ScotPHO Smoking Ready Reckoner – 2011 Edition

Introduction

The purpose of the ScotPHO Smoking Ready Reckoner is to show the potential effect of reduced smoking prevalence on three outcomes:

- smoking-attributable deaths;
- smoking attributable hospital admissions;
- smoking-attributable NHS costs.

Tables are presented showing the estimated reduction in the outcome if the prevalence of current smoking was reduced by one or by two percentage points. Currently, prevalence appears to be reducing by approximately 0.5% each year. As a result this document shows some of the potential health gains that could be achieved by increasing the rate of reduction. It does not, however, suggest how such a reduction in smoking prevalence might be achieved.

ScotPHO first released a smoking ready reckoner in 2007. It was prepared by Dr Oliver Harding, who was a Consultant in Public Health Medicine attached to the team at that time. The current document is an update to Dr Harding's work and uses similar methods. Some of the data sources on which calculations are based have been updated to reflect more recently published research.

The Appendices give details of the methodology used in this Ready Reckoner.

Data are presented for Scotland's 14 regional NHS boards plus the total for the whole of Scotland.

Smoking attributable deaths

Table 1 shows the estimated reduction in smoking attributable deaths where deaths are approximated using the method of Peto, Lopez et al[1]. The Peto method is based on using death rates from lung cancer to estimate deaths attributable to smoking. We then used information on estimated smoking prevalence by NHS Board to estimate deaths avoided or delayed if smoking prevalence fell by a specified amount. The results indicate that 539 deaths would have been avoided in Scotland in 2009 if smoking prevalence were reduced by 1%, increasing to 1,078 deaths avoided if smoking prevalence were reduced by 2%.

Table 1: Smoking attributable deaths

Health Board Area	Deaths attributable to smoking (2009)[1]	Estimated Smoking Prevalence (2009-10)[2]	Estimated potential reduction in number of deaths if smoking prevalence was reduced by 1%[3]	Estimated potential reduction in number of deaths if smoking prevalence was reduced by 2%[3]
Ayrshire and Arran	994	25.0%	*40*	*80*
Borders	239	19.9%	*12*	*24*
Dumfries and Galloway	358	20.8%	*17*	*34*
Fife	951	24.4%	*39*	*78*
Forth Valley	615	24.9%	*25*	*49*
Grampian	1,026	22.5%	*46*	*91*
Greater Glasgow and Clyde	4,039	25.9%	*156*	*312*
Highland	677	22.1%	*31*	*61*
Lanarkshire	1,297	27.7%	*47*	*94*
Lothian	1,779	22.0%	*81*	*162*
Orkney	24	15.5%	*2*	*3*
Shetland	15	15.0%	*1*	*2*
Tayside	969	24.7%	*39*	*78*
Western Isles	61	33.5%	*2*	*4*
Scotland	13,044	24%	*539*	*1,078*

[1] Uses the method of calculating smoking attributable deaths first developed by Peto, Lopez et al in *Mortality from smoking in developed countries 1950-2000, 2nd* edition. Results as published in ScotPHO Profiles 2010. More details on the methods can be found in the Appendices.

[2] Source: Scottish Household survey (2009-10): survey of 16-64 year olds – self reported current smoking status. Mean of two-years samples.

[3] Calculated assuming a proportionate reduction in the number of attributable deaths with each percentage point reduction in prevalence of self-reported smoking. Further details can be found in Appendix 1.

Smoking attributable hospital admissions

Table 2 is based on a method for calculating smoking-attributable hospital admissions first published by the Royal College of Physicians[4]. The method compares the observed hospital admission rate among smokers with the rate observed in non-smokers and estimates the impact on admission rates if some of the smokers had always been non-smokers. The figures relate to hospital admissions (continuous inpatient stays [CIS]) and individuals can contribute more than one admission to the total (see Appendix 1). The results suggest an estimated reduction of 2,320 hospital admissions per annum across Scotland if prevalence were reduced by 1%, increasing to 4,641 admissions if prevalence were reduced by 2%.

Table 2: Smoking attributable admissions

Health Board Area	Admissions attributable to smoking (2009)[4]	Estimated Smoking Prevalence (2009-10)[5]	Estimated reduction in number of admissions if smoking prevalence were reduced by 1%[6]	Estimated reduction in number of deaths if smoking prevalence were reduced by 2%[6]
Ayrshire and Arran	4,703	25%	*188*	*376*
Borders	1,229	20%	*62*	*124*
Dumfries and Galloway	1,520	21%	*73*	*146*
Fife	3,797	24%	*156*	*311*
Forth Valley	2,187	25%	*88*	*176*
Grampian	4,916	23%	*218*	*437*
Greater Glasgow and Clyde	14,902	26%	*575*	*1,151*
Highland	3,555	22%	*161*	*322*
Lanarkshire	6,663	28%	*241*	*481*
Lothian	8,081	22%	*367*	*735*
Orkney	199	16%	*13*	*26*
Shetland	135	15%	*9*	*18*
Tayside	3,902	25%	*158*	*316*
Western Isles	365	34%	*11*	*22*
Scotland	***56,153***	***24%***	***2,320***	***4,641***

[4] *Nicotine Addiction in Great Britain.* Available at: http://bookshop.rcplondon.ac.uk/details.aspx?e=131.

[5] Source: Scottish Household survey (2009-10): survey of 16-64 year olds – self reported current smoking status. Mean of two-years samples.

[6] Calculated assuming a proportionate reduction in the number of attributable admissions with each percentage point reduction in prevalence of self-reported smoking. Further details can be found in Appendix 1.

Smoking attributable Costs

Two methods of calculating smoking attributable costs are shown below. The first uses a global estimate of 3.53% of NHS operating costs attributable to smoking as given in the report "The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006–07 NHS costs" by Scarborough et al.(7). The second, larger estimate, of 5.48% of NHS operating costs attributable to smoking is taken from a study by Allender et al.(11).

The Scarborough methodology shows a potential reduction in NHS spending of approximately £13.4 million across Scotland with a 1% reduction in prevalence of current smoking and £26.8 million following a 2% reduction in prevalence (see Table 3). The Allender methodology shows a potential reduction in NHS spending of approximately £20.8 million across Scotland with a 1% reduction in prevalence and £41.6 million following a 2% reduction in prevalence (see Table 4).

Table 3: Smoking Attributable Costs (in Millions) (Scarborough estimate)

Health Board Area	Percentage of global NHS operating costs attributable to smoking[7]	Costs attributable to smoking (2009)[8]	Estimated Smoking Prevalence (2009-10)[9]	Estimated potential reduction in NHS expenditure if smoking prevalence were reduced by 1%[10]	Estimated potential reduction in NHS expenditure if smoking prevalence were reduced by 2%[10]
Ayrshire and Arran	3.53%	£22.2M	25%	*£0.9M*	*£1.8M*
Borders		£6.1M	20%	*£0.3M*	*£0.6M*
Dumfries and Galloway		£9.2M	21%	*£0.4M*	*£0.9M*
Fife		£19.3M	24%	*£0.8M*	*£1.6M*
Forth Valley		£15,1M	25%	*£0.6M*	*£1.2M*
Grampian		£30,0M	23%	*£1.3M*	*£2.7M*
Greater Glasgow and Clyde		£90.5M	26%	*£3.5M*	*£7.0M*
Highland		£19.3M	22%	*£0.9M*	*£1.7M*
Lanarkshire		£29.9M	28%	*£1.1M*	*£2.2M*
Lothian		£49.4M	22%	*£2.2M*	*£4.5M*
Orkney		£1.3M	16%	*£0.1M*	*£0.2M*
Shetland		£1.4M	15%	*£0.1M*	*£0.2M*
Tayside		£27.1M	25%	*£1.1M*	*£2.2M*
Western Isles		£2.2M	34%	*£0.1M*	*£0.1M*
Scotland	***3.53%***	***£323M***	***24%***	***£13.4M***	***£26.8M***

[7] Source: The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006–07 NHS costs. Scarborough et al, Journal of Public Health, 2011. More information can be found in Appendix 1.

[8] Calculated by applying the fraction given in the first column of this table to operating costs for each NHS board as given in 2009 costs book: http://www.isdscotlandarchive.scot.nhs.uk/isd/6480.html

[9] Source: Scottish Household survey (2009-10): survey of 16-64 year olds – self reported current smoking status. Mean of two-years samples.

[10] Calculated assuming a proportionate reduction in the number of attributable admissions with each percentage point reduction in prevalence of self-reported smoking. Further details can be found in Appendix 1.

Table 4: Smoking attributable costs (in Millions) (Allender estimate)

Health Board Area	Percentage of global NHS operating costs attributable to smoking[11]	Costs attributable to smoking (2009)[12]	Estimated Smoking Prevalence (2009-10)[13]	Estimated potential reduction in NHS expenditure if smoking prevalence were reduced by 1% [14]	Estimated potential reduction in NHS expenditure if smoking prevalence were reduced by 2% [13]
Ayrshire and Arran	5.48%	£34.5M	25%	*£1.4M*	*£2.8M*
Borders		£9.5M	20%	*£0.5M*	*£1.0M*
Dumfries and Galloway		£14.4M	21%	*£0.7M*	*£1.4M*
Fife		£29.9M	24%	*£1.2M*	*£2.5M*
Forth Valley		£23.5M	25%	*£0.9M*	*£1.9M*
Grampian		£46.6M	23%	*£2.1M*	*£4.1M*
Greater Glasgow and Clyde		£140.4M	26%	*£5.4M*	*£10.8M*
Highland		£30.0M	22%	*£1.4M*	*£2.7M*
Lanarkshire		£46.5M	28%	*£1.7M*	*£3.4M*
Lothian		£76.7M	22%	*£3.5M*	*£7.0M*
Orkney		£2.0M	16%	*£0.1M*	*£0.3M*
Shetland		£2.2M	15%	*£0.15M*	*£0.3M*
Tayside		£42.0M	25%	*£1.7M*	*£3.4M*
Western Isles		£3.4M	34%	*£0.1M*	*£0.2M*
Scotland	***5.48%***	***£509.7M***	***24%***	***£20. 8M***	***£41.6M***

[11] Source: Allender, S. et al *the burden of smoking-related ill health in the UK.* Tobacco Control 2009 18: 262-267.
[12] Calculated by applying the fraction given in the first column of this table to operating costs for each NHS board as given in 2009 costs book: http://www.isdscotlandarchive.scot.nhs.uk/isd/6480.html
[13] Source: Scottish Household survey (2009-10): survey of 16-64 year olds – self reported current smoking status. Mean of two-years samples.
[14] Calculated assuming a proportionate reduction in the number of attributable admissions with each percentage point reduction in prevalence of self-reported smoking. Further details can be found in Appendix 1.

APPENDIX 1 – Technical Note

Smoking Attributable Deaths

Peto, Lopez et al.[15] used a complex algorithm for calculating smoking attributable mortality across the world (see details in Appendix 2). The basic premise of their approach is that the ratio of lung cancer mortality rates between current smokers and never smokers (a quantity known as the *smoking impact ratio*) is a reliable indicator of cumulative exposure to tobacco smoke. The ability to calculate this ratio is predicated upon the availability of data from a relevant longitudinal study of smoking habits and health outcomes. Peto and Lopez use the smoking impact ratio from the American Cancer Society CPS-II cohort study – a large prospective study with over 1 million subjects and which is broadly accepted as a robust enquiry into cancer mortality. Nevertheless, in an attempt to provide a conservative estimate, Peto halved the CPS-II excess mortality ratio when calculating the attributable fractions for causes other than lung cancer. It is therefore conceivable that the actual number of smoking attributable deaths in a given country or area is significantly higher than is suggested by Peto's estimates.

Peto published a comprehensive assessment in 2004 comparing smoking attributable mortality in several countries in 2000. At this time, Peto's calculations suggested that in the UK 26% of male deaths and 14% of female deaths were attributable to smoking. In the original Smoking Ready Reckoner we simply applied the summary percentage figures to total death counts for NHS Boards for the calendar year 2002.

Jill Boreham, the lead statistician in the Peto-Lopez collaboration, provided smoking attributable deaths by NHS Boards for 2007-09 for the 2010 ScotPHO Profiles.[16] She estimated that 24.1% of premature deaths in Scotland during this period were attributed to smoking. The current Ready Reckoner applies these NHS Board level estimates to 2009 deaths (as reported by National Records for Scotland (NRS)) for each NHS board.

An estimate of the population of current smokers in each NHS Board in 2009 was calculated as the population aged 16 years or over for that NHS Board (from NRS) multiplied by the NHS Board level smoking prevalence estimates from the Scottish Household Surveys for 2009-10 combined[17].

The smoking attributable mortality rate for each NHS Board was calculated as the number of smoking attributable deaths divided by the local smoking population.

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[15] *Mortality from smoking in developed countries 1950-2000,* 2nd edition. Available at http://www.ctsu.ox.ac.uk/~tobacco/

[16] http://www.scotpho.org.uk/profiles

[17] SHoS: http://scotland.gov.uk/Topics/Statistics/16002/SurveyOverview/

Next, the 'modelled' smoking population was estimated if there was a one percentage point reduction in smoking prevalence. The previously calculated smoking attributable mortality rate was applied to this figure to gain an estimate of the number of smoking related deaths following a reduction in prevalence. This figure was subtracted from the previously calculated estimate of smoking deaths to indicate the reduction in smoking attributable deaths.

Smoking attributable admissions

The Scottish Morbidity Record **(**SMR01**)** is an episode-based record relating to all inpatients and day cases discharged from non-psychiatric, non-obstetric wards in Scottish hospitals (acute hospital admissions). We counted all smoking attributable hospital continuous inpatient stays (CIS) with a discharge date in 2009. A CIS can contain multiple diagnoses as a person moves within the hospital during their stay. For each CIS we took the diagnosis (principal diagnosis field only) with the highest attributable fraction (see below) and then summed up all the fractions for all admissions within the year.

Using the same methodology as the original ScotPHO Smoking Ready Reckoner, we used smoking attributable fractions published by the Royal College of Physicians (RCP) in 2000.[18] Though the RCP report states that these codes and fractions were used to calculate admissions, they appear to have taken the codeset from another publication by Callum et al[19] which used the codeset to calculate attributable *deaths*. This same codeset was also used by the Health Development Agency in their 2004 report 'The Smoking Epidemic in England'[20] to calculate attributable deaths. Table T1 lists the ICD10 codes and the attributable fractions that were used to calculate smoking attributable hospital admissions in this report.

The steps taken to calculate the reduction in admissions following a percentage point fall in smoking prevalence were similar to those previously outlined for smoking related deaths. A smoking attributable admission rate *among smokers* was calculated. This rate was then applied to a 'modelled' smoking population that resulted from a single percentage point fall in prevalence. The difference between the current and the modelled admissions is given in table 2 of the Ready Reckoner.

[18] *Nicotine Addiction in Great Britain.* Available at: http://bookshop.rcplondon.ac.uk/details.aspx?e=131
[19] Callum, C. (1998), The UK Smoking Epidemic: deaths in 1995. London: Health Education Authority.
[20] Twigg et al (2004),The smoking epidemic in England. London: Health Development Agency.

Appendix T1: ICD10 Codes and Attributable Fractions used by Royal College of Physicians (2000)

Disease Grouping	ICD Codes Used	Attributable Fraction (Males)	Attributable Fraction (Females)
Lung Cancer	C33 and C34	90%	77%
Upper Respiratory Cancer	C00-C14 C32	75%	53%
Oesophagus Cancer	C15	71%	66%
Bladder Cancer	C67	47%	19%
Kidney Cancer	C65	41%	7%
Stomach Cancer	C16	35%	11%
Pancreas Cancer	C25	21%	28%
Cancer of unspecified site	C76-C80	25%	4%
Myeloid Leukaemia	C92	19%	11%
COPD	J40-J47	86%	82%
Pneumonia	J12-J18	26%	20%
Ischaemic Heart Disease	I20-I25	34%	23%
Cerebrovascular Disease	I60-I69	19%	18%
Aortic Aneurysm	I71	62%	55%
Atherosclerosis	I70	19%	13%
Stomach or duodenal ulcer	K25-K28	49%	51%
Diseases where smoking confers some protection			
Parkinson's Disease	G20	56%	30%
Endometrial Cancer	C54	n/a	17%

Smoking attributable NHS costs

The 2009 Costs Book represents the financial accounts for NHS Scotland for the financial year ending 31st March 2009[21]. There are a large number of accounting and auditing systems in place to ensure the accuracy of these estimates.

Smoking related conditions account for a significant portion of the resources of special health boards but as these do not generally deal with patients directly, they have been excluded from this analysis.

The original Ready Reckoner applied figures derived from a 1998 study by Parrot et al[22] to calculate the costs to the NHS of treating smoking related conditions. The Parrot study is now somewhat out of date but work with a similar focus has been done since that paper was published. Parrot used two methods to calculate smoking related costs but also noted that smoking accounted for approximately 3% of global costs for a notional health authority. Rather than using complex methods to arrive at a total cost figure, the approach in this version of the Ready Reckoner is to apply more recent, summary percentage estimates of global NHS costs to financial figures for Scottish Health Boards.

[21] http://www.isdscotland.org/Health-Topics/Finance/Costs/costs-archive.asp

[22] Parrot et al. Guidance for commissioners on the cost effectiveness of smoking cessation interventions. *Thorax* 1998:53(Supplement 5): S1-S37 (December).

Three publications have appeared in recent years that give a summary figure of smoking-related NHS costs. The first was by Allender et al,[23] which suggested that smoking accounted for £5.2billion or 5.48% of the NHS budget in the UK in 2005-6. The authors of this paper suggested this figure may be an underestimate as they did not estimate the costs resulting from passive smoking-related disease and they suggested that there are diseases to whose aetiology the contribution of smoking has not yet been quantified.

The Allender paper received media attention[24] but was the subject of an academic response in the same journal by Callum.[25] Callum made two challenges to the Allender figures. She questioned the manner in which costs were apportioned to particular disease types and also the population attributable fractions that were used. She suggested that more realistic estimated smoking costs should be between 3.37% and 3.87% of NHS operating figures.

A more recent paper by Scarborough et al,[26] which included Allender amongst the co-authors addresses the concerns raised by Callum. In this paper, two percentage figures were presented: treating smoking related conditions accounted for £3.3 billion or 3.53% of the budget for financial year 2006/07.

The Ready Reckoner presents two figures for cost savings in association with a 1% fall in smoking prevalence. The first figure applies the Scarborough estimate of 3.53% to NHS Board Costs and the second figure applies the 5.48% estimate by Allender. Even though Allender's methods have been disputed, he does make a valid point about his figures underestimating the true costs to the NHS and this possibility still applies to the more up to date methodology of Scarborough. Therefore, it seems reasonable to include a higher cost estimate in the Ready Reckoner so that readers have an idea of a range of costs that may result from smoking and the cost savings that might ensue should there be a reduction in prevalence.

Using the estimated percentage of global NHS costs that are attributable to smoking given in the papers of Scarborough and Allen, each board's smoking attributable cost was calculated. Using smoking prevalence estimates applied to local population estimates, a 'cost per smoker' was calculated. This fixed cost was then applied to the smoking population that would exist were there to be a single percentage point fall in smoking prevalence. The difference between the

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[23] Allender, S. et al. The burden of smoking related ill health in the UK. *Tobacco Control* 2009; 18:262-267.

[24] For example: http://news.bbc.co.uk/1/hi/health/8086142.stm and http://www.independent.co.uk/life-style/health-and-families/health-news/smoking-costs-nhs-pound5bn-a-year-1700509.html

[25] Callum, C. Overestimated of cost of smoking to the NHS: A response to 'The burden of smoking related ill health in the UK' by Allender et al. *Tobacco Control* 2009; 18:262-267. Available at: http://tobaccocontrol.bmj.com/content/18/4/262/reply

[26] Scarborough, P. et al. The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006-07 costs.

modelled cost figure and the current cost figure for each NHS board is given in the final column of the table in the Ready Reckoner.

Ready Reckoner assumptions

There is an assumption within the Ready Reckoner that there is a direct relationship between prevalence of current smoking (or at least self-reported prevalence among 16-64 year olds) and smoking attributable deaths, costs and admissions. This Ready Reckoner assumes that there is a simple linear relationship between current smoking prevalence and the burden of disease. The true relationship is unlikely to be linear as the people who give up smoking first may be the lightest smokers or those who have been smoking for shorter periods of time. Their risk of developing disease would be lower than those who have heavier, more well-established smoking habits. An initial reduction in prevalence is unlikely to yield the savings suggested within the Ready Reckoner, though further reductions beyond 2% may come closer.

A further issue with the calculation of costs is that a huge portion of the non-smoking population require NHS treatment. Those individuals who successfully quit smoking are still likely to require some form of NHS treatment for the rest of their life. Such treatment will have a cost associated with it and so the cost savings given in the Ready Reckoner will be somewhat mitigated by the cost of treating disease that is not attributable to smoking or is attributable to being an ex-smoker

Error margins

Although the estimated potential savings are presented as unit figures, this implies a greater level of accuracy than is valid. There are inaccuracies and assumptions at every stage of calculation. These inaccuracies may be multiplicative rather than additive. For example, the Scottish Household Survey may not detect a drop of 1% in smoking prevalence unless the sample size is increased dramatically. It is beyond the scope of this work to produce accurate error margins for the estimates presented: the intention of the Ready Reckoner is to give a reasonable overview of the gains that might be made. At the least, a margin of error for costs, admissions and deaths of +/- 10% is likely to be appropriate.

APPENDIX 2: Description of Peto et al's method for calculating smoking attributable deaths.

At the centre of the method is the excess mortality ratio of smokers to non-smokers for lung cancer in the American Cancer Society CPS-II cohort study. Peto et al assume that the non-smoker lung cancer death rate is the same in the population of interest as it is in the CPS-II study.

For each age and for each age group in the target population (i), first define:

$Ri = Li/Ai$

Where *Li* is the lung cancer mortality rate in the target group and Ai is the smoothed non-smoker lung cancer mortality rate in the CPS-II cohort.

Calculate the smoking impact ratio *Ii*

$Ii = Ri - 1$

This is equivalent to $(Li-Ai)/Ai$ which is the excess ratio due to smoking in the target population, assuming the non-smoker mortality rate in the target population is the same as in the CPS-II cohort.

Next, calculate *Fi* – it should be noted that in contrast to Peto et al, some analysts call *Fi* the smoking impact ratio .

$Fi = Ii/Si$

Where *Si* is the CPS-II excess mortality ratio for lung cancer.

Peto et al use 9 groups of mortality causes as follows

1 = Lung cancers
2 = Upper aero-digestive cancers
3 = Other cancers
4 = Chronic obstructive pulmonary disease
5 = Other respiratory disease
6 = Vascular disease
7 = Cirrhotic liver disease
8 = Other medical causes
9 = External cuases

For each cause of death *k* (where *k* = 1 to 9), define *Eik:*

Either

For *k* = 1 to 4
*Eik = Fi*Mk*

Where Mk is the CPS-II excess mortality ratio for cause of death *k* for all ages (35+).

Or

For *k*= 5,6 and 8

*Eik = Fi*Vi*

Where *Vi* is the CPS-II exess mortality ratio for vascular disease plus other respiratory diseases plus other medical causes in age group *i*.

Or

For *k* = 7 or 9, no deaths are attributed to these causes

Eik = 0

So, for **lung cancer,** attributable fraction (*B*) is given as

B = Eik / (Eik+1)

For **all other diseases** , the excess mortality is halved to provide a conservative estimate:

B = (Eik/2)/(1+Eik/2) which is equivalent to *B = Eik/(Eik+2)*

Finally, smoking attributable deaths *Djk* for the target population from cause *k* in age group j is given as:

*Djk = Bik*Njk*

Where *Njk* is the total number of deaths from cause *k* in age group *j* for the target population.