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An Economic Evaluation of Different Interventions to Promote Tobacco Harm Reduction

Final Report

Providing Consultancy & Research in Health Economics

DR MATTHEW TAYLOR, Deputy Director
LILY LEWIS, Research Assistant

THE UNIVERSITY of York
INVESTORS IN PEOPLE

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Section 1: Introduction

1.1 BACKGROUND

The National Institute for Health and Clinical Excellence (NICE) has commissioned the development of an economic model for the evaluation of interventions to reduce harm from tobacco use.

Smoking is linked to many health related problems including an increased risk of cancer, heart disease, digestive problems, dementia, stomach/duodenal ulcer, impotence and infertility. It is also linked with complications of pregnancy and low birth weight, osteoporosis, cataracts, age-related muscle degeneration, periodontitis, lower survival rates after surgery, delayed wound healing and postoperative respiratory complications. It is thought that approximately 80% to 90% of chronic obstructive pulmonary disease (COPD) is caused by smoking.

Smoking not only affects the smoker but also those around them. In the short term, passive smoking can exacerbate respiratory symptoms and trigger asthma attacks. In the longer term it can increase the risk of lung cancer, respiratory illness, heart disease and stroke.

The NHS provides services to assist smokers who wish to quit outright, or to reduce their level of tobacco use. A wide range of potential interventions are available, including services for the provision of counselling and support to smokers who want to quit and the provision of stop smoking aids such as nicotine containing products (NCP) and pharmacological therapies (such as bupropion and varenicline).

There is evidence that smoking cessation services work. Previous modelling commissioned by NICE has demonstrated that the health gains associated with quitting smoking are significant. Further, cost savings can be substantial. However, there is relatively little evidence around the effectiveness and cost-effectiveness of interventions aimed at tobacco harm reduction. That is, those interventions aimed at reducing the level of smoking (i.e. tobacco intake), as opposed to actually quitting smoking.

1.2 AIMS

The aim of this project is to determine the cost-effectiveness of interventions for reducing the harm caused by smoking, either by quitting (with the support of long-term nicotine containing products), or by reducing the level of tobacco intake. Specifically, the model will assess the costs and outcomes associated with a range of different interventions. The model will estimate the following outcomes:

- Life years;
- Quality-adjusted life years (QALYs);
- Total lifetime costs;
- Number of co-morbidities.

Outputs will be assessed on both an individual basis, and for a 'population' cohort.

Section 2: Methods

2.1 MODEL DESIGN

A cohort simulation model was designed to estimate the costs and quality-adjusted life years (QALYs) associated with interventions to reduce tobacco harm (either by quitting or reducing smoking) and to determine and compare different interventions' relative cost-effectiveness. A hypothetical cohort of 1,000 smokers (representative of a population of typical smokers who may potentially benefit from tobacco harm reduction strategies[1]) was assembled; this was intended for use in a simulated 'population cohort' approach with modelling in annual cycles over cohort smokers' lifetimes. In each cycle, smokers could:

- Quit smoking (i.e. become a former smoker);
- Reduce their level of smoking (i.e. become a low-level smoker, defined in this model as being below 15 cigarettes per day)
- Relapse after quitting or reducing (i.e. returning to being a 'smoker);
- Die.

The probabilities of each event depend upon several factors, such as the effectiveness of an intervention, and patient's baseline characteristics.

Each person's smoking status also dictates their likelihood of experiencing one of five co-morbidities that are built into the model. The probability of each co-morbidity (on an annual basis) is dependent upon the person's smoking status *and* their age. The co-morbidities included in the model (in addition to all-cause mortality) are:

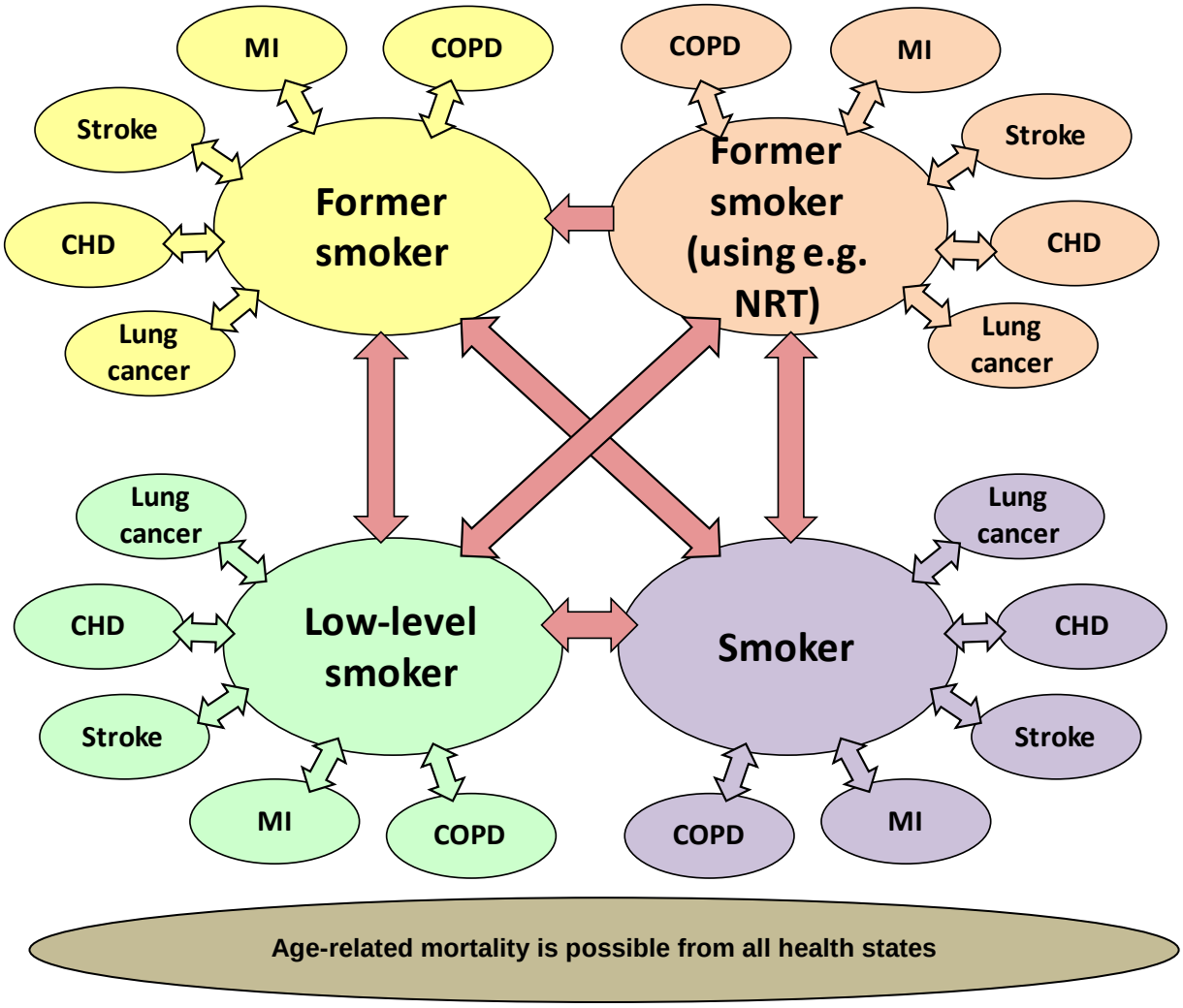
- Lung cancer;
- Chronic obstructive pulmonary disease (COPD);
- Myocardial infarction;
- Stroke;
- Coronary heart disease (CHD).

It is noted that myocardial infarction is a subset of CHD. However, it is felt that the impact of smoking status on the rates of MI and CHD may differ substantially enough to treat the two as mutually exclusive states within the model. As such, 'CHD' should be viewed as 'coronary heart disease other than myocardial infaction'.

Figure 2.1, below, demonstrates the relationships between smoking status and smokers' co-morbidities permitted by model which are explained further below.

[1] Note that the characteristics of the cohort can be changed for subgroup or 'target population' scenarios in the model.

Figure 2.1: Movement between health states (note that a smoker can have more than one co-morbidity at any one time)



The probability of patients moving between smoking different smoking status (i.e. the pink arrows) are based on the effectiveness of each intervention, and vary over time. These can be summarised as follows:

Figure 2.2: Description of movements between health states

		Current smoking status			
		Former smoker	Former smoker (using NCP)	Low-level smoker	Smoker
Smoking status in next cycle	Former smoker	Former smoker remains abstinent	Non-smoking nicotine user stops using nicotine	Low-level smoker quits smoking completely	Smoker quits smoking completely
	Former smoker (using NCP)	[Assumed to not happen in this model]	Former smoker using NCP continues to use NCP	Low-level smoker quits smoking, but continues to use nicotine	Smoker quits smoking, but continues to use nicotine
	Low-level smoker	Former smoker relapses to low-level smoking	Former smoker using NCP relapses to low-level smoking	Low-level smoker remains a low-level smoker	Smoker reduces tobacco intake
	Smoker	Former smoker relapses to high tobacco intake	Former smoker using NCP relapses to high tobacco intake	Low-level smoker relapses back to high tobacco intake	Smoker remains a smoker

In each annual cycle, all people remaining alive have a chance of experiencing one or more of five potential co-morbidities (see Figure 2.1). The probability of experiencing each co-morbidity is based on disease prevalence rates, and is calculated based on two factors:

- Smoking status;
- The person's age.

For example, the model contains specific rates for each age (by year) and smoking status (e.g. a 55 year old smoking male has an 'x' per cent probability of experiencing lung cancer, a 'y' per cent probability of experiencing a myocardial infarction, and so forth). The risk of each co-morbidity was calculated as follows:

Firstly, estimates for the prevalences of each co-morbidity within regular and former smokers of different ages and genders were calculated; Section 2.3.2 gives details of methods used. To calculate the number of people with co-morbidities, in each cycle, the numbers of smokers and former smokers were multiplied by the estimated prevalences (e.g. to calculate the number of smokers with lung cancer, the number of smokers in each cycle was multiplied by the prevalence of lung cancer amongst smokers). One qualification is that, as there were insufficient available data on the relative risks of former smokers experiencing co-morbidities, the model could not take into account the impact of the length of abstinence from smoking amongst former smokers; therefore, the same probabilities of each co-morbidity are attributed to recent or long term ex-smokers (these are, however, adjusted for different age groups).

