Costing the burden of ill health related to physical inactivity for Scotland

August 2012

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Table of Contents

1. Executive Summary

This report describes the work undertaken to develop and apply a methodology to produce estimates of the primary and secondary care costs attributable to physical inactivity for Scotland. Each estimate was derived using previous methods applied within Scotland and the UK. The results show a range of estimated primary and secondary care costs for five disease areas associated with physical inactivity. Results at national level were calculated as £94.1m (£91.8-96.4m). This equates to a mean cost of physical inactivity of approximately £18 per Scottish resident per year. For the first time, costs relating to prescription costs, consultations in General Practice and premature mortality associated with physical inactivity were calculated.

2. Introduction

2.1 What is the global burden of physical inactivity?

The World Health Report (2003) found that physical inactivity is responsible for 1% of Disability Adjusted Life Years (DALYs) lost globally and 3% of those lost in established market economies. In Scotland, a majority of adults report positive attitudes to physical activity yet only 45% of men and 33%of women are meeting new government targets for healthy levels of physical activity (Department of Health PA, Health Improvement and Protection, 2011).

2.2 What are cost of disease estimates?

Most cost of disease studies will include the direct costs of a disease area across different types of health sectors, including acute, hospital based, primary care, outpatient and pharmacy services. Costs can be derived for data on expenditure if categorised against a particular disease type but often data is collected at a hospital level and within the specialities that deliver care, like oncology or mental health. Data collected within medical specialities may include a range of different disease categories, including those not related to physical inactivity. For example, in cancer services cost data would include cancers such as bowel or breast cancer (both related to physical inactivity) but also non-related cancers such as leukaemia.

Other estimates of the costs of disease include indirect costs. A past UK government report, Choosing Activity, provided an estimate of the indirect cost of physical inactivity in England of £8.2 billion (Department of Culture Media and Sports Strategy Unit, 2002). This calculation summed the direct costs of health care and the indirect costs such as lost earnings due to inability to work and premature death. Estimates of the cost of alcohol to Scotland included health, social and economic costs. Healthcare related costs were put at £267.8 million or 7.5%of the total; social care costs were estimated to be £230.5 million or 6.5%of the total; crime costs were put at £727.1 million or 20.4%of the total; loss of productivity was expected to cost the economy £865.7 million or 24.3% of the total; and finally wider social costs were estimated at £1.46 billion or 41.2% of the total (total £3.55 billion per year) (York Health Economics Consortium, 2010). Such estimations are costly and take time as many assumptive models are needed in order to assess the costs of a wider range of impacts.

2.3 How can cost of physical inactivity data be used?

The cost of current health-related behaviour and the potential savings of behaviour change can help policy makers to justify health programme decisions. These decisions are being used currently by the National Institute of Health and Clinical Excellence (NICE), who adopt a costs saved by an intervention metric versus potential programme costs to deliver the intervention metric. For example, costs arising from increasing brief interventions delivered in primary care (in England) were estimated to be £11.8 million (NICE, 2006). The proportion of costs will vary by the distribution of disease within a country, as some areas have higher levels of disease, illness and physical activity levels so investment plans could adopt a cost approach

using this type of data. The production of local level cost data of physical inactivity was very successful in helping highlight such local costs and burden after the publication of *Be Active, Be Healthy: A Plan for Getting the Nation Moving* (Department of Health, 2009).

2.4 How has cost of physical inactivity data been estimated previously?

The British Heart Foundation Health Promotion Research Group (BHF HPRG) has developed a method for estimating financial and ill health burden to the UK due to physical inactivity (Allender et al., 2007). This method has been subject to peer review before publication in a high quality epidemiology journal and has been successfully applied to estimating the cost of other behaviours to the UK National Health Service including poor diet, overweight and obesity, alcohol consumption and tobacco use (Rayner & Scarborough, 2005). The same method was used to calculate the costs of physical inactivity for English Primary Care Trusts (PCTs) for the Department of Health in 2009.

At the request of the Scottish Government, the Scottish Physical Activity Research Collaboration (SPARColl) undertook research to produce Scottish estimates of the cost of physical inactivity which would be invaluable in providing feedback to Health Boards in Scotland. This data could help provide a sound evidence base on which to prioritise physical activity interventions. This cost information helps strengthen the case for intervention by providing an indication as to the cost savings attainable should the population reach a sufficient level of physical activity.

3. Study aims

1. To develop and apply a methodology to estimate the cost of physical inactivity across Scotland

3.1 Additional research questions

1. Is it possible to estimate the ill health burden of physical inactivity for individual Health Boards across Scotland?
2. Is it possible to develop a clear understanding of the diseases and the proportion of that disease attributable to physical inactivity in a Western European Population?
3. Is it possible to identify the cost of disease with some relation to physical inactivity at Health Board level?
4. What is the cost of physical inactivity at Health Board level across Scotland?
5. What are the sensitivities of this estimate?
6. Are there additional direct NHS Scotland costs such as prescriptions, GP consultations or indirect costs that could also be estimated?

4. Methods

The cost data for this analysis were taken from the Scottish costs from Net Operating Expenditure of R086: NHS Board Operating Costs & Capital Expenditure (2011). The dataset provides details of different costs, including that on primary care services. Some of these are provided at a national level and others show health board level expenditure. The cost data allocated to these programmes was used to develop costs attributable to physical inactivity.

4.1 Calculating the contribution of physical inactivity to diseases

The diseases defined by the World Health Organisation (WHO) as having some relation to physical inactivity are ischaemic heart disease, ischaemic stroke, breast cancer, colon/rectum cancer and diabetes mellitus (Table 1). The contribution of a risk factor to a disease or death is called the Population Attributable Fraction (PAF). The WHO defines a PAF as the "proportional reduction in population disease or mortality that would occur if exposure to a risk factor were reduced to an alternative ideal exposure scenario or eliminated (e.g. no tobacco use or no overeating of animal fats in diets). Many diseases are caused by multiple risk factors, and individual risk factors may interact in their impact on overall risk of disease. As a result, PAFs for individual risk factors often overlap and add up to more than 100%. To account for this, PAFs express the amount and relative contribution of a risk factor to overall disease levels." Calculation of a PAF is presented for illustration below.

$$\mathbf{PAF} = \frac{\sum_{i=1}^{n} P_i \; RR_i - \sum_{i=1}^{n} P_i' \; RR_i}{\sum_{i=1}^{n} P_i \; RR_i}$$

Pi = proportion of population at exposure level i, current exposure
P'i = proportion of population at exposure level i, counterfactual or ideal level of exposure
RR = the relative risk at exposure level i
n = the number of exposure levels

Table 1: Disease categories for physical inactivity and relevant PAFs within WHO 2002 report

WHO attributable disease	PAF for physical inactivity (%)
Ischaemic heart disease	23
Cerebrovascular disease	12
Breast cancer	11
Colon/rectum cancer	16
Diabetes mellitus	15

The original aim was to use the direct costs of each disease area in the analysis. However, the data architecture was not suitable for such an approach.
The research also planned to follow as closely as possible the methods used in the ScotPHO *Obesity in Scotland*, 2007 report, as this would allow some basic comparisons and net contribution (http://www.scotpho.org.uk/home/Publications/scotphoreports/pub_obesityinscotland.asp).

The research team liaised with the team who undertook this modelling and were aware of the assumptions used in the data.

All calculations were performed using the software, STATA 11 SE. Output was then reconverted into an excel file.

We made three data requests to ISD Scotland for inpatient and outpatient costs, GP and practice nurse consultation costs, and pharmacology prescription costs of five conditions associated with physical inactivity.

4.2 Calculating direct costs

Request 1 sought the direct costs associated with hospital admissions for both inpatients (R040) and consultant led outpatients (R044) for the health conditions detailed in Table 2.

Table 2: The diagnosis code for inpatients (R040) and consultant led outpatients (R044) by specialty (for the following conditions)

Condition	Diagnosis Code (ICD10)	Diagnosis Description
Hypertension	I10-I15	Hypertensive diseases
Diabetes	E10-E14	Diabetes mellitus
Angina Pectoris	I20	Angina pectoris
Myocardial Infarction	I21-I22	Acute myocardil infarction
Stroke	I60-I69	Cerebrovascular diseases
Rectum/Colon Cancer	C18-C21	Malignant neoplasm
Breast Cancer	ICD- 174	Malignant neoplasm female breast

The data architecture did not allow for the use of raw data to estimate the ill health burden of physical inactivity at Health Board level across Scotland as intended. Instead it was necessary to develop a clear picture of the diseases and the proportion of that disease attributable to physical inactivity in a Western European Population using an established approach used at a national level in England (Scarborough et al, 2011). This meant it was not possible to identify the cost of

disease with some relation to physical inactivity at Health Board level as the calculation was based on overall national costs.

Direct costs were derived by applying the relative burden of disease attributable to physical inactivity to the direct costs (i.e. the cost of NHS Scotland) for Scotland. The cost per disease numbers for Scotland were derived by applying the proportion of disease by ICD10 chapter heading in England (which has program budget data to ICD10 chapter level) to overall NHS Scotland Costs (which does not have disease specific cost or even disease specific activity data).

Additionally, interpreting health board level data was difficult due to the movement of patients across health board areas. For example, people may use services in multiple health board areas, and some specialist centres may only exist in particular locations.

The sensitivities around the final estimate of total national costs were calculated using an approach used in a previous analysis of the economic burden of disease (Scarborough et al, 2011). Prevalence rates used to generate the PAFs for each risk factor were compared with equivalent rates drawn from the Scottish Health Survey. The ratio between the Scottish prevalence rate and the EUR-A region prevalence rate was applied to the modelled cost estimates, and the range for the sensitivity analysis was between the estimates adjusted for Scottish prevalence rates and the original estimates using the EUR-A prevalence rates. This adjustment factor of 1.025 was the ratio of Scottish prevalence rate to EUR-A prevalence rate.

It was possible to obtain data in order to estimate the contribution of GP consultations and prescriptions to overall national costs

4.3 Calculating GP and Practice Nurse consultation costs

Request 2 focused upon the same health conditions as Request 1 for data on the Practice team information (based on GP sample survey data), located at http://www.isdscotlandarchive.scot.nhs.uk/isd/1044.html. This would allow calculation of the GP consultation costs associated with physical inactivity conditions, using standard costs of a consultation, estimated at £25, (provided in a recent estimate of alcohol related costs by BMA Scotland, http://www.bma.org.uk/images/bmascotlandonedayalcohol_tcm41-209349.pdf).

4.4 Calculating prescription costs

Finally Request 3 focused on the Gross Ingredient Costs (GIC) for prescriptions for the following conditions in order to calculate the prescription costs of physical inactivity disease, using the British National Formulary (BNF) as a reference in relation to disease specific prescriptions. This method was also adopted for calculation of the cost of obesity in Scotland. Cost of prescriptions were estimated by applying the relative global burden of disease attributable to physical inactivity (WHO) to cost of prescriptions for preparations related to the key diseases attributable to physical inactivity. Again we used PAFs to generate the proportion of costs within each disease category, as outlined in the BNF, see Table 3, and totalled within disease groups costs. These costs include prescriptions dispensed by community

pharmacists, appliance suppliers and dispensing doctors only. Data did not include hospital related costs or prescription costs of disease where physical activity could prevent or aid treatment of particular conditions.

Table 2: Disease categories and BNF chapter, sections and codes

Use	BNF Chapter	BNF Section	BNF Subsection
Cancer	08	0801	N/A
Cancer	08	0803	N/A
Diabetes	06	0601	060101
Diabetes	06	0601	060102
Diabetes	06	0601	060106
Angina	02	0206	020603
Angina, Myocardial Infarction	02	0206	020601
Angina, Myocardial Infarction, Hypertension	02	0206	020602
Myocardial Infarction	02	0205	020505
Myocardial Infarction	02	0202	020203
Myocardial Infarction, Hypertension	02	0204	N/A
Hypertension	02	0205	N/A
Hypertension	02	0202	N/A
Myocardial Infarction, Stroke	02	0212	N/A
Myocardial Infarction, Stroke	02	0209	N/A
Osteoarthritis	10	1001	100101
Osteoarthritis	04	0407	040701
Stroke	02	0202	020201
Stroke	02	0208	020802

5. Results

Physical inactivity cost the NHS in Scotland £94.1M in 2010-2011 (Figure 1).The sensitivity range for this estimate was £91.8M to £96.4M and has an average cost per Scottish resident per year of £18.30.This cost represents approximately 17% of the overall costs of physical inactivity related diseases for Scotland (Figure 2). Costs of all disease and physical inactivity related disease have dropped very slightly since 2007 (Figure 3: Figure 4) and may be a reflection of a general trend of reduction in cardiovascular disease (CVD) (Figure 5). There were just fewer than 16,000 deaths per year in physical inactivity disease categories, with physical inactivity contributing to 2,565 deaths per annum.

In addition to estimating these costs, this project also included a number of scoping questions. These questions are reexamined below;

Questions 1, 3, 4 and 5 all relate to data collected at a health board level.

1. Is it possible to estimate the ill health burden of physical inactivity for individual Health Boards across Scotland?
3. Is it possible to identify the cost of disease with some relation to physical inactivity at Health Board level?
4. What is the cost of physical inactivity at Health Board level across Scotland?
5. What are the sensitivities of this estimate?

As previously discussed, the data collected in Scotland did not allow for this. Instead these calculations were calculated at a national level for Scotland.

Question 2 related to a broader remit.

2. Is it possible to develop a clear understanding of the diseases and the proportion of that disease attributable to physical inactivity in a Western European Population?

To some extent this has been possible to show for a Scottish population. Using PAFs that were available for conditions related to physical inactivity (ischaemic heart disease, ischaemic stroke, breast cancer, colon/rectum cancer and diabetes mellitus) the proportion of diseases attributable to physical inactivity can be seen in Table 1 and in Figures 2-4. It has not been possible to include conditions for which there are no PAFs (e.g. osteoporosis or depression) or for which there is limited epidemiological data (reduced falls or increased independent living amongst older adults).

Question 6 explored the additional costs to NHS Scotland, which would not be included in hospital rates.

5.1 Are there additional direct NHS Scotland costs such as prescriptions, GP consultations or indirect costs that could also be estimated?

For the first time in Scotland, the costs of prescriptions and GP or practice nurse consultations related to physical inactivity diseases were calculated. Within the total cost of 94.1M, the cost of prescriptions related to physical inactivity diseases for Scotland was £58M in 2010-2011 and the cost of GP consultations related to physical inactivity diseases for Scotland was £8.3M in the same period. The total number of physical inactivity disease related consultations in Scotland was 395,780 in 2010-2011, which is approximately 2 consultations per GP per day.
It was not possible to estimate indirect costs such as social care with the data and time available.

6.0 Discussion

This study followed a well-established methodology. The estimate of the national cost of physical inactivity is not only a first for Scotland but is directly comparable, based on recent financial estimates and can also easily be repeated in future years. This estimate presents total of direct costs of physical inactivity to the NHS Scotland, and within this estimate an idea of the cost of GP e consultation (which would be considered under the community health services clinical component of the overall budget) and of the cost of prescription outside hospital (which is also likely to fall under total NHS budget).

This research aimed to create an estimate of the disease related costs of physical inactivity at a Health Board level across Scotland, but was unable to do so for two reasons, (i) the data architecture was not detailed to create raw disease area costs, and (ii) there was not a clear understanding of how health services use across health board levels would bias the results.

6.1 Previous research

This estimate is lower than a previous estimate of the cost of physical inactivity to Scotland, of £141 million presented to the Physical Activity and Health Alliance (PAHA) annual conference in 2009. The difference in the figures is based on previously applying a cruder proportion of physical inactivity related costs and a different total for costs of the Scottish NHS budget. Both estimates adopted the same methodology where the relative burden of specific diseases attributable to physical inactivity is applied to the cost of that disease and so the costs of physical inactivity within a specific cost area (NHS total, GP and nurse visits, or prescriptions) are determined. The methods were the same but the cost areas now differed. This new estimate included direct costs and estimates within this total of the costs of prescriptions and costs of GP consultations.

However, it would be unwise to judge or compare this estimate in terms of costs or deaths with others that have used different methods, for example against smoking, obesity or alcohol. Each analysis is built on a different set of heroic assumptions and datasets for disease costs and mortality.

6.2 Using WHO generated PAFs

The methods used to develop these estimates are based on the PAFs calculated by the WHO (WHO, 2002; Murray et al, 2003).These PAFs are based on broad WHO regions (specifically the EUR-A region of developed European countries with very low child and adult mortality) and as such they may not accurately represent the picture in Scotland. PAFs must take account of the underlying prevalence of a risk factor within a population (since, for example, in a population with zero smokers, none of the ischemic heart disease could be attributed to smoking), and the use of WHO regional PAFs will therefore affect the accuracy of these estimates. This limitation has been addressed by a sensitivity analysis, which suggests that using EUR-A PAFs for Scotland has very little impact on the estimated costs for physical inactivity.

In addition the WHO list of attributable diseases is shorter than others (Mathers et al., 2001; Kazmarzyk et al: 2000) and does not include other factors such as osteoporosis or mental health and other conditions that are believed to be associated with physical inactivity. This omission limits any estimation of physical inactivity related costs as relevant conditions like mental health, dementia, loss of function, hip fractures, obesity are excluded. This limitation of PAFs lies in the mechanism of their construction rather than any lack of data, as they have to use country level mortality data across multiple countries. At present, the basic epidemiological studies do not exist to capture data on these conditions across enough countries. Studies tend to focus on a single condition (outcome) and then derive the relative risks (which lead to PAFs) for multiple risks. It is further complicated because most epidemiological studies focus on sub-populations and so generalising PAFs from small studies of specific populations (e.g. heart disease in >55s) to the broader population brings bias and error into any estimates. A perfect scenario would be to conduct (or find) a relatively contemporary study, at population level, involving the population of interest, which develops relative risk estimates for the relationship between level of activity, and the incidence/ prevalence of the disease. If these studies and then subsequent estimates exist at all, the difficulties associated with dealing with differing definitions of active, different expressions of the 'not active' referent population and using different definitions of the outcome and co-morbidity. This is one of the reasons why the use of Global Burden of Disease (GBD) estimates produced by the WHO is preferred as they come from a very large global exercise to try and capture PAFs for a range of risk factors for a number of diseases. The GBD study has its limitations but it reports PAFs across a number of diseases with physical inactivity as the key risk factor.

6.3 Prescription costs

Cost of prescriptions were estimated by applying the relative burden of disease attributable to physical inactivity to cost of prescriptions for preparations related to the key diseases attributable to physical inactivity. Note that these costs were an underestimate of total prescription costs for a number of reasons not least of which is that data were from prescriptions dispensed by community pharmacists, appliance suppliers and dispensing doctors only. Data did not include hospital related costs or prescription costs of disease where physical activity could prevent or aid treatment of particular conditions. This severe underestimate would be most closely felt in acute conditions such as heart disease and so on which have major invasive episodes in hospital. All of these cost estimates were also limited by the availability of PAFs for the calculations. These calculations do not include related conditions where physical inactivity is preventive such as osteoarthritis or mental health. Prescription costs for dementia (£36m) and depression (£12m) are quite high and this could conceivably be related at least in part to levels of PA. At present it is not possible to use diseases without a PAF in this approach but never the less it is felt that this estimate is a new and valuable resource for Scotland's physical activity community.

6.4 GP consultation costs

Cost of GP consultations were estimated by applying the relative burden of disease attributable to physical inactivity to primary care consultation codes related to the key diseases attributable to physical inactivity. These costs have been calculated as £8.3M per year, although the number of consultations was approximately 400,000 per year. This compares (using the similar approach) to 1.5M consultations for alcohol related consultations (BMA Scotland, 2011) but excludes possible other related conditions.

6.5 Calculating indirect costs

It was not possible to include any estimation of indirect health costs. Many studies deal only in direct costs (costs specifically to the Health Service budget) while fewer try and calculate costs to the broader health services. Generally a broader societal study of direct and indirect costs (i.e. NHS costs, plus time off work, carer time, lost productivity etc.) is a very large undertaking and beyond the resources for this study. This method provides a basic snapshot in relatively short time and so focused on direct costs, where secondary data was available. There were no available data providing estimates for costs for mental health, social care, prolonged independent living or even costs associated with falls, and as such this estimate must be (if these conditions and costs are related to physical inactivity) an underestimate.

6.6 Calculations by Health Board Area in Scotland

This research was also not able to weight any summary estimates of disease costs at a local Health Board level by population or by disease levels. It would be difficult to interpret as the same proportion of disease by category would be applied to board costs. This will not take into account the different burden of disease in each board (which is currently not available) but would simply reflect the different bottom line budget of each Health Board. Plans are underway to improve the estimates of Health Board level risk prevalence data, by the next Scottish Health Survey.

These estimates are limited because they cannot reflect, among other things, the different age, gender, ethnicity and social class structures which define different areas in Scotland and impact upon physical activity.

6.7 Future research

There is considerable scope to replicate and refine this method with physical inactivity data. One important refinement to this model would be to derive Scotland specific estimates of risk for the five main disease types (PAFs) and to expand this to other diseases with a known relationship with physical inactivity.

The use of cost data is most effective when used in a comparative scenario. For example previous research has produced estimates of the cost of physical inactivity related disease per head for London alongside estimates of spend per head, (£13.94 cost v £0.85 spend). This allows a sense of the action versus the scale of the problem. It may be possible to investigate if the overall figure £94.1M could be apportioned to specific Health Board areas, by weighting for population numbers. However this approach would also need the correct prevalence data of physical

activity in order to calculate sensitivity range for any estimates, which would be dependent upon the data availability of health board area pooled samples of the Scottish Health Survey. Calculating total spend on physical activity per health board area is also a timely exercise due to the different services involved and different ways this data is collected across regions and as such was out with the scope of this study. The place of physical activity promotion has been championed by SPARColl and the provision of comparison of costs of physical inactivity should help policy-makers and practitioners to prioritize resource allocation and make effective use of limited resources.

7.0 Conclusion

Physical inactivity cost the NHS in Scotland £94.1M (£91.8M to £96.4M) in 2010-2011. This equates to an average cost per Scottish resident per year of £18.30. Future changes to support the need for developing future research and policy evaluations are suggested: There is a need to express Scottish healthcare spending by a cost per condition by ICD chapter, as used in England, by the heading in NHS accounts used in English NHS budgeting program. This would allow focused and possible broader estimates of disease costs including dementia and depression. This would also lead to better datasets to monitor the relationship between policy and spending on prevention and actual impact on PA prevalence and subsequent disease.

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9.0 Figures

Figure 1: Costs of physical inactivity in Scotland by disease 2010/2011 (£M)

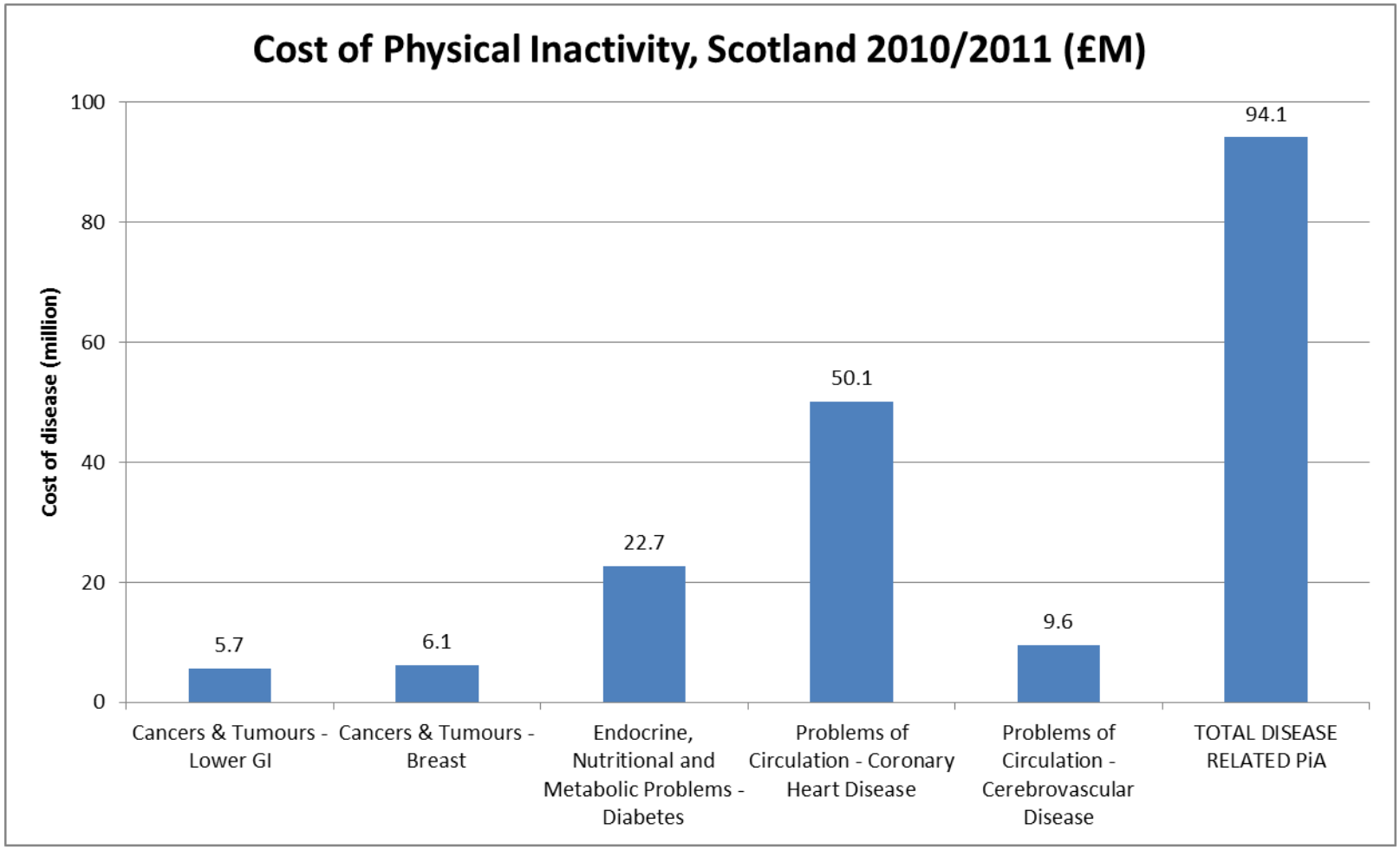

Figure 2: Total costs of all physical inactivity related diseases in Scotland, 2010-2011 (£M)

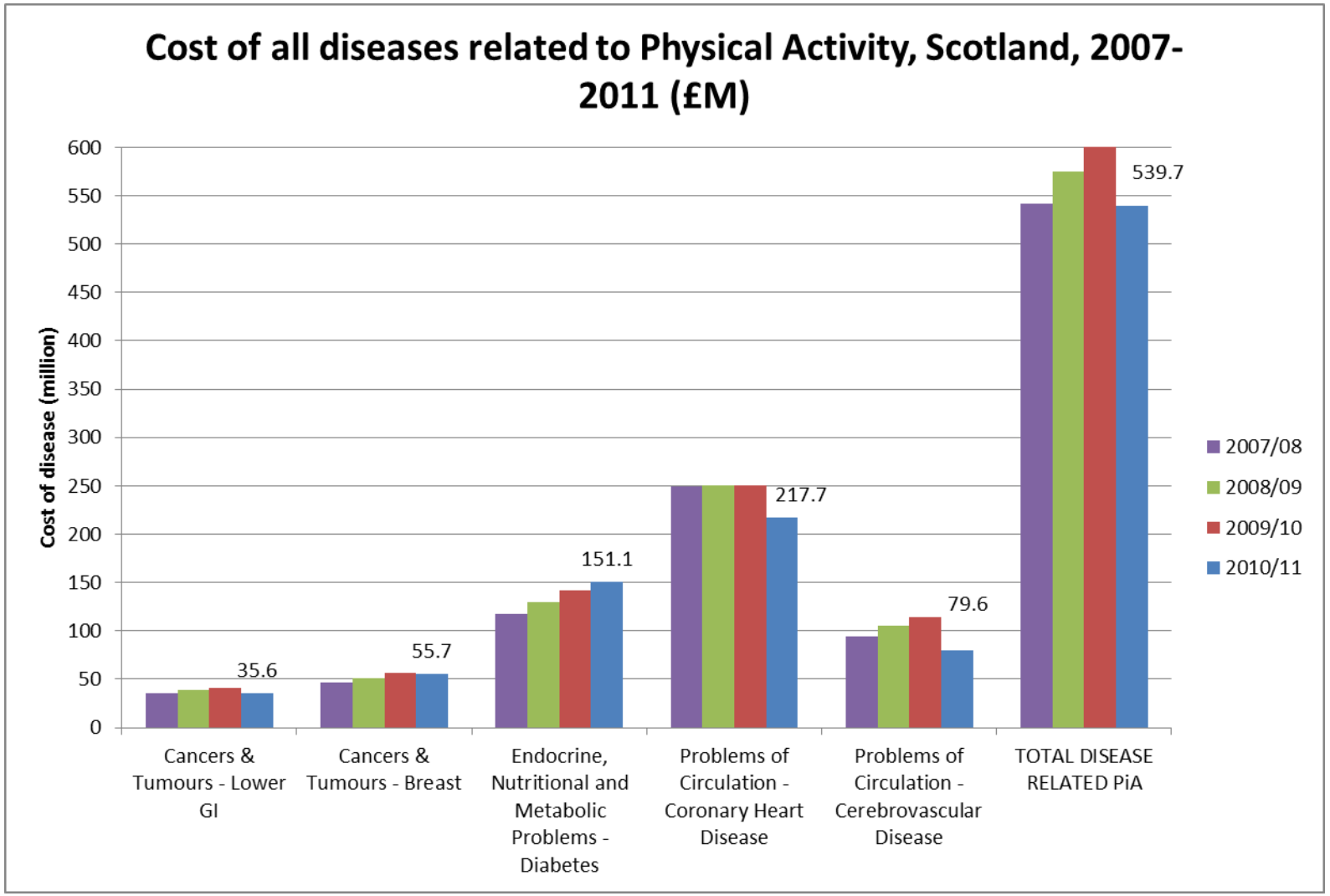

Figure 3: Total costs of all diseases related to physical inactivity in Scotland, 2007/08 to 2010/11 (£M)

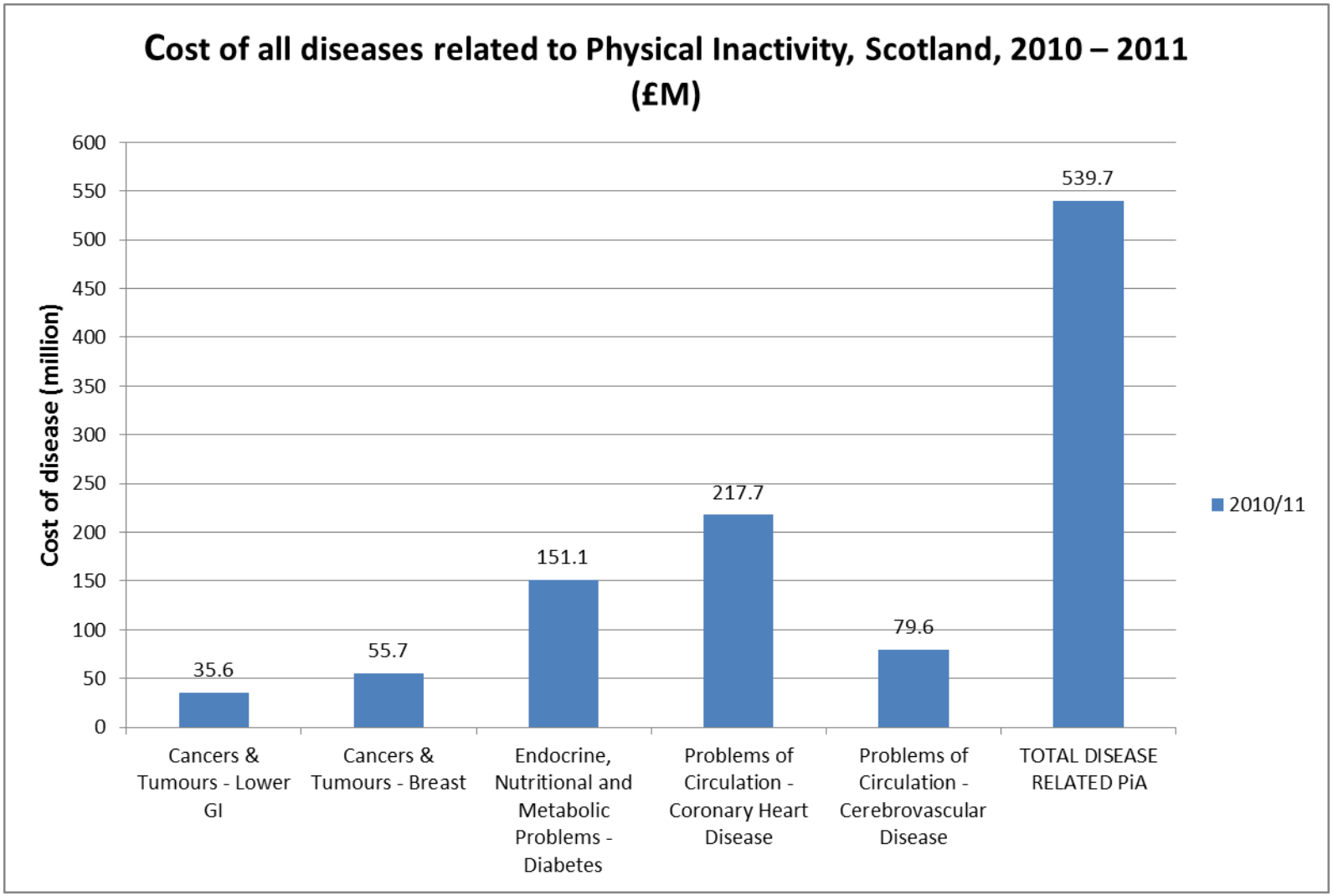

Figure 4: Total cost of disease related to physical inactivity in Scotland, 2007/08 to 2010/11 (£M)

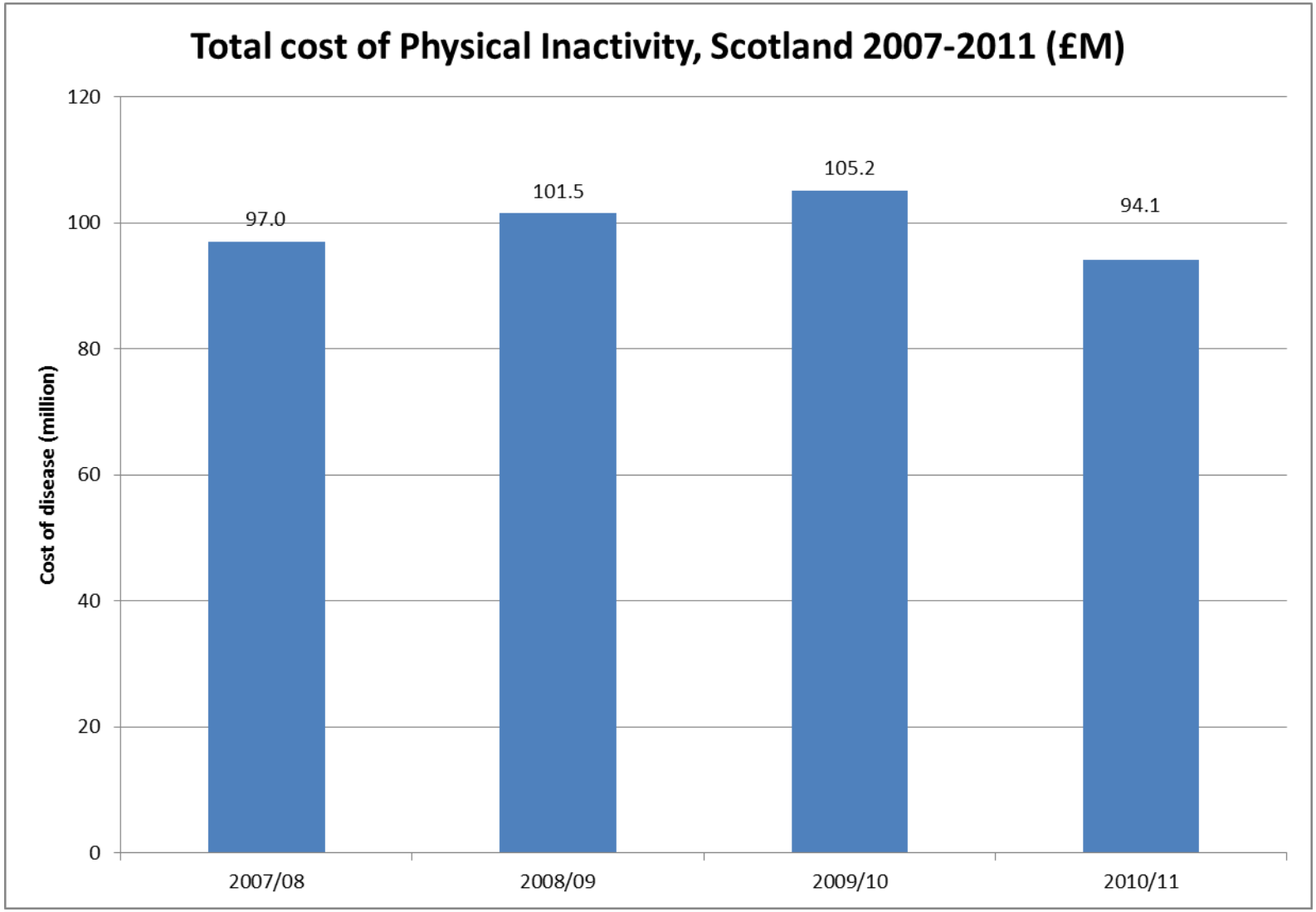

Figure 5: Total cost of physical inactivity related disease in Scotland, 2007/08 to 2010/11 (£M)