>PREVENTION</th>
<th></th>
<th>THERAPY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Evidence</td>
<td>Effect</td>
<td>Evidence</td>
<td>Effect</td>
</tr>
<tr>
<td>CHD</td>
<td>High</td>
<td>Strong</td>
<td>Medium</td>
<td>Moderate</td>
</tr>
<tr>
<td>Stroke</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
<td>Weak</td>
</tr>
<tr>
<td>Obesity</td>
<td>Medium</td>
<td>Moderate</td>
<td>Medium</td>
<td>Moderate</td>
</tr>
<tr>
<td>Cancer</td>
<td>Medium</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Diabetes</td>
<td>High</td>
<td>Strong</td>
<td>Medium</td>
<td>Weak</td>
</tr>
<tr>
<td>Musculo-skeletal</td>
<td>Medium</td>
<td>Moderate</td>
<td>Medium</td>
<td>Moderate</td>
</tr>
<tr>
<td>Mental health</td>
<td>Medium</td>
<td>Moderate</td>
<td>Medium</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
Public health relevance

• Prevalence of suffering
  – % of population

• Burden of suffering
  – Mortality and morbidity
  – Economic costs – health care, work productivity
  – Human costs – QoL, carers,

• Potential for reduction
  – Cost-effectiveness
  – Feasibility
### Disease burden measured in Disability-Adjusted Life Years (DALYS)

**Estimate 1990**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cause</th>
<th>% total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lower respiratory infections</td>
<td>8.2</td>
</tr>
<tr>
<td>2</td>
<td>Diarrhoeal diseases</td>
<td>7.2</td>
</tr>
<tr>
<td>3</td>
<td>Perinatal conditions</td>
<td>6.7</td>
</tr>
<tr>
<td>4</td>
<td>Unipolar major depression</td>
<td>3.7</td>
</tr>
<tr>
<td>5</td>
<td>Ischaemic heart disease</td>
<td>3.4</td>
</tr>
<tr>
<td>6</td>
<td>Cerebrovascular disease</td>
<td>2.8</td>
</tr>
<tr>
<td>7</td>
<td>Tuberculosis</td>
<td>2.8</td>
</tr>
<tr>
<td>8</td>
<td>Measles</td>
<td>2.7</td>
</tr>
<tr>
<td>9</td>
<td>Road traffic accidents</td>
<td>2.5</td>
</tr>
<tr>
<td>10</td>
<td>Congenital abnormalities</td>
<td>2.4</td>
</tr>
</tbody>
</table>

**Projection 2020**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cause</th>
<th>% total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ischaemic heart disease</td>
<td>5.9</td>
</tr>
<tr>
<td>2</td>
<td>Unipolar major depression</td>
<td>5.7</td>
</tr>
<tr>
<td>3</td>
<td>Road traffic accidents</td>
<td>5.1</td>
</tr>
<tr>
<td>4</td>
<td>Cerebrovascular disease</td>
<td>4.4</td>
</tr>
<tr>
<td>5</td>
<td>Chronic obs pulmonary disease</td>
<td>4.2</td>
</tr>
<tr>
<td>6</td>
<td>Lower respiratory infections</td>
<td>3.1</td>
</tr>
<tr>
<td>7</td>
<td>Tuberculosis</td>
<td>3.0</td>
</tr>
<tr>
<td>8</td>
<td>War</td>
<td>3.0</td>
</tr>
<tr>
<td>9</td>
<td>Diarrhoeal diseases</td>
<td>2.7</td>
</tr>
<tr>
<td>10</td>
<td>HIV</td>
<td>2.6</td>
</tr>
</tbody>
</table>

*In females and developing countries, unipolar major depression is projected as becoming the leading cause of disease burden.*

Common mental problems presenting in primary health care

- Depression
- Anxiety
- Alcohol and drug use disorders
- Sleep problems
- Chronic tiredness
- Unexplained somatic complaints
  - aches, pains, nausea, digestion, rashes etc.
- Schizophrenia, bipolar and obsessive disorders
Mental illness and disorders in the UK: Prevalence

- 1 in 4 adults will suffer a mental health problem sometime in a year (ONS, 2001)

- 5% of over 65s and 20% of over 80s have dementia (NICE, 2004)

- Prevalence of depression (8-12%) greater than CHD (4-7%) or diabetes (3-4%) (BHF, 2002)
Mental illness and disorders in the UK: Economic costs

- 23% of primary care consultations concern mental illness (ONS, 2005)
- 17% of health care expenditure (Henderson et al., 2005)
- Main reason for 40% of sick notes but estimated productivity loss is 1.5 x loss due to absenteeism (Black 2008).
Why focus on older adults?
A rapidly ageing population

[ Source: Office for National Statistics UK ]
Common health problems of older age

- Loss of strength and physical function
- CHD and stroke
- Obesity and diabetes
- Arthritis
- Falls
- Cognitive decline, dementia, and Alzheimer’s disease
- Depression, isolation, and loneliness
Percentage of adults meeting the physical activity recommendations – questionnaire estimates. The Health Survey for England 2008
Ageing and the decline spiral?

1. Sedentary and low activity habits
2. Decline in physical and cognitive function
3. Increasing isolation and loss of independence
4. Accelerated biological ageing / subclinical disease
5. Chronic disease development
6. Premature death / poor quality of life / huge health care bills
Mental health

- Physical Disease Risk
  - Prevention
  - Treatment/Therapy
- Mental Illness
- Cognitive Function
- Mental Well-Being
Does physical activity help prevent mental illness in older adults?
Physical activity and prevention of depression

- 20 prospective cohort studies showing positive effect
  - Farmer et al. (1988) 1500 women and recreational activity 8 yrs
  - Camacho et al. (1991) 8000 adults 9-18 yrs
  - Paffenbarger et al. (1994) 10,000 men, 25 yrs.
  - Lampinen et al. (2000) 663 adults 65+, 8 yrs
  - Motl et al. (2004) 4600 adolescents, 2 yrs
  - Fukukawa et al. (2004) 1151 adults 65-80, 2 yrs
  - Bernaards et al. (2006) 1750 workers, 3 yrs
  - Ball et al. (2008) 6600 females, 3 yrs
  - Wise et al. (2006) 37000 black females, 4 yrs
  - Mobily (1996) 2000 older, 3 yrs
  - Strawbridge et al. (2002) 2000 older, 6 yrs
  - Van Gool (2003) 1300 mid-old, 6 yrs
  - Ku & Fox (2009) 1500 older adults, 7 yrs

  ---

  Finland
  Japan
  Netherlands
  Australia
  Netherlands
  Taiwan
Exercise and depression: prevention

Camacho et al. 1991 18-year follow-up: relative risk of clinical depression

Hi-Hi  Lo-Hi  Hi-Lo  Lo-Lo
1.11  1.22  1.61  1.8

Relative risk of subsequent depression
Cognitive decline

Cognitive impairment is the advanced deterioration of memory, attention, language, problem solving, and time and spacial orientation.

Dementia is “chronic deterioration of intellectual function and other cognitive skills severe enough to interfere with the ability to perform activities of daily living”

Alzheimers is the most common form of dementia and involves excessive senile plaques and neuronal atrophy.
Physical activity is associated with lower risk of premature cognitive decline, dementia and Alzheimer’s disease: Systematic review and meta-regression analysis
Kenneth R Fox, Neha Khandpur, Rod Taylor (in preparation)

• 42 cohort studies show a reduced risk of either cognitive impairment, dementia or Alzheimer’s or some combination
• Reduced risk is in the region of 25-30% (more in some cases).
• Similar effects for men and women
• Effect remains when controlling for physical function and health difficulties
• No evidence of a dose response effect
Physical activity and risk of dementia

- Andel (2008)
- Carlson (2008) Male
- Fabrigoule (1995)
- Hebert (2000) Male
- Hebert (2000) Female
- Larson (2006)
- Laurin (2001) Male
- Laurin (2001) Female
- Podevilis (2005)
- Ravaglia (2008)
- Rovio (2005)
- Simons (2006) Female
- Yoshitake (1995)
- Combined

risk ratio
Physical activity and risk of Alzheimer’s

<table>
<thead>
<tr>
<th>Study ID</th>
<th>Physical Activity Level</th>
<th>95% CI</th>
<th>Risk Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbot &lt;0.25 mile/d</td>
<td>Light PA</td>
<td>0.45 (0.21, 0.94)</td>
<td></td>
</tr>
<tr>
<td>Abbot 0.25-1.0 mile/d</td>
<td>Moderate PA</td>
<td>0.54 (0.26, 1.10)</td>
<td></td>
</tr>
<tr>
<td>Abbot &gt;1-2.0 mile/d</td>
<td>Hard PA</td>
<td>0.54 (0.25, 1.10)</td>
<td></td>
</tr>
<tr>
<td>Andel liight PA</td>
<td>Light PA</td>
<td>0.64 (0.41, 1.00)</td>
<td></td>
</tr>
<tr>
<td>Andel moderate PA</td>
<td>Moderate PA</td>
<td>0.34 (0.14, 0.86)</td>
<td></td>
</tr>
<tr>
<td>Andel hard PA</td>
<td>Hard PA</td>
<td>0.65 (0.33, 1.29)</td>
<td></td>
</tr>
<tr>
<td>Laurin low PA</td>
<td>Light PA</td>
<td>0.67 (0.39, 1.14)</td>
<td></td>
</tr>
<tr>
<td>Laurin medium PA</td>
<td>Moderate PA</td>
<td>0.67 (0.46, 0.98)</td>
<td></td>
</tr>
<tr>
<td>Laurin high PA male</td>
<td>Hard PA</td>
<td>0.50 (0.28, 0.90)</td>
<td></td>
</tr>
<tr>
<td>Podewilis 248-742 kcal/d</td>
<td>Light PA</td>
<td>1.07 (0.73, 1.57)</td>
<td></td>
</tr>
<tr>
<td>Podewilis 743-1657 kcal/d</td>
<td>Moderate PA</td>
<td>0.92 (0.62, 1.39)</td>
<td></td>
</tr>
<tr>
<td>Podewilis &gt;1657 kcal/d</td>
<td>Hard PA</td>
<td>0.70 (0.44, 1.13)</td>
<td></td>
</tr>
<tr>
<td>Ravaglia 4774-8090 kcal/w</td>
<td>Light PA</td>
<td>0.70 (0.33, 1.49)</td>
<td></td>
</tr>
<tr>
<td>Ravaglia &gt; 8090 kcal/w</td>
<td>Moderate PA</td>
<td>0.95 (0.50, 1.80)</td>
<td></td>
</tr>
<tr>
<td>Taaffe low RF Moderate PA</td>
<td>Light PA</td>
<td>0.57 (0.23, 1.42)</td>
<td></td>
</tr>
<tr>
<td>Taaffe low RF High PA</td>
<td>Moderate PA</td>
<td>0.43 (0.17, 1.09)</td>
<td></td>
</tr>
<tr>
<td>Taaffe Moderate RF Moderate PA</td>
<td>Hard PA</td>
<td>1.03 (0.40, 2.63)</td>
<td></td>
</tr>
<tr>
<td>Taaffe Moderate RF High PA</td>
<td>Moderate PA</td>
<td>0.56 (0.17, 1.86)</td>
<td></td>
</tr>
<tr>
<td>Taaffe High RF Moderate PA</td>
<td>Hard PA</td>
<td>0.56 (0.17, 1.86)</td>
<td></td>
</tr>
<tr>
<td>Taaffe Moderate RF High PA</td>
<td>Moderate PA</td>
<td>1.57 (0.61, 4.00)</td>
<td></td>
</tr>
</tbody>
</table>
Physical activity and the prevention of cognitive disorders in older adults

A study of 18,000 women showed those who did more exercise scored better on mental agility tests in later life (Weuve et al., JAMA, 2004)

A study of over 2,000 men over 71 found those who walked least had almost twice the risk of developing dementia than those who walked the most (Abbott et al., JAMA, 2004)

Exercising more than 30 mins twice a week during 40s and 50s reduces risk of subsequent dementia and Alzheimers by 50% (Rovio et al., Lancet, 2005)
Risk factors for Alzheimer’s

- Type 2 diabetes
- Midlife hypertension
- Midlife obesity
- Depression
- Smoking
- Cognitive inactivity
- Physical inactivity
Preventable cases of Alzheimer’s given 10% or 25% change in key risk factors

From Barnes and Yaffe, Lancet Neurology Sept, 2011
Cognitive function

Physical activity and enhanced fitness to improve cognitive function in older people without known cognitive impairment. Cochrane Systematic review (Angevaren et al, 2008)

- “Eight out of 11 studies reported that aerobic exercise interventions resulted in increased cardiorespiratory fitness of the intervention group of approximately 14% and this improvement coincided with improvements in cognitive capacity.
- The largest effects were found on motor function, auditory attention and delayed memory functions (effect sizes of 1.17, 0.52 and 0.50 respectively)”. 
Effect of physical activity on cognitive function in older adults at risk of Alzheimer disease


- RCT with 138 volunteers with reported memory problems aged 50 and over
- Home-based programme of activity (mainly walking) in 3 x 50 mins sessions (150 mins/wk)
- ITT analyses indicated 0.26 point increase in intervention and 0.73 point decrease in control on Alzheimer Disease Assessment Cognitive subscale that was maintained over 18 months
What are the potential pathways: Brain structure, function and survival?

- Maintenance of neurotransmitter function?
- Nerve cell survival?
- Synaptic plasticity?
- Increased vascularisation?
- Disposal of amyloid-B which produces plaques (rats)
- Nerve growth (rats)
- Hippocampus growth (humans)

(Eriksen et al., 2011)
Exercise training increases size of hippocampus and improves memory

Erikson et al. (2011) Proc Nat Acad Sci, USA

- 120 older adults without dementia assigned to intervention and control
- Moderate intensity aerobic exercise 3 days per week for 12 months
- Size of hippocampus (anterior) increased 2% in exercise group and decreased 1.4% in stretching control
- Change was related to change in aerobic fitness
Exploring the effects of exercise and brain stimulation on brain plasticity

NIHR Biomedical Research Unit
University of Oxford
Heidi Johansen-Berg, Claire Mackay, Helen Dawes, Ken Fox et al. (2012-17)

Key changes in brain structure and function
Exercise frequency, intensity, duration, setting, and concomitant conditions?
Which types of activity work for mental health?

- Aerobic, rhythmic exercise of moderate intensity
- Resistance exercise
- Martial arts and Tai Chi
- Yoga
- Team sports?
- Expressive activity such as dance?
- Daily movement – walking or cycling to work?
- Green gyms?
- Adventurous activity – outward bound?
- Rambling, health walks, nature walking?
Public health recommendation

More movement - 30 minutes of moderate intensity physical activity on at least 5 days of the week

- Heavy household activity (chores, gardening, DIY)
- Transport activity (walking, cycling)
- Occupational
- Sports and gym-based fitness/exercise
- Leisure time physical activity (swimming, dancing, walking, cycling)
- Non exercise activity thermogenesis (NEAT) (fidgeting)
Ageing and the decline spiral?

- Sedentary and low activity habits
- Decline in physical and cognitive function
- Increasing isolation and loss of independence
- Accelerated biological ageing / subclinical disease
- Chronic disease development
- Premature death / poor quality of life / huge health care bills
Physical activity guidelines for older adults

• be active daily.

• over a week activity should add up to at least 150 minutes

• one way to approach this is to do 30 minutes on at least 5 days a week (in 10 mins bouts is OK).

• undertake physical activity to improve muscle strength on at least two days a week

• something is better than nothing
Thanks for listening