The likelihood of a cohort individual developing one or more co-morbidities in each cycle changes with their increasing age and their probability of being a smoker, low-level smoker or former smoker also alters. Each co-morbidity has an associated cost and utility (quality of life); to enable the total costs and utilities of the interventions to be compared with 'no intervention', the number of people with each co-morbidity was, within each cycle, multiplied by the associated cost/utility of that co-morbidity, giving an estimated cost/utility for each co-morbidity, and these were summed together to calculate an overall estimate for total cost/utility.

Where people experience more than one co-morbidity in the model, the following assumptions are made:

- The cost of each co-morbidity is incurred, in an additive fashion (i.e. a person experiencing lung cancer *and* CHD will incur the cost of both;
- The quality of life of the patient will be equivalent to that of the more severe condition (i.e. that with the lowest utility value).

2.2 STUDY POPULATION

The model generates average (or 'expected') outcomes for specific baseline characteristics (i.e. the outcomes are calculated for a person of a pre-specified age and smoking status). However, results are calculated for every possible baseline characteristic, and the model then produces a 'weighted average' output, based on the known demographics of the assessed group.

Population weights derived from population estimates provided by the Office for National Statistics were applied to each cohort group, to ensure that the cohort was representative of the England and Wales population. The costs and QALY outcomes for each age group were also multiplied by these weights to ensure overall QALY and cost outcomes were similarly representative. Weighted cohort simulations were not used to reflect socio-demographic characteristics other than age; theoretically this would only have been possible using data on variations in model parameters (e.g. rates of complications, co-morbidities, smoking status, etc.) with these characteristics, but such data were unavailable.

2.3 DATA

This section describes the data sources from which estimates for parameters used in the cohort simulation were derived.

2.3.1 Mortality by age and smoking status

We estimated mortality by age, gender and smoking status, reflecting general population mortality rates for the cohort, using a number of data sources. Firstly, mortality rates per 1,000 population and smoking exposure data from Doll *et al.* 2004, a study of doctors' mortality, were used to derive odds ratios for mortality amongst former (A) and non-smokers (B), compared with current smokers (see Table 2.1). The Actuary Life Tables provide the 'real' mortality for each age (C) and the prevalence of smoking for each age and gender (D) was taken from the Health Survey for England 2004 (Table 2.4). These data were used to calculate the actual mortality rates for smokers (E), former smokers (F) and non-smokers (G), by ensuring that the following equation was satisfied:

$$(E \times D1) + (F \times D2) + (G \times D3) = C$$

Where E:F = the odds ratio, A; E:G = B

This calculation is best illustrated by example; taking a 44 year old and substituting the prevalence of smoking and the actual mortality rate into the equation gives:

$$(E \times 0.26) + (F \times 0.21) + (G \times 0.53) = 0.002144$$

Further substituting the odds ratios reduces the equation to:

$$(E \times 0.26) + (E \times 0.21 \times 0.7143) + (E \times 0.53 \times 0.571) = 0.002144$$

This allows the equation to be solved as follows, to give an accurate estimate of the mortality for a 44 year old smoker, former smoker and non-smoker:

$$(E) = \frac{0.002144}{(0.26 + (0.21 \times 0.71423) + (0.53 \times 0.571))}$$

$$(E) = 0.0030$$

$$(F) = 0.002$$

$$(G) = 0.0017$$

This process was repeated for all ages. It should also be noted, here, that the *ratios* taken from Doll *et al*. were applied to the general population mortality rates. Therefore, although he Doll *et al*. rates were based on males only, the ratios were applied to the underlying mortality risk for men and women.

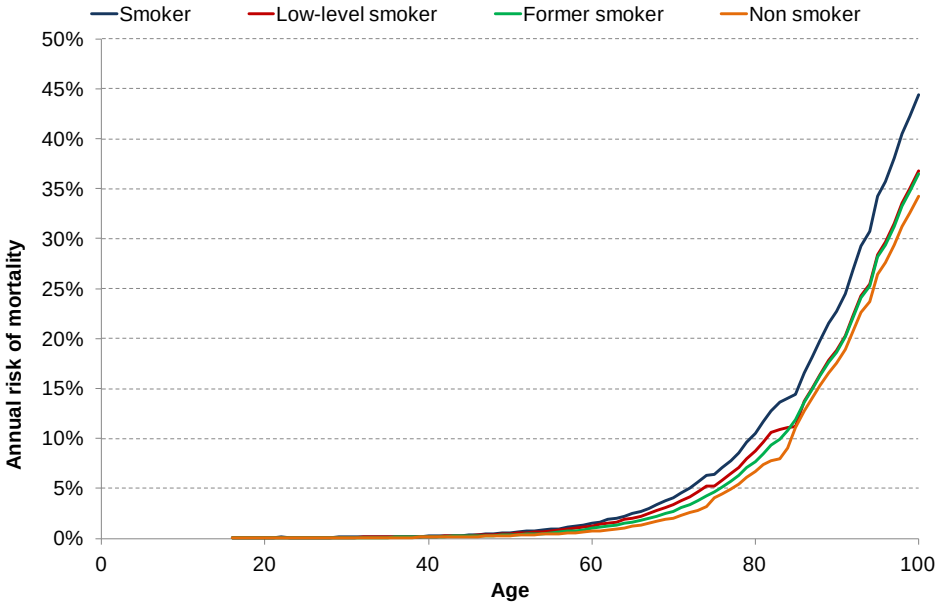
One final note should be made that, since the rates of mortality were drawn from the 2004 Doll study, these had to be modified (as shown above) to reflect the different overall rates for smokers, low-level smokers and former smokers. It was essential that the proportion of smokers, low-level smokers and former smokers was drawn *from the same time period* as that of the overall mortality rates (i.e. from 2004). As such, the Health Survey from 2004 was used to disentangle the mortality rates for each smoking status. Of course, in 2012, smoking levels are much lower than in 2004. This is reflected in the current model, leading to improved overall survival rates compared to the outcomes predicted by Doll (which was based on a higher level of smoking).

Table 2.1: Mortality by age, per 1,000

Age at death	Doll 1994			Doll 2004				
	Current smoker	Former	Non-smoker	Current smoker	Former smoker, by age stopped			Non-smoker
					35-44	45-54	55-64	
35-44	2.8	2	1.60	2.7	-	-	-	1.6
45-54	8.1	4.9	4.00	8.5	5.4	-	-	3.8
55-64	20.3	13.4	9.50	21.4	9.0	16.4	-	8.4
65-74	47	31.6	23.70	50.7	22.7	31.7	36.4	18.6
75-84	106	77.3	67.40	112.2	53.1	39.1	78.9	51.7
85+	218.7	179.7	168.60	-	-	-	-	-

In the same study by Doll (2004), it was demonstrated that low-level (i.e. those smoking fewer than 15 cigarettes per day) smokers had a mortality risk ratio of 0.829 compared to smokers. This ratio was, therefore, applied to the low-level smoking group.

Figure 2.3: Annual risk of all-cause mortality, by age and smoking status



2.3.2 Prevalence of co-morbidities by age and smoking status

We searched for information concerning: i) the prevalence, by age, of each co-morbidity in the general population, regardless of smoking status (A), ii) the relative risk of each co-morbidity by smoking status [i.e. smokers, low level smokers, former smokers (B) and non-smokers (C)] and ii) the prevalence of smoking in England and Wales (D) (Appendix H). These data were used to calculate the prevalence of each co-morbidity within current (E), former (F) and non-smokers (G), by ensuring that the following equation was satisfied:

$$(E \times D1) + (F \times D2) + (G \times D3) = A$$

Where E:F = the odds ratio, B; G:F = the odds ratio C.

This can be illustrated using the example of a 60-year-old person with lung cancer. The prevalence of lung cancer comes from Table 2.2 (Forman *et al.* 2003[6]), the relative risk of lung cancer from Table 2.3 (Peto *et al.* 2000[7]) and the prevalence of smoking from Table 2.4 (Health Survey for England 2004).

Table 2.2: Prevalence of lung cancer

Age	Prevalence
0-44	0.00%
45-64	***0.15%***
65+	0.80%
All ages	0.14%

Table 2.3: Relative risk of lung cancer by smoking status

	Smoker	Former smoker	Non smoker
RR	1	0.44	0.03

Table 2.4: The prevalence of smoking for men (women)*

Age	Current cigarette smoker (D1)	Ex-regular cigarette smoker (D2)	Never regularly smoked cigarettes (D3)
16-24	0.25 (0.29)	0.05 (0.07)	0.69 (0.64)
25-34	0.37 (0.28)	0.14 (0.16)	0.49 (0.56)
35-44	0.26 (0.27)	0.21 (0.18)	0.53 (0.55)
45-54	0.25 (0.25)	0.30 (0.24)	0.44 (0.51)
55-64	**0.19** (0.20)	**0.44** (0.30)	**0.36** (0.50)
65-74	0.10 (0.13)	0.56 (0.29)	0.34 (0.57)
75+	0.07 (0.09)	0.61(0.34)	0.32 (0.57)
All ages	**0.24 (0.23)**	**0.29 (0.22)**	**0.47 (0.56)**

* The figures in brackets indicate the female prevalence figures

- Substituting the prevalence of smoking and the actual prevalence rate:

$$(E \times 0.19) + (F \times 0.44) + (G \times 0.36) = 0.15\%$$

- Substituting the odds ratios:

$$(E \times 0.19) + (E \times 0.44 \times 0.44) + (E \times 0.36 \times 0.03) = 0.15\%$$

$$(E) = \frac{0.15\%}{(0.19 + (0.44 \times 0.44) + (0.36 \times 0.03))}$$

$$(E) = 0.0038$$

$$(F) = 0.0017$$

$$(G) = 0.0001$$

It is further known that the relative risk of lung cancer for low-level smokers compared to smokers is 0.483 (Bjartveit *et al*., 2005). Therefore, the rates for all smoking status levels, by age can be calculated.

This process was repeated for all age and gender categories within each co-morbidity. The prevalence of each co-morbidity, the relative risk by smoking status and resulting prevalence by age, gender and smoking status are shown in Figures 2.4 to 2.8.

