

## RESEARCH REPORT

## The burden of physical activity-related ill health in the UK

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**Background:** Despite evidence that physical inactivity is a risk factor for a number of diseases, only a third of men and a quarter of women are meeting government targets for physical activity. This paper provides an estimate of the economic and health burden of disease related to physical inactivity in the UK. These estimates are examined in relation to current UK government policy on physical activity.

**Methods:** Information from the World Health Organisation global burden of disease project was used to calculate the mortality and morbidity costs of physical inactivity in the UK. Diseases attributable to physical inactivity included ischaemic heart disease, ischaemic stroke, breast cancer, colon/rectum cancer and diabetes mellitus. Population attributable fractions for physical inactivity for each disease were applied to the UK Health Service cost data to estimate the financial cost.

**Results:** Physical inactivity was directly responsible for 3% of disability adjusted life years lost in the UK in 2002. The estimated direct cost to the National Health Service is £1.06 billion.

**Conclusion:** There is a considerable public health burden due to physical inactivity in the UK. Accurately establishing the financial cost of physical inactivity and other risk factors should be the first step in a developing national public health strategy.

Each year, cardiovascular diseases are responsible for more than 200 000 (37% of total) deaths in the UK and cancers are responsible for a further 156 000 deaths (27% of total).<sup>1</sup> It is accepted that at least part of the cause of these diseases is due to modifiable risk factors. The INTERHEART study compared 12 461 cases and 14 637 controls from more than 52 countries and established a number of modifiable risk factors for coronary heart disease including smoking, diabetes, hypertension and obesity.<sup>2</sup> The same study found a protective effect from fruit and vegetable consumption, moderate alcohol use and physical exercise.

The World Health Report<sup>3</sup> found that physical inactivity is responsible for 1% of Disability Adjusted Life Years (DALYs) lost globally and for 3% of those lost in established market economies. In England, a majority of adults report positive attitudes to physical activity, yet only 37% of men and 25% of women are meeting government targets for healthy levels of physical activity of at least 30 min of moderate intensity activity on  $\geq 5$  days per week.<sup>1, 4</sup>

The Government's recent national physical activity action plan, *Choosing activity*, sets out plans to encourage and coordinate the action of a range of departments and organisations to promote increased participation in physical activity across England.<sup>5</sup> This document includes an estimate of the indirect cost of physical inactivity in England as £8.2 billion, published by the Prime Minister's Strategy Unit in an earlier policy discussion document called *Game Plan*.<sup>6</sup> This calculation summed the direct costs of healthcare and the indirect costs such as earnings lost due to inability to work and premature death. This model excluded the additional contribution of physical inactivity to overweight and obesity, whose overall cost has been estimated to be £6.6–7.4 billion per year.<sup>7</sup>

The cost of current health-related behaviour and the potential savings of behaviour change can help policy makers in justifying health programme decisions. *Game Plan*<sup>6</sup> makes claims about the cost of physical inactivity without clearly spelling out the methods used to estimate this cost. Accurate estimates would allow comparison between the costs of different risk factors. We feel that the validity of such potentially attractive social and financial benefits should be

based on evidence rather than enthusiastic conjecture. Recent work<sup>8</sup> proposed a method for estimating financial and ill-health burden to the UK related to diet. In this paper, we apply this method to estimate the burden of ill health related to physical inactivity in the UK.

## METHOD

The method involved four steps:

1. Identification of diseases where physical inactivity is a risk factor;
2. Calculation of the total numbers of deaths and the DALYs lost for these diseases;
3. Identification of the population attributable fractions (PAFs) for each disease;
4. Application of these PAFs to National Health Service (NHS) cost data, to calculate the direct costs of physical inactivity to the NHS

A PAF indicates the proportion of disease that can be attributed to a particular risk factor. The World Health Report calculated the PAF due to physical inactivity against a theoretical population in which all individuals participated in regular physical activity defined as being physically active in any of the four domains of work, transport, domestic duties or during leisure time.<sup>3</sup>

The cost, or burden, of an illness can be measured by the loss of duration and quality of life, and by the financial impact of related disease on the health system (direct costs) and on society (indirect costs). Mortality provides a clear measure of the overall loss of life due to specific diseases and is relatively easy to measure when mortality records are accurate. The burden of disease can be measured by its effect on the duration and quality of life using DALYs; an aggregate measure derived from years of life lost to premature death (YLL) and the years of

**Abbreviations:** AMI, acute myocardial infarction; DALY, Disability Adjusted Life Year; ICD, International Classification of Disease; NHS, National Health Service; PAF, population attributable fraction; PAR, population attributable risk; YLD, years of life impeded by disability; YLL, years of life lost to premature death

**Table 1** Amount of deaths, years of life lost in early deaths, years of life lost in disability and Disability Adjusted Life Years in World Health Organization EUR-A region, 2002

Cause	% of mortality (n=3 920 000)	% of YLLs (n=23 972 000)	% of YLDs (n=27 762 000)	% of DALYs (n=51 725 000)
Communicable diseases, maternal and perinatal conditions, and nutritional deficiencies	6.1	6.0	4.0	4.9
Cancer (malignant and other neoplasms)	27.2	32.8	3.1	16.9
Cardiovascular diseases	41.1	29.5	6.4	17.1
Diseases related to physical inactivity				
Ischaemic heart disease	17.1	13.7	1.1	6.9
Cerebrovascular disease	10.6	6.9	3.6	5.1
Breast cancer	2.3	3.2	0.6	1.8
Colon/rectum cancer	3.5	3.6	0	2
Diabetes mellitus	2.3	1.9	2.4	2.1
Total	35.8	29.2	7.6	18
Respiratory diseases	5.6	4.2	8.7	6.6
Injuries	4.8	11.5	4.7	7.9
Other	19.2	15.9	73.1	46.6
Total	100	100	100	100

DALY, Disability Adjusted Life Year; YLD, years of life lost in disability; YLL, years of life lost in early deaths. Diseases related to physical inactivity are a subset of other categories. Source: World Health Organization.<sup>3</sup>

life impeded by disability (YLD). Estimates of the burden of disease attributable to 10 major risk factors were produced by the global burden of disease project.<sup>9</sup> The risk factors were tobacco, alcohol, illicit drugs, occupation, air pollution, poor water supply, poor sanitation and hygiene, hypertension, physical inactivity, malnutrition and unsafe sex.

We relied on data from the World Health Organisation (WHO) both for mortality and disability measures and for PAF estimates. As such we were constrained by the limitations of the burden of disease project. Data on mortality, YLL, YLD and DALYs were taken from the World Health Report<sup>3</sup> for European countries with very low child and very low adult mortality (WHO region EUR-A). We used the diseases defined by the WHO as having some relationship with physical inactivity— ischaemic heart disease, ischaemic stroke, breast cancer, colon/rectum cancer and diabetes mellitus. Although the WHO project provides a PAF for ischaemic stroke, data on DALYs, YLLs and YLDs are available only at the level of cerebrovascular diseases; this category was used as a surrogate for ischaemic stroke.<sup>3</sup> In addition, the WHO list of attributable diseases was shorter than others<sup>13 14</sup> and did not include other factors such as osteoporosis.

We used the published PAF to calculate the mortality, YLL, YLD and DALYs attributable to physical inactivity within WHO region EUR-A for broad disease categories and for each disease

linked to physical inactivity. The number of deaths owing to physical inactivity in the UK was calculated by applying PAFs to mortality data.<sup>1</sup>

In 1996, the National Health Executive<sup>10</sup> published a study which ascribed NHS costs 1992–3 to the International Classification of Disease (ICD) 9 codes. This report represents the most recent detailed estimate of NHS costs by ICD codes. NHS total cost was defined as the sum of NHS in-patient and out-patient costs, NHS primary care expenditure, NHS pharmaceutical expenditure and NHS net community care services expenditure for the year 1992–3. NHS expenditure by disease code in 1992–3 was applied to the 2002 NHS total to provide an estimate of costs per disease for 2002. The cost of physical inactivity was calculated by applying the PAFs for diseases related to physical inactivity to 2002 disease-specific costs.

## RESULTS

Cardiovascular disease was responsible for 41.1% of all mortality and 17.1% of all DALYs lost; cancer caused 27.2% of mortality and 16.9% of DALYs (table 1). Those diseases with some relationship with physical inactivity comprised 36% of all mortality, 29% of YLLs, 8% of YLDs and 18% of DALYs. Among these, 17.1% of all mortality was from ischaemic heart disease and 10.6% from ischaemic stroke. Of the 18% of total DALYs lost, 6.9% was due to ischaemic heart disease and 5.1% due to

**Table 2** Total Disability Adjusted Life Years lost and population attributable fractions for physical inactivity by sex, in World Health Organization EUR-A region, 2002

	Males				Females				Total			
	DALYs lost (n)	PAF DALYs lost (%)	DALYs lost to PiA	% of all DALYs	DALYs lost (n)	PAF DALYs lost (%)	DALYs lost to PiA	% of all DALYs	DALYs lost (n)	PAF DALYs lost (%)	DALYs lost to PiA (n)	% of all DALYs
Ischaemic heart disease	2 305 911	23	530 360	1.025	1 266 047	22	278 530	0.538	3 571 958	23	808 890	1.564
Cerebrovascular disease	1 328 909	12	159 469	0.308	1 327 525	13	172 578	0.334	2 656 434	12	332 047	0.642
Breast cancer	6414				932 944	11	102 624	0.198	939 358	11	102 624	0.198
Colon/rectum cancer	562 723	16	90 036	0.174	466 108	17	79 238	0.153	1 028 831	16	169 274	0.327
Diabetes mellitus	547 093	15	82 064	0.159	559 015	15	83 852	0.162	1 106 108	15	165 916	0.321
Total	4 751 050	18	861 929	1.666	4 551 639	16	716 822	1.386	9 302 689	17	1 578 751	3.052

DALY, Disability Adjusted Life Year; PAF, population attributable fraction; PiA, physical inactivity; YLD, years of life lost in disability; YLL, years of life lost in early deaths. Source: World Health Organization.<sup>3</sup>

**Table 3** Percentage of total National Health Service costs attributable to different diseases in 1992–3 and 2001–2

Cause	% of NHS Total costs 1992–3 (£ millions)	Costs 2002 (£ millions)	PAF for DALYs lost within specific disease to physical inactivity*	Cost owing to physical inactivity (£ millions)
Infectious diseases	1.0	702		
Cancer (malignant and other neoplasms)	4.1	2878		
Cardiovascular diseases	12.1	8494		
Diseases related to physical inactivity				
Ischaemic heart disease	3.3	2287	23	526
Cerebrovascular disease	4.1	2892	12	347
Breast cancer	0.3	240	11	26
Colon/rectum cancer	0.5	383	16	61
Diabetes mellitus	1.0	675	15	101
Total	9.2	6477		1062
Musculoskeletal diseases	7.8	5476		
Mental and nervous system disorders	25.0	17 550		
Respiratory diseases	6.2	4352		
Injuries	3.8	2668		
Other	40.0	28 080		
Total	100.0	70 200		

DALY, Disability Adjusted Life Years; NHS, National Health Service; PAF, population attributable fraction.

Note: Diseases related to physical inactivity are a subset of the cardiovascular disease group.

\*Attributable DALYs lost within disease due to physical inactivity as a percentage of total DALYs lost to disease.

ischaemic stroke. Table 1 summarises the contribution of specific diseases to the total burden of disease in WHO region EUR-A.

Table 2 shows that ischaemic heart disease was the largest contributor to this burden accounting for 1.6% of all DALYs lost, followed by ischaemic stroke (0.6%). The burden of DALYs lost was higher in males (1.7%) than in females (1.4%). A large proportion of this difference is explained by ischaemic heart disease contributing to 1.03% of DALYs lost in males, almost double the 0.5% of DALYs lost among women to the same disease. Among women, breast cancer contributed to 0.2% of all DALYs lost. Table 2 shows that 3% of all DALYs lost are directly attributable to physical inactivity.

When we applied these rates to 2003–4 mortality figures, we found that a total of 287 206 deaths within the UK occurred due to diseases which were linked to physical inactivity. We estimated that 35 429 deaths were directly attributable to physical inactivity, with almost two thirds (64%) of these deaths being due to coronary heart disease.

In 1992–3, 9% of total NHS costs, or £6.5 billion, were coded to diseases with some component of physical inactivity (table 3). Stroke (4.1%) and ischaemic heart disease (3.3%) were the two major contributors to the economic burden. Extrapolated to 2002 terms, the cost of disease which is directly attributable to physical inactivity was £1.06 billion. Of the £1.06 billion directly attributable to physical inactivity, a large proportion was due to ischaemic heart disease (526 million), stroke (347 million) and diabetes mellitus (101 million).

## DISCUSSION

Our analysis suggests that, in 2003–4, over 35 000 deaths could have been avoided if the population were physically active at the levels recommended by the UK government. We found that physical inactivity was responsible for 3.1% of morbidity and mortality in the UK, contributing over £1 billion to the direct health cost burden to the UK National Health Service.

### Burden of disease—morbidity and mortality

Earlier studies have provided estimates of the burden of ill health attributable to physical inactivity in the developed world ranging from 1.4%<sup>11</sup> to 6.7%.<sup>12</sup> Murray and Lopez<sup>9</sup> estimated

that the DALYs attributable to physical inactivity were 1% worldwide, 4% in the developed world and 4.8% among established market economies. Murray and Lopez included the US and Japan in their calculations, making any comparison with European figures problematic because of the heterogeneity of these populations, particularly in the variation in prevalence of other factors influencing disease, such as obesity, diabetes mellitus, adverse blood lipid profiles and hereditary factors.

The Swedish National Institute of Public Health<sup>11</sup> applied relative risk estimates from a review of the literature to estimate that 1.4% of DALYs lost were attributable to physical inactivity, based on a conservative estimate of 18% of the population leading a sedentary lifestyle. This would seem to be an underestimate as data from the Health Survey for England<sup>12</sup> suggest that only 37% of men and 25% of women are meeting government activity targets whereas the remaining 63% of men and 75% of women are sedentary.

Mathers *et al*<sup>13</sup> estimated the burden of ill health due to physical inactivity in Australia at 6.7% of all DALYs lost. The Australian study differed from the global burden of disease study in applying Australian life expectancy rates, applying different weights for years lost due to disability and adjusting for comorbidities. A Canadian study<sup>14</sup> calculated relative risks for each disease category using a meta-analysis of observational studies. As with Murray and Lopez,<sup>9</sup> the study population included North American populations and is similarly difficult to compare with a UK population.

### Burden of disease—£s

In interpreting our findings, it is important to bear in mind that indirect costs such as production losses due to mortality and morbidity and informal care would greatly increase the ill-health burden of physical inactivity. If indirect costs such as days lost to sickness absence and premature mortality, private healthcare costs and home care had been included, the figure would have been far higher. For example, Leal *et al*<sup>15</sup> calculated that the indirect healthcare costs of cardiovascular diseases in the UK in 2003 were £21 billion, or around 60% of the total cost of £36 billion.

The extrapolated costs for ICD disease codes were another source of potential error. In 2002 Wanless published an

### What is already known

Costs of illness studies which estimate the burden of unhealthy behaviours such as poor diet have been undertaken. Within the UK, the low prevalence of people meeting the government's targets for healthy levels of physical activity is well known. Recent estimates of the cost to the National Health Service have been based on a number of different data and out-of-date sources.

### What this study adds

This study shows that physical inactivity leads to a direct cost to the UK National Health Service of £1.06 billion per year. It also presents an accurate and up-to-date method which may be used in other countries to estimate direct costs of physical inactivity to the health service. Estimates of the costs of unhealthy behaviours are useful in setting health promotion policy.

independent review, which provided an evidence-based assessment of the resource requirements of the NHS. Data from the Wanless report compare favourably with our estimates of costs. Wanless set the 2002 cost to the NHS of cancer at £2.5 billion and of ischaemic heart disease at £2.4 billion, which compares favourably with our estimates of £2.9 and £2.3 billion, respectively.<sup>16</sup>

The *Game Plan* estimate of £8 billion for all diseases related to physical inactivity was very high in comparison to our estimate of £1.06 billion, but *Game Plan* estimates were for direct and indirect costs whereas our estimate is for direct costs only. Furthermore, the *Game Plan* calculations included a number of diseases not considered in the current study—that is, angina pectoris, osteoarthritis and hypertension—although it excluded breast cancer. This would explain our reduction in the estimate of overall direct costs to the NHS.

We adopted the PAFs calculated in the *World Health Report*<sup>3</sup>; however, these PAFs did not quantify other benefits of physical activity such as the improvement in musculoskeletal conditions or reduction in symptoms of depression. Musculoskeletal diseases caused just under 5% of the burden measured in DALYs among developed regions.

For these reasons, our figures are undoubtedly an underestimate of the true cost of physical inactivity to the UK economy. Despite this, our study is important because it provides an up-to-date evidence-based estimate of the direct financial cost of physical inactivity to the UK NHS which can be used by policy makers and others.

### Limitations

The comparison of studies which use PAFs to determine the overall burden of disease attributable to particular behaviours is hampered by the different diseases considered in each study. The current study considers ischaemic heart disease, cerebrovascular disease (stroke), breast cancer, colon/rectum cancer and diabetes mellitus as diseases with some proportion of cause attributable to physical inactivity. The burden of disease project calculates a PAF based on ischaemic stroke, but provides data only to the level of cerebrovascular disease for mortality, DALYs, YLLs and YLDs. The application of PAFs for ischaemic stroke due to physical inactivity to outcome data for cerebrovascular disease will result in an overestimate of the burden of ill health due to physical activity. The overestimate will not be severe as ischaemic stroke accounts for 80–85% of all

### Policy implications

Estimates of the costs of unhealthy behaviours are useful in setting health promotion policy.

cerebrovascular diseases (with the remainder due to haemorrhagic stroke).<sup>17</sup>

### Directions for future research

A limitation to studies of this type is the absence of current NHS cost by disease category, which in this paper has been extrapolated from 1992 data. We would encourage future research to gain accurate contemporary cost by disease data, which when used in conjunction with more recent work on attributable risk<sup>8</sup> could provide robust estimates on the direct costs of unhealthy behaviours. Cost analysis provides a rationale for developing and promoting specific types of intervention to increase physical activity. This method is retrospective and as such does not consider the lead time from intervention to outcome (ie, adopting physical activity across a life course). Owing to its retrospective nature, it is a picture of past rates and costs of physical inactivity and cannot reflect the success or otherwise of recent interventions. The next steps in this type of work may be the development of models to estimate potential cost and health savings from interventions.

### Implications for policy

This information should be of use in developing health strategy, particularly in prioritising physical activity in the discussion of public health interventions. In particular, it should inform discussions around the distribution of resources and supplement the current debate in the UK about the role of preventive action. The INTERHEART study<sup>2</sup> found that modifiable risk factors account for 90% of the PAR for acute myocardial infarction (AMI) in men and 94% of the PAR for AMI in women. Physical inactivity is just one of the modifiable risk factors for coronary heart disease and contributed 12% to the PAR for AMI. We are not arguing that the findings of this paper change the importance given to achieving a reduction in the main risk factors for premature mortality (such as smoking). We are arguing that the potential impact of changing other risk factors would be further enhanced if they were to include an increase in physical activity. Our results show that there is an economic case for developing policies and interventions that promote physical activity.

### CONCLUSION

One third of all deaths are due to diseases which could be at least partly reduced by increased physical activity. Physical inactivity was directly responsible for 3% of morbidity and mortality in the UK. The estimated direct cost to the NHS is £1.06 billion. There is a considerable public health burden due to physical inactivity in the UK. Accurately establishing the financial cost of physical inactivity is an important step in developing national public health strategy.

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