It may be noted that the risk of each co-morbidity, by age, appears as a 'stepped' function in the Figures below. This is because the risk are reported for various 'bands' of ages in each study. Whilst it is possible to fit parametric functions to such curves in order to derive 'smoothed' curves, there remain a number of uncertainties around the curve fitting, namely:

- Different parametric approaches (e.g. exponential, polynomial, inverse Weibull, inverse lognormal, inverse Gompertz, inverse loglogistic) would each give different values and there is no clear consensus on the most appropriate approach;
- The use of parametric functions introduces illogical values (e.g. negative risks). Whilst these can be limited by assumptions, this often means that the minimised least squares or minimised weighted least squares approach to curve fitting would be potentially underestimating the 'true' risks for the older people in the model.

Figure 2.4: Annual risk of lung cancer, by age and smoking status

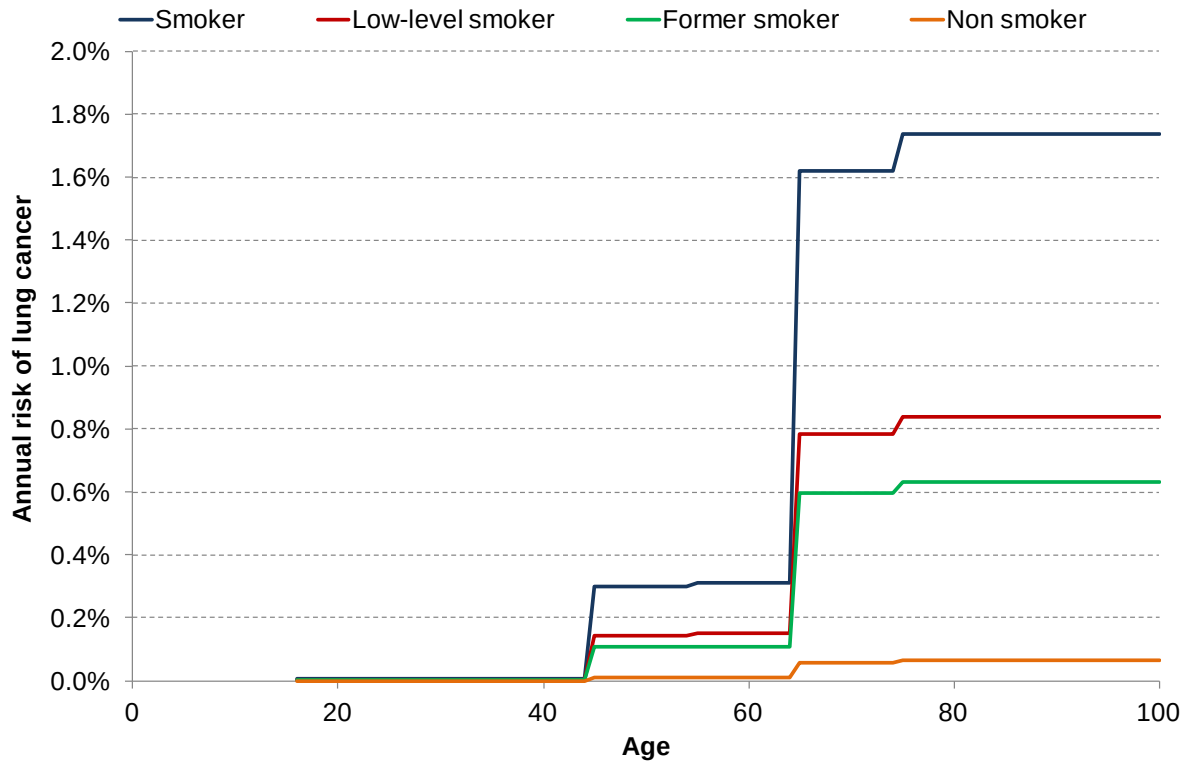


Figure 2.5: Annual risk of myocardial infarction, by age and smoking status

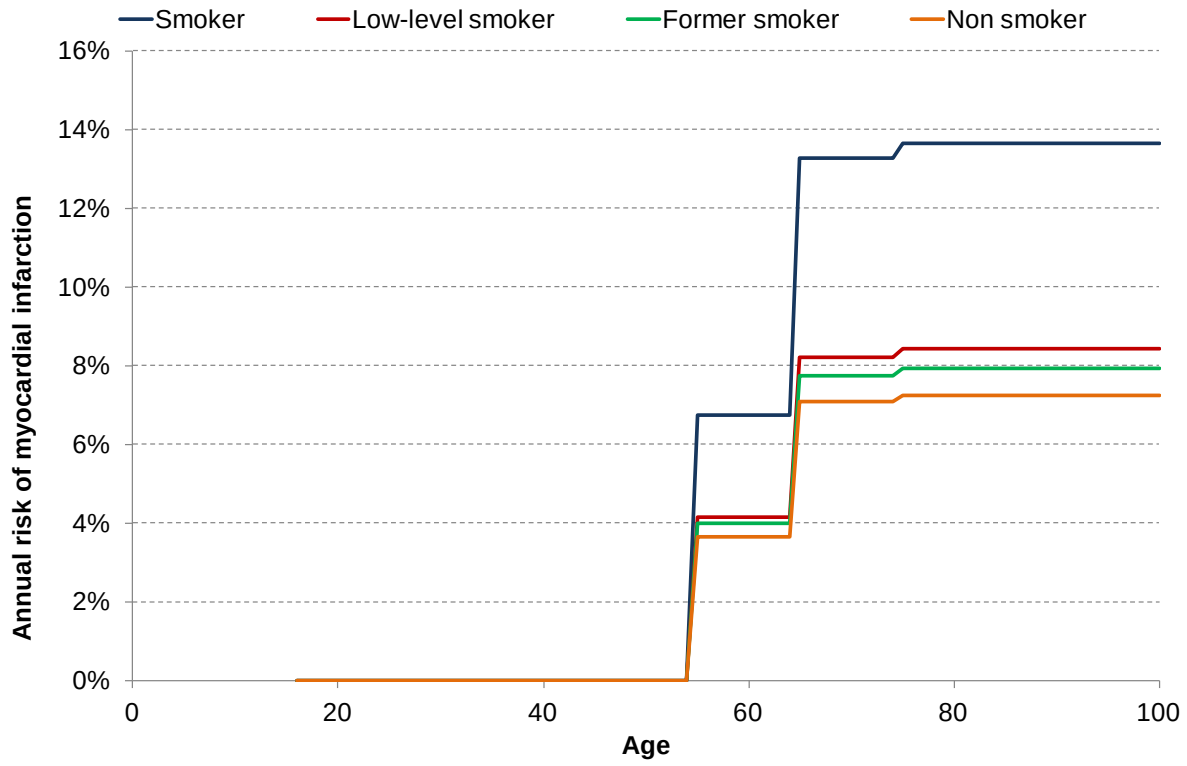


Figure 2.6: Annual risk of coronary heart disease, by age and smoking status

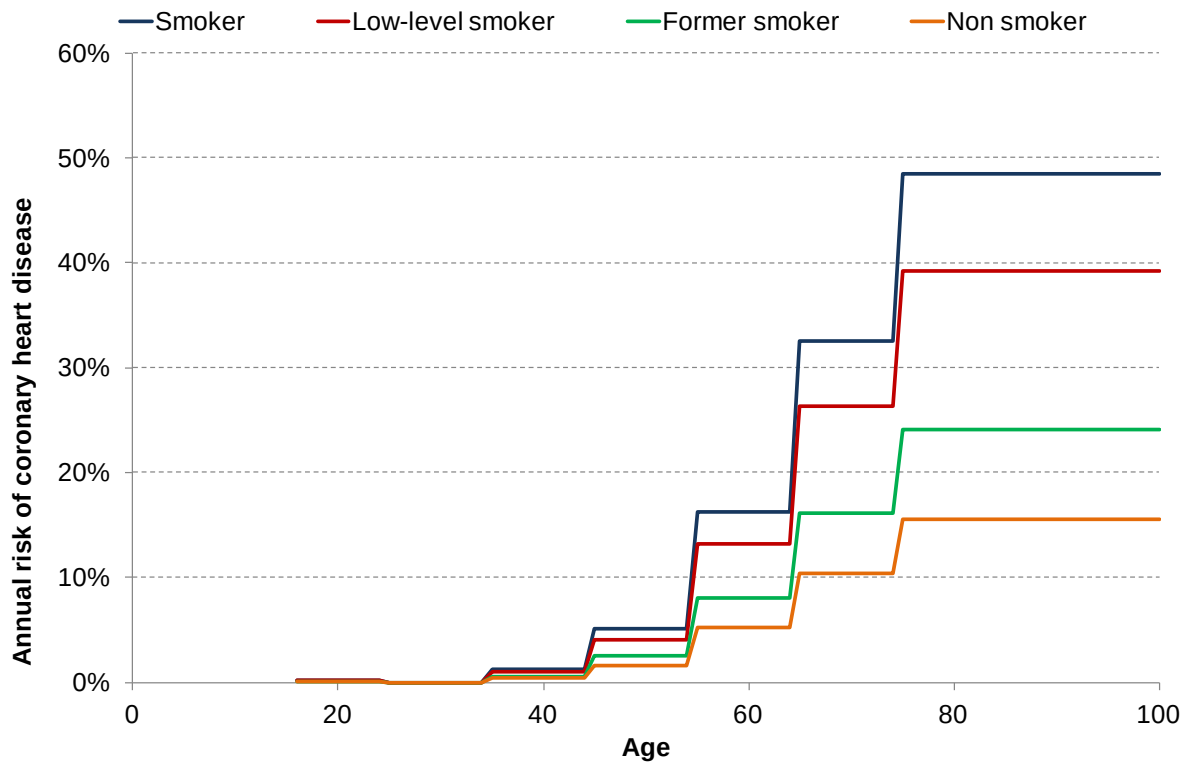


Figure 2.7: Annual risk of chronic obstructive pulmonary disease, by age and smoking status

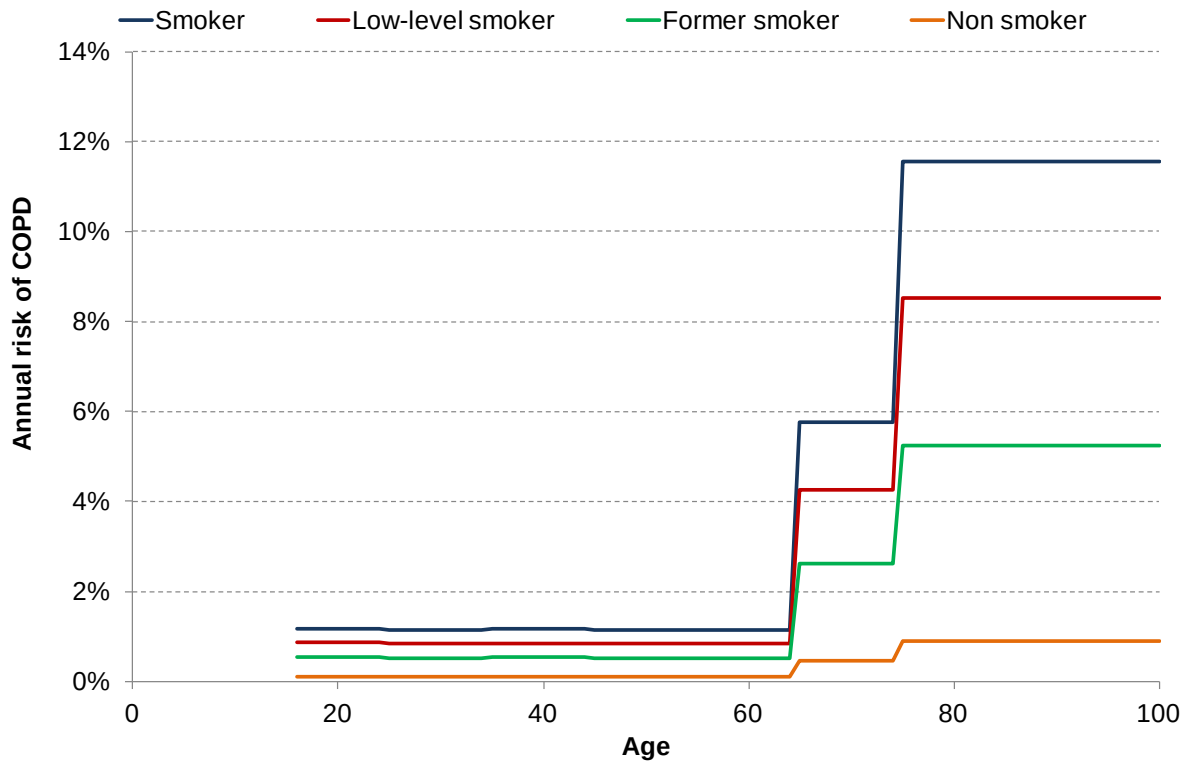
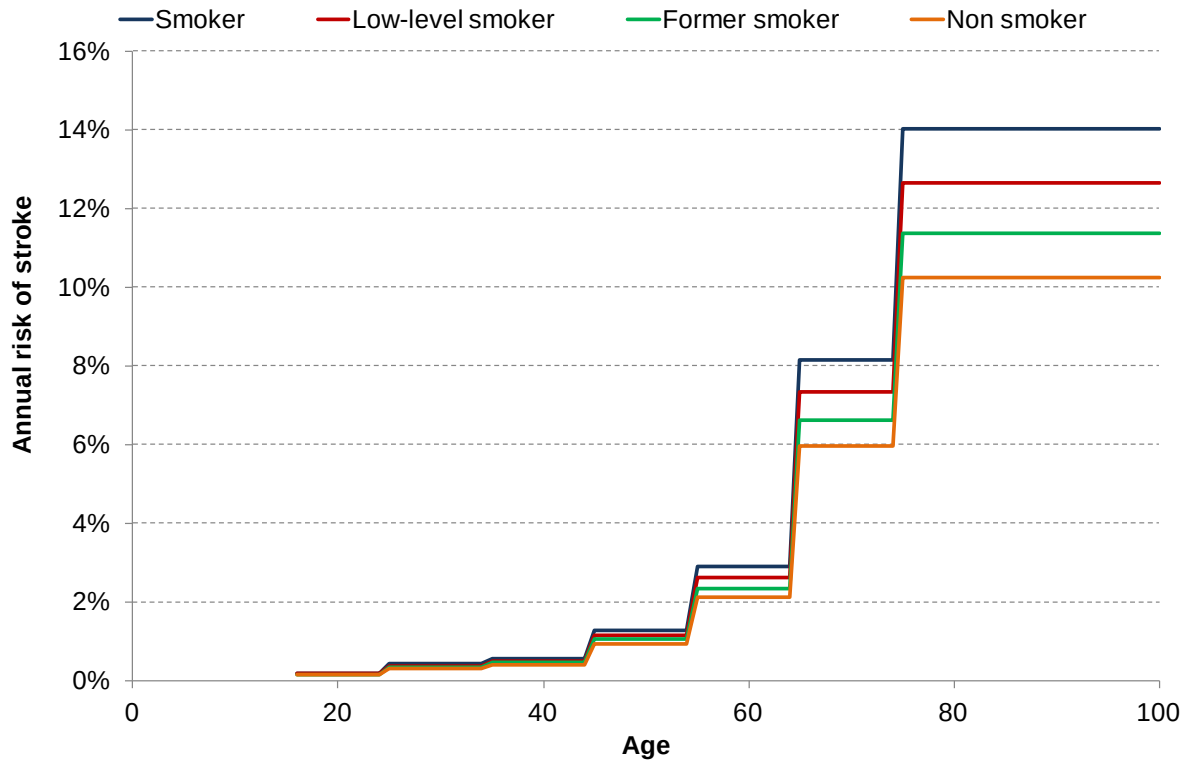


Figure 2.8: Annual risk of stroke, by age and smoking status



2.4 QUALITY OF LIFE

Co-morbidities within our cohort were each allocated an associated utility and, for every annual cohort cycle, the number of people with each co-morbidity was multiplied by the associated utility and adjusted for the time-period spent in the morbid health state. Where a person had more than one co-morbidity, the lowest utility value was used and, as such, 'double counting' of morbidities resulting in false multiplicative or additive assumptions will not have occurred. Attaching utilities to morbidities in this way permitted our model to determine estimates for the utilities of morbidities when no intervention was used, enabling comparison of the total QALYs attributable to interventions and 'no intervention', or between different interventions.

The following procedure was used to derive utilities for our cohort. A search of quality of life databases, the National Health Service Economic Evaluation Database, Medline and bibliographies in retrieved papers, identified 1,100 potential studies of which 243 contained potentially relevant information on utilities and 154 reported original data. Tengs and Wallace calculated the average values of the relevant utility scores that were identified, and these were used in our model for lung cancer, CHD, MI and stroke. We did not attempt to combine these utilities with those from other sources due to a lack of sufficient evidence on the quality of the respective data.

2.4.1 Lung cancer utilities

Bolin *et al*. (2009) reported a pan-European cost-effectiveness analysis of a pharmacological agent aimed at promoting smoking cessation. A review of potential quality of life studies for that study identified a utility score of 0.61 for patients who developed smoking-related lung cancer. The vast majority of all other quality of life literature focuses on specific types of lung cancer (e.g. progressed, end-stage cancer, treatment-specific utilities) and, therefore, the Bolin *et al*. estimate for use for this model.

2.4.2 Stroke utilities

Tengs and Wallace identified 28 papers with QoL stroke weights, including patients in the following health states:

- Minor stroke:
  - With or without cognitive deficit;
  - First year after stroke;
  - Left with residual cerebral arterio-venous malformations after treatment.
- Moderate stoke:
  - With or without cognitive deficit;
  - Residual deficit in patients with prior myocardial infarction;
  - Language deficit;
  - Motor deficit.
- Acute requiring hospitalisation;
- Major stroke:
  - With or without the ability to speak;
  - First year after stroke;
  - Left with residual cerebral arteriovenous malformations after treatment;
  - Severe residual deficit in patients with prior myocardial infarction;
  - With or without cognitive deficit;
  - Language deficit;
  - Motor deficit.

2.4.3 Coronary Heart Disease and Myocardial infarction utilities

Tengs and Wallace only identified one paper for CHD (utility = 0.8) and 83 for health status after myocardial infarction (MI); the MI papers covered the following health states:

- All MIs (no further details provided);
- MI treated with streptokinase or recombinant tissue plasminogen activator, no dyspnoea at rest/ on mild exertion or on strenuous exertion;
- MI patients unable to care for themselves;
- MI patients who did not experience a stroke or refraction;
- MI patients where rehabilitation had been provided.

2.4.4 Chronic obstructive pulmonary disease utilities

Rutten-van Molken *et al.* 2006 investigated the differences in COPD utility measured in 13 countries using data from a subset of 1,235 trial patients (from 6,000 participants) who completed a baseline EQ-5D questionnaire as part of a double-blind, placebo-RCT investigating whether dopropium reduces the rate of decline in FEV. EQ-5D utility score was 0.76 at baseline; scores were split into six groups based on the severity of COPD (moderate, severe and very severe) and location (UK / US); our model used an average of UK scores for all severities of COPD.

2.4.5 Utility of current and former smoking: no co-morbidity

Vogl *et al*. (2012) reported quality of life for patients of various smoking levels. It was reported that the mean utility associated with non-smokers was 0.8839. Age and demographic-adjusted 'disutility' values were reported for other levels of smoking. Former smokers were shown to have a disutility of -0.017 compared to 'never smokers'. (Current) low level smokers had a disutility of -0.021, whilst current medium and heavy smokers had disutilities of -0.033 and -0.052 respectively. The latter two categories were combined for the purposes of this model to represent 'higher-level smokers'.

It is possible, of course, that the disutilities described above could be derived as a result of one, or both, of two factors:

- Non-smokers feeling better than smokers simply *because they do not smoke*;
- Non-smokers feeling better than smokers because they experience fewer co-morbidities (as already captured in the model).

If the latter is the greater driver of differences in quality of life, then potential double-counting was be occurring in the model. However, it was felt that the former effect would be significant in isolation and, as such, the base case model allows a differentiation by smoking status. A sensitivity analysis dropped this approach and assumed that quality of life would only be driven by the rate of co-morbidity in each smoking group.

2.4.6 Summary of utility scores used

The utility scores identified from the literature and used in the model are shown in Table 2.5. There were insufficient data on how co-morbidity severity might be distributed amongst smokers, former smokers and non-smokers so, as per Tengs and Wallace, we used average utility scores rather than scores intended to reflect varied severity of co-morbidity.

Table 2.5: Utility scores

Co-morbidity	Utility
Lung cancer	0.61
Stroke	0.48
CHD	0.80
MI	0.80
COPD	0.73
No co-morbidities (never smoked)	0.8839
No co-morbidities (former smoker)	0.8669
No co-morbidities (low-level smoker)	0.8629
No co-morbidities (heavy smoker)	0.8414

2.5 CO-MORBIDITY COSTS

Annual costs associated with each co-morbidity in the model were derived from a previous model (Taylor *et al*. 2010) and were inflated to reflect 2012 costs. Costs were multiplied by the number of people with each co-morbidity in the model to generate the total costs associated with each cohort.

Table 2.6: Annual cost of each co-morbidity (2012 £)

Disease	Average annual cost
Lung cancer	£5,908
Stroke	£2,213
CHD	£1,142
MI	£2,336
COPD	£994

The sources of the costs described above, as reported in the source study, are provided below:

2.5.1 Lung Cancer

The Health Care Needs Assessment provides evidence for cost, cost-effectiveness and optimum service configuration for treatment of diseases including lung cancer. The authors acknowledge that there is uncertainty surrounding the cost of palliative and terminal lung cancer care, but estimate it to be between £2,000 and £7,100 per person (1998 UK sterling); we used average figures in the model, £4,550 (£5,501 at current prices). This figure represents an average cost of treating all types of lung cancer, and is not specific to any specific subgroup population.

2.5.2 Stroke and coronary heart disease

The National Audit Office (NAO) estimated that the direct cost of stroke was 2.8 billion each year (in 2005). The total cost per person was calculated by dividing the NAO estimated cost by the number of people with stroke in the UK, giving an estimated annual 2012 cost of £2,213; it was assumed that the same definition of stroke was used for both data sources. A similar approach was used for the cost of CHD with the annual cost provided by the British Heart Foundation; stroke and CHD costs are shown in Table 2.7.

Table 2.7: Annual cost of stroke and CHD (2008 £)

	Stroke	CHD
Total cost per year	2,867,200,000	3,809,320,747
Total population (men)	29,668,033	29,668,033
Total population (woman)	30,864,468	30,864,468
Percent with stroke / CHD (men)	2.4%	7%
Percent with stoke / CHD (women)	2.2%	5%
Average cost per person	**£2,061**	**£1,063**

2.5.3 Myocardial infarction

The cost of MI has two components; those of the acute event and ongoing annual healthcare costs. Event costs were taken from national published databases and the calculation of long-term costs assumed monthly general practitioner and three monthly cardiology follow up visits with use of cholesterol lowing drugs.

2.5.4 Chronic obstructive pulmonary disease

The annual cost of COPD care was taken from Appendix D of the *Chronic Obstructive Pulmonary Disease: National Clinical Guideline on Management of Chronic Obstructive Pulmonary Disease in Adults in Primary and Secondary Care*. This includes GP visits, medication, oxygen, inpatient stay and emergency admission; it is unclear whether this takes account of the gender distribution amongst people with COPD.

2.6 THE IMPACT OF SMOKING ON OTHER PEOPLE

Evidence surrounding the health and cost implications of 'passive smoking' is mixed. Although many studies indicate that there is likely to be a negative 'externality' effect from smoking, quantifying that effect is very difficult due to the large number of potential confounding factors. The consequences of passive smoking can take many potential forms:

- Increased risk of co-morbidities;
- Reduced day-to-day quality of life;
- Increased risk of mortality;
- Increased likelihood of starting smoking (or failing to quit).

Due to the paucity of reliable data, this modal does not include the potential impacts of second-hand smoke in the base case. However, a scenario analysis is included that incorporates the impact on the health and cost treating people who may suffer from second-hand smoke. To do so, it was necessary to calculate an estimate for the probable impact on health (i.e. lost QALYs) and costs (i.e. resource use).

One study (Trapero-Bertram 2011) undertook a review of existing literature, and estimated that people exposed to second-hand smoke are between 1.25 and 1.31 times as likely to develop CHD and 1.24 times as likely to develop lung cancer compared to somebody not exposed to second-hand smoke. If we conservatively assume that half of all smokers in the model exposes another person to second-hand smoke, the model can account for the additional costs and disutility arising from the increased level of co-morbidities in the overall population.

2.7 INTERVENTIONS

The economic model has been designed to assess a wide range of potential interventions and scenarios. Due to a lack of available data, it was not possible to assess the sequential use of different interventions. As such, each intervention was modelled as a 'one-off' approach. Each intervention has an individual characteristic and impact upon the model in a number of ways:

- Incurs a cost associated with the delivery and/or acquisition of the intervention;
- Has a short-term impact on smoking cessation and/or reduction;
- Has a long-term impact on smoking cessation and/or reduction (i.e. accounting for the level of relapse).

The Programme Development Group (PDG) identified seven key scenarios to assess. These are:

- Quit smoking gradually by **cutting down to quit** (CDTQ) **supported by NCP** (twelve weeks' therapy) (Review 2, ES 2.1a, 2.1b)
- Quit smoking gradually by **cutting down to quit** (CDTQ) **without NCP**
- **Quit abruptly and substitute** cigarette use with long-term nicotine use (long-term use is assumed to be for two years in the base case);
- Achieve **temporary abstinence** for a specific occasion (for example while in hospital) or for regular events (for example when at work) **supported by NCP**
- Achieve **temporary abstinence** for a specific occasion (for example while in hospital) or for regular events (for example when at work) **without NCP**
- **Reduce the amount smoked supported by NCP** (Review 3, ES 3.1a, 3.1b, 3.1c, 3.1e, 3.8a, 3.8b)
- **Reduce the amount smoked without NCP**.

For each of these interventions, various different routes to delivery can be used. Table 2.8, below, highlights the various permutations of approaches, and the relevant *input* costs (of intervention) and effectiveness levels.

Table 2.8: Interventions modelled in this study

#	Goal	Use of NCP*?	Behavioural support?	Intervention cost	Intervention effect (quits) (studies <u>underlined</u> were used in the model)	Intervention effect (reduce) (studies <u>underlined</u> were used in the model)
1	Cut down to quit	Yes	Yes – generic professional	£235 (2 units of generic advice at £25 per unit + 12 weeks of NCP at £15.42 per week)	**Martin (1997)+** 6 month mean quit rate standard treatment (21%) vs. behavioural counselling with NCP (27%). 12 months = 26% and 27% Recovering alcoholics Behavioural counselling **Jimenez Ruiz (2009)-** 6 month abstinence = 39% NCP and behavioural therapy Unlikely to be feasible within the UK **<u>Hughes (2010)++</u>** 6 month OR (gradual/abrupt) = 0.6. Gradual cessation counselling	**<u>Jimenez Ruiz</u> (2009)-** 8 week 50% reduction in cigarette consumption = 68%. NCP and behavioural therapy Unlikely to be feasible within the UK
2	Cut down to quit	Yes	Yes – specialist services and providers	£397 (2 units of specialist advice at £106 per unit + 12 weeks of NCP at £15.42 per week)	**Martin (1997)+** 6 month mean quit rate standard treatment (21%) vs. behavioural counselling with NCP (27%). 12 months = 26% and 27% Recovering alcoholics Behavioural counselling **Jimenez Ruiz (2009)-** 6 month abstinence = 39% NCP and behavioural therapy Unlikely to be feasible within the	**<u>Jimenez Ruiz</u> (2009)-** 8 week 50% reduction in cigarette consumption = 68%. NCP and behavioural therapy Unlikely to be feasible within the UK

					UK **Hughes (2010)++** 6 month OR (gradual/abrupt) = 0.6. Gradual cessation counselling	
3	Cut down to quit	Yes	No	£185 (12 weeks of NCP at £15.42 per week)	**Etter (2009)+** CO and cotidine validated four week quit rate at 12 months = 16.5% for gradual and 24% for abrupt cessation. **Shiffman (2009)++** 6 month continuous abstinence OR NCP vs. placebo = 6.0 for 4mg and 1.8 for 2mg	No data available.
4	Cut down to quit	No	Yes – generic professional	£50 (2 units of generic advice at £25 per unit)	**Cinciripini (1994)+** 6months: 53% of CBT group and 6% of control group were abstinent 12 months: 41% of CBT group and 6% of control group were abstinent **Marks (2002)+** 12 month abstinence: 19.8% of contactable CBT group and 5.8% of control group	**Marks (2002)+** 12 month 25% CPD reduction: 11.5% of CBT group and 0% in control group
5	Cut down to quit	No	Yes – specialist services and providers	£212 (2 units of specialist advice at £106 per unit)	**Cinciripini (1994)+** 6months: 53% of CBT group and 6% of control group were abstinent 12 months: 41% of CBT group and 6% of control group were abstinent **Marks (2002)+** 12 month abstinence CBT	**Marks (2002)+** 12 month 25% CPD reduction: 11.5% of CBT group and 0% in control group

					Gunther (1992)- 12 month self-reported abstinence: 51.85% in sudden and 38.71% in gradual withdrawal	
6	Cut down to quit	No	No	£0	No data available.	No data available.
7	Abrupt quit	Substitute	Yes – generic professional	£1653.33 (2 units of generic advice at £25 per unit + 104 weeks of NCP at £15.42 per week)	**Parrott (1994):** 12m quit rate for BA plus self-help material plus NCP plus specialist clinic' = 15%	No data available.
8	Abrupt quit	Substitute	Yes – specialist services and providers	£1815.33 (2 units of specialist advice at £106 per unit + 104 weeks of NCP at £15.42 per week)	**Parrott (1994):** 12m quit rate for BA plus self-help material plus NCP plus specialist clinic' = 15%	No data available.
9	Abrupt quit	Substitute	No	£1603.33 (104 weeks of NCP at £15.42 per week)	**Parrott (1994):** 12m quit rate for BA plus self-help material plus NCP plus specialist clinic' = 6%	No data available.
10	Temporary abstinence	Yes	Yes – generic professional	£235 (2 units of generic advice at £25 per unit + 12 weeks of NCP at £15.42 per week)	No data available (assumed same as reduce, below).	No data available.
11	Temporary abstinence	Yes	Yes – specialist services and providers	£397 (2 units of generic advice at £106 per unit + 12 weeks of NCP at £15.42 per week)	No data available (assumed same as reduce, below).	No data available.
12	Temporary abstinence	Yes	No	£185 (12 weeks of NCP at £15.42 per week)	No data available (assumed same as reduce	No data available.
13	Temporary abstinence	No	Yes – generic professional	£50 (2 units of generic advice at £25 per unit)	No data available (assumed same as reduce	No data available.
14	Temporary abstinence	No	Yes – specialist services and providers	£212 (2 units of generic advice at £106 per unit)	No data available (assumed same as reduce	No data available.
15	Temporary	No	No	£0	No data available (assumed same as reduce	No data available.

	abstinence					
16	Reduce	Yes	Yes – generic professional	£235 (2 units of generic advice at £25 per unit + 12 weeks of NCP at £15.42 per week)	**Chan (2011)++** 6 month Self-reported cessation: NCP and counselling = 17.03% vs. Control = 10.18% CO validated cessation: 7.97% vs. 4.42% Behavioural support = MI	**Chan (2011)++** 6 month Self-reported 50% reduction: NCP and counselling = 50.86% vs. Control = 25.66% CO validated 50% reduction: 19.18% vs. 9.73% Behavioural support = MI
17	Reduce	Yes	Yes – specialist services and providers	£397 (2 units of specialist advice at £106 per unit + 12 weeks of NCP at £15.42 per week)	**Chan (2011)++** 6 month Self-reported cessation: NCP and counselling = 17.03% vs. Control (simple cessation advice) = 10.18% CO validated cessation: 7.97% vs. 4.42% Behavioural support = MI	**Chan (2011)++** 6 month Self-reported 50% reduction: NCP and counselling = 50.86% vs. Control (simple cessation advice) = 25.66% CO validated 50% reduction: 19.18% vs. 9.73% Behavioural support = MI
18	Reduce	Yes	No	£185 (12 weeks of NCP at £15.42 per week)	**Meta-analysis 3.1e** Cessation RR = 1.93 for NCP	**Meta-analysis 3.1b** 50% point prevalence reduction in CPD RR = 1.35 NCP vs. placebo **Meta-analysis 3.1c** % reduction in CPD Risk difference = – 13.85
19	Reduce	No	Yes – generic professional	£50 (2 units of generic advice at £25 per unit)	No data available.	No data available.
20	Reduce	No	Yes – specialist services and providers	£212 (2 units of specialist advice at £106 per unit)	No data available.	No data available.

21	Reduce	No	No	£0	**Chan (2011)++** 6 month self-reported and CO validated % and OR cessation and 50% reduction	**Chan (2011)++** 6 month self-reported and CO validated % and OR cessation and 50% reduction
22	No intervention	No	No	£0	Assume background rate of 2%	Assume background rate of 2%

2.7.1 Cost of interventions

The cost of each intervention is calculated by including any acquisition costs of pharmacological products or other materials, as well as the costs associated with staff time.

Because of uncertainties associated with the duration of interventions (particularly for nicotine containing products), the model will allow for the assessment of a wide range of durations. The cost of long-term use of NCP was only applied to those former smokers who remained abstinent.

2.8 ECONOMIC EVALUATION

Cost-effectiveness models are used to assess the relative benefits of a given treatment using patient outcomes and the costs incurred in achieving those outcomes. The calculation of the additional cost per additional unit gain of benefit (i.e. QALYs) is known as the incremental analysis and results are presented as incremental cost-effectiveness ratios (ICERs). After incremental costs and QALYs were estimated, the ICERs were calculated using the following formula:

$$ICER = \frac{Cost_{\text{int}ervention} - Cost_{Comparator}}{Effect_{\text{int}ervention} - Effect_{Comparator}}$$

The incremental cost per QALY is calculated for all the interventions modelled, allowing the user to compare any two interventions.

2.8.1 Discounting

Future costs and outcomes are discounted in the model at a rate of 3.5% per year.

2.8.2 Time horizon

In the base case, the time horizon of the model is that of the person's lifetime. However, the time horizon in the model is variable, and short-term outcomes of 1 year, 3 years and 5 years are also assessed.

2.8.3 Perspective

The primary perspective of this analysis will be that of the National Health System (NHS). However, alternative scenarios will be assessed in order to estimate the impact from different perspectives, including that of the individual, and a wider societal perspective (i.e. including productivity costs).

2.8.4 Sensitivity Analyses

Because there is uncertainty associated with a number of the model inputs, sensitivity analyses are carried out on a range of different parameters within the model, to assess the relative importance of different model sources and values. Scenarios assessed within the sensitivity analysis are:

- The duration of use of long-term NCP;
- The impact of reducing upon quitting;
- Discount rates for health benefits and for costs;
- The impact of secondhand smoke;
- Dropping the assumption of quality of life gains for quitters and reducers;
- No direct benefits associated with low-level smoking;
- The weekly cost of NCP.

2.8.5 Population approach

In addition to the cost-effectiveness analysis described above, the model will also be designed to answer several additional questions regarding the overall 'population' approach to intervention coverage. That is, rather than simply comparing 'Intervention A' against 'Intervention B', the model is able to take an epidemiological approach to model a 'mix' of treatment strategies. For example, for a known number of smokers in a population, the model uses inputs on the proportion of smokers who would use each intervention (if any). A counterfactual scenario, supposing a different 'mix' of interventions is then modelled, with the model determining the likely impact on outcomes, including:

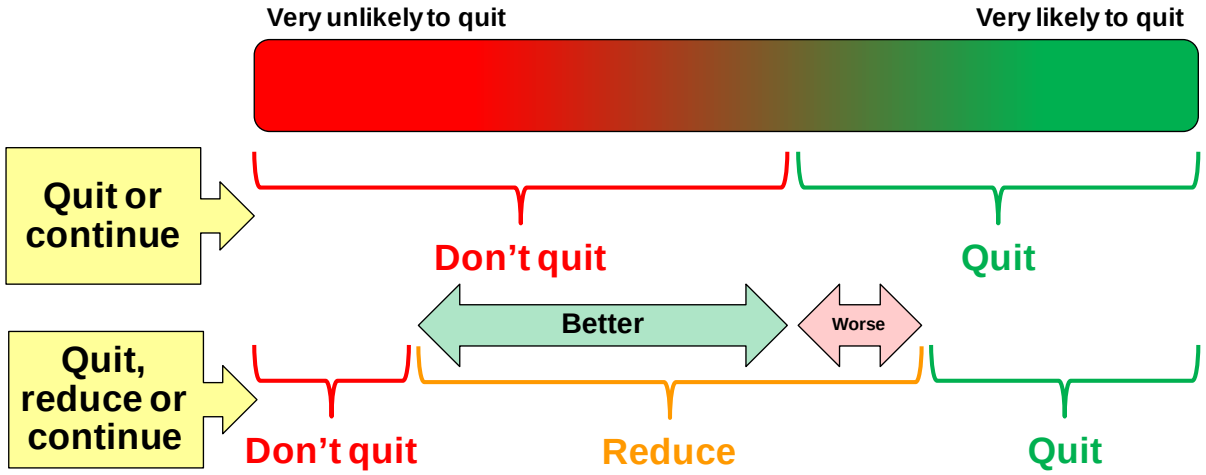
- Total number of deaths over a given time period;
- Total number of co-morbidities over a given time period;
- Total cost of a given time period;
- Total life years;
- Total quality-adjusted life years.

2.8.6 Scenario analysis: "Quit versus reduce"

One concern of some commentators is that, although some interventions appear to be effective in helping smokers to cut down their tobacco intake, this might have the inadvertent consequence of reducing the number of smokers that quit. The model accounts for this by including a scenario analysis, whereby the proportion of people that 'reduce' their tobacco intake is drawn from the population of smokers who may have either 'quit' or 'continued'. There remains very little evidence to demonstrate the true consequences of interventions to reduce smoking, but the model will run a number of hypothetical scenarios, as shown in Figures 2.9 to 2.11.

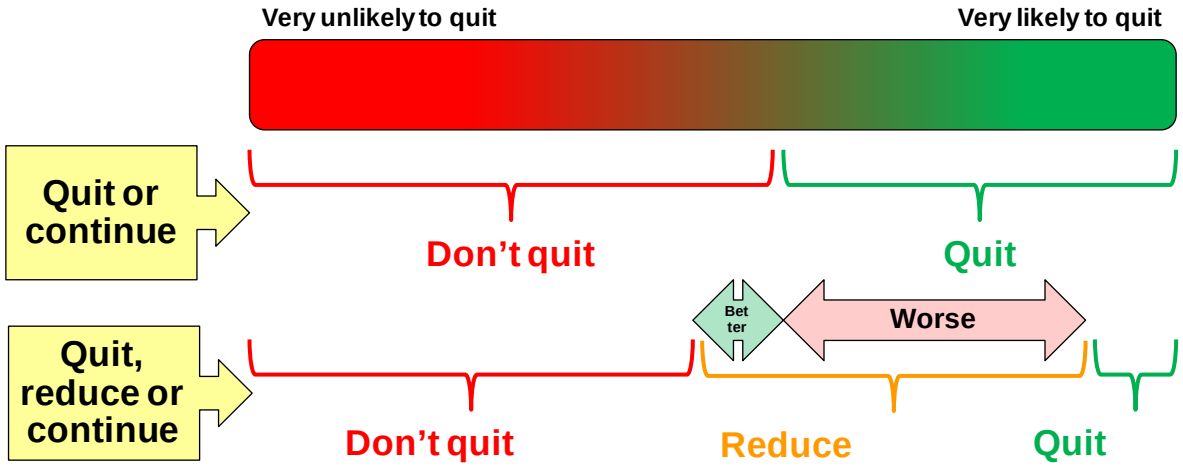
In this example, approximately 40% of people would quit smoking, if the only options were 'quit' or 'continue'. By introducing a 'reduce' option, a number of scenarios may arise. In the first, 'optimistic' scenario, the introduction of a 'reduce' option is successful in that it attracts a large number of smokers who would otherwise have continued smoking (see Figure 2.9). It may be that a small number of people who would otherwise have quit smoking may now 'reduce' instead, but this loss is likely to be outweighed by the benefits of attracting the 'new' reducers.

Figure 2.9: Optimistic scenario: 'Reducers' replace 'continuers'



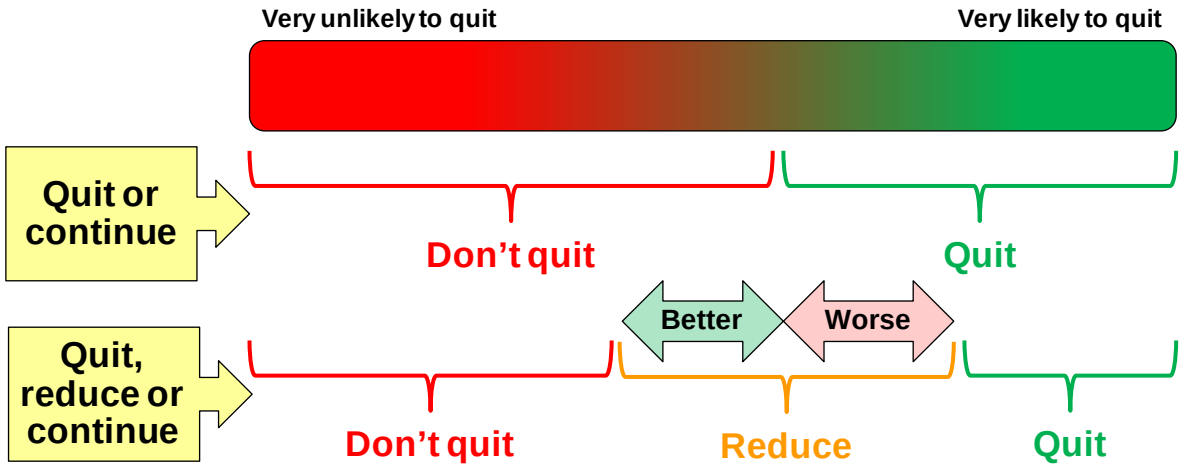
In a second, more pessimistic, scenario (see Figure 2.10), the introduction of a 'reduce' option has converted a large number of smokers who would, otherwise, have quit smoking. Although it may attract a small number of 'new' quitters, the net effect of the 'reduce' option may be proved to be negative in this case.

Figure 2.10: Pessimistic scenario: 'Reducers' replace 'quitters'



In a third scenario, the ‘reduce’ option attracts an equal number from the pool of smokers who would have quit, and from the pool who would have continued.

Figure 2.11: Neutral scenario: ‘Reducers’ replace ‘quitters’ and ‘continuers’



The model will assess each of the above scenarios (and any intermediate scenarios). Although there is little data to provide firm evidence of the likely ‘true’ scenario, the model can be used to answer the question: “What ratio of ‘quitters’ and ‘continuers’ would be required to switch to ‘reduce’ in order for a tobacco harm reduction programme to be cost-effective?”

Section 3: Results

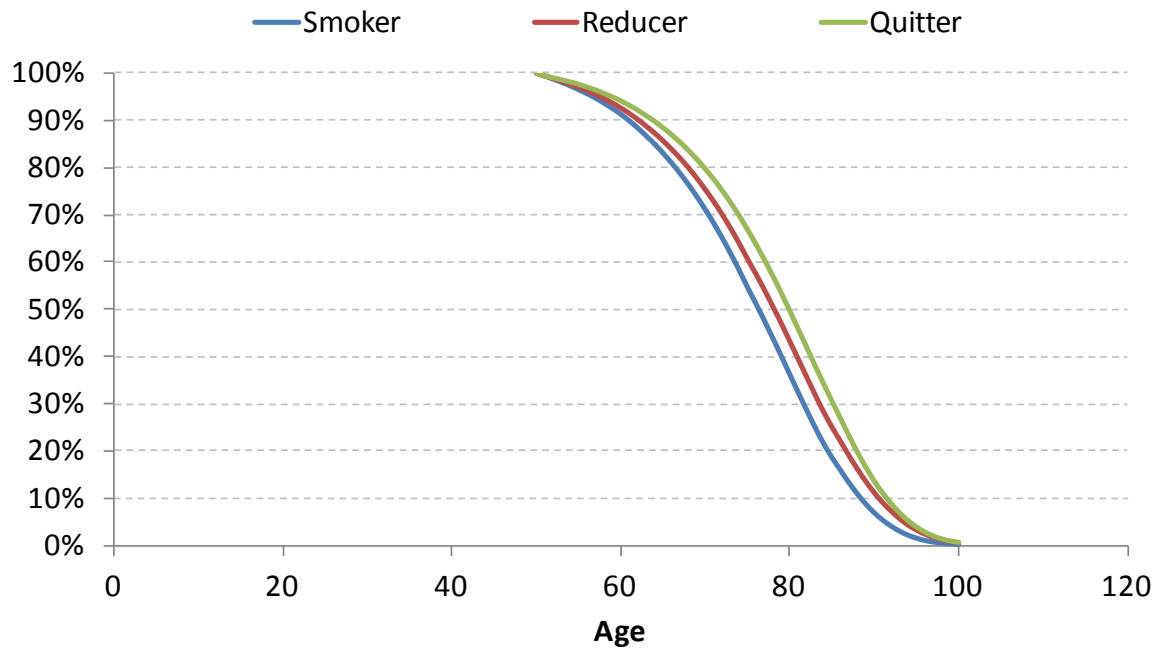
3.1 BASELINE OUTCOMES BY SMOKING STATUS

As a validation check, the model was used to demonstrate the lifetime outcomes for a number of scenarios, namely:

- A 50 year old who continues to smoke;
- A 50 year old who reduces their tobacco intake;
- A 50 year old who quits smoking.

Figure 3.1, below, shows the expected survival curves for each level of smoking status.

Figure 3.1: Survival for a 50 year old, by smoking status



The average (mean) survival, in years, is shown in Table 3.1.

Table 3.1: Mean survival for a 50 year old, by smoking status

Smoking status	Survival (years)	Additional years
Smoker	25.99	-
Low-level smoker	27.71	1.72
Former smoker	29.26	3.27

By applying quality of life weights to each of the health states in the model, it is possible to calculate the lifetime quality-adjusted life years (QALYs) for each level of smoking status. These are shown, below, in Table 3.2. Please note that future QALYs are discounted at 3.5% per year.

Table 3.2: Expected lifetime QALYs for a 50 year old, by smoking status

	Discounted		Undiscounted	
Smoking status	**Expected QALYs**	**Additional QALYs**	**Expected QALYs**	**Additional QALYs**
Smoker	13.47	-	20.76	-
Low-level smoker	14.34	0.87	22.66	1.90
Former smoker	15.01	1.54	24.16	3.40

Costs are also applied to each health state in the model. The total costs for each smoking status are shown in Table 3.3, below. It is important to note that these are *average* costs across the whole cohort of patients (i.e. many patients never experience the co-morbidity and, as such, the average cost can be low) and that costs are discounted at 3.5% per year. Therefore, costs occurring in the future are valued a lot less from today's perspective.

Table 3.3: Expected cost for a 50 year old, by smoking status

Smoking status	LC	Stroke	CHD	MI	COPD	Total	Saving
Smoker	£733	£1,750	£3,816	£2,734	£535	£9,567	-
Low-level smoker	£392	£1,722	£3,338	£1,811	£439	£7,701	-£1,866
Former smoker	£319	£1,669	£2,211	£1,829	£575	£6,603	-£2,964

Figure 3.1: Cumulative costs for a 50 year old smoker

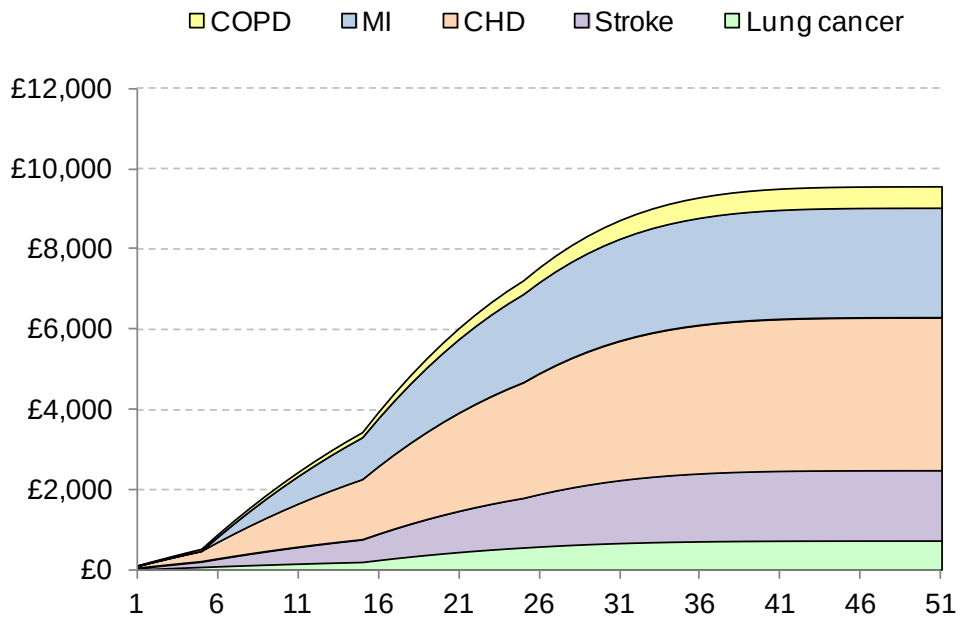


Figure 3.2: Cumulative costs for a 50 year old low-level smoker

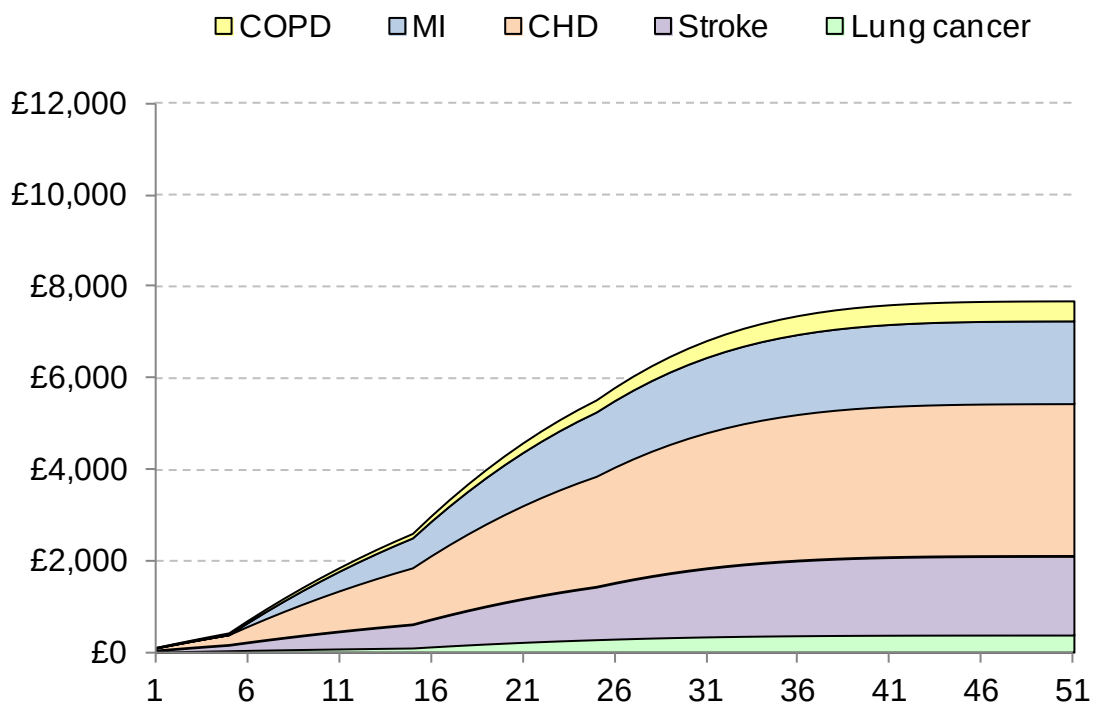
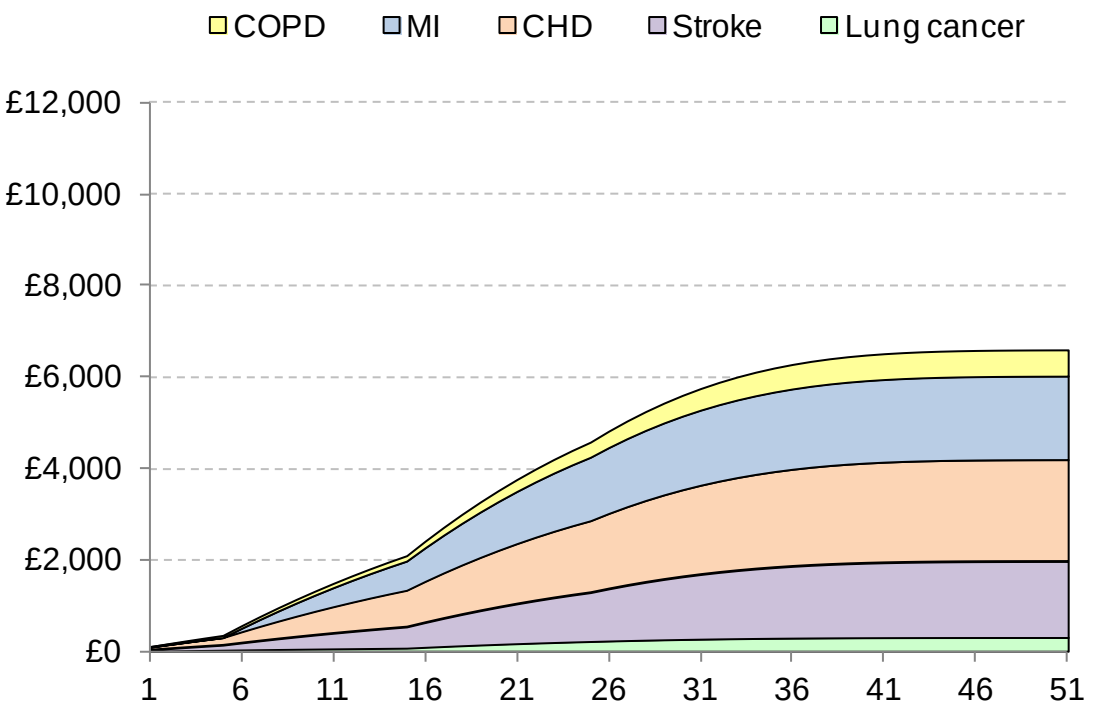


Figure 3.3: Cumulative costs for a 50 year old former smoker



3.2 OUTCOMES BY INTERVENTIONAL APPROACH

As identified in Table 2.8, the model assesses a wide of potential scenarios for tobacco harm reduction. The model uses a quit rate *and* a reduction rate for each intervention (see Table 2.8). The results are shown in Table 3.4, below. It should be noted that, for some interventions, it was not possible to differentiate between modes of delivery and so the outcomes (e.g. QALYs and LYs) will be presented as identical. Please also remember that these outputs are *average* results for a distribution of patient characteristics.

Table 3.4: Approaches to tobacco harm reduction

#	Intervention	Overall cost	Overall QALYs	Overall LYs	ICER (cost per QALY) versus no treatment
1	CDTQ + NCP + generic support	£7,132	14.099	30.769	£668
2	CDTQ + NCP + specialist support	£7,294	14.099	30.769	£2,294
3	CDTQ + NCP	£7,111	14.082	30.739	£544
4	CDTQ + generic support	£6,947	14.099	30.769	Dominant
5	CDTQ + specialist support	£7,109	14.099	30.769	£437
6	CDTQ	£6,926	14.082	30.739	Dominant
7	Abrupt + NCP substitute + generic support	£7,384	14.111	30.808	£2,836
8	Abrupt + NCP substitute + specialist support	£7,546	14.111	30.808	£4,280
9	Abrupt + NCP substitute	£7,321	14.034	30.660	£7,388
10	Temporary abstinence + NCP + generic support	£7,139	14.095	30.760	£765
11	Temporary abstinence + NCP + specialist support	£7,301	14.095	30.760	£2,458
12	Temporary abstinence + NCP	£7,218	14.019	30.630	£7,843
13	Temporary abstinence + generic support	£7,081	14.020	30.634	£706
14	Temporary abstinence + specialist support	£7,243	14.020	30.634	£8,464
15	Temporary abstinence	£7,066	13.999	30.594	No benefit
16	Reduce + NCP + generic support	£7,139	14.095	30.760	£765
17	Reduce + NCP + specialist support	£7,301	14.095	30.760	£2,458
18	Reduce + NCP	£7,218	14.019	30.630	£7,843
19	Reduce + generic support	£7,081	14.020	30.634	£706
20	Reduce + specialist support	£7,243	14.020	30.634	£8,464
21	Reduce	£7,031	14.020	30.634	Dominant
22	No intervention	£7,066	13.999	30.594	No benefit

The incremental cost-effectiveness plane is shown below, in Figure 3.4.

Any of the above interventions can be compared against any other interventions. The table below, Table 3.5, demonstrates such comparisons. This allows the user to compare any treatment (the 'intervention' in the left-hand column) against any comparator (the 'comparator' in the top row). The outcomes shown are the 'net monetary benefit', a measure that converts health gains into a monetary value and offsets this against any cost increases. A positive number indicates that the 'intervention' is cost-effective against the 'comparator'.

Figure 3.4: Incremental cost-effectiveness plane (versus 'no intervention')

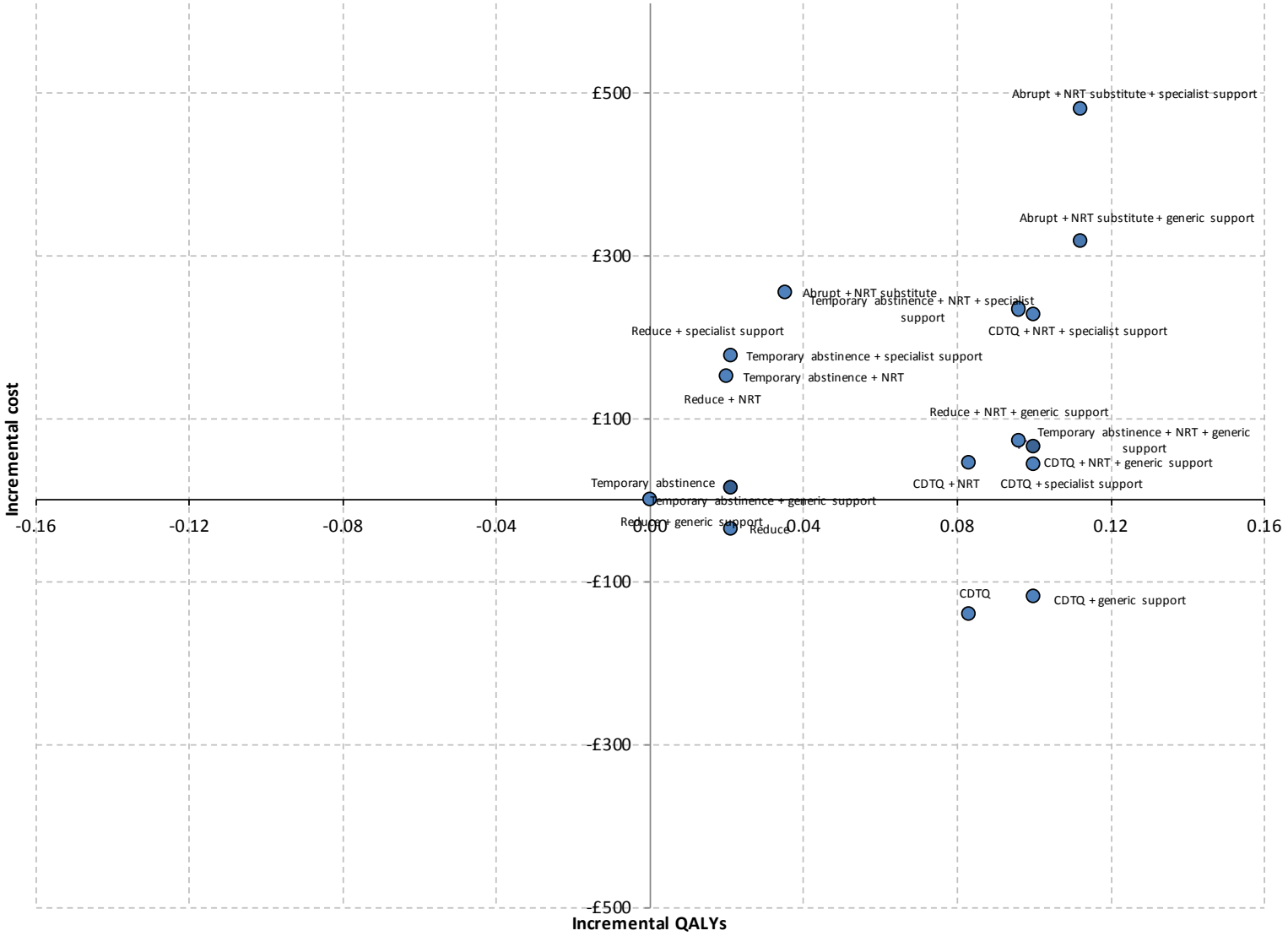


Table 3.5: Incremental comparisons between interventions

Treatment	Comparator: CDTQ + NCP + generic support	CDTQ + NCP + specialist support	CDTQ + NCP	CDTQ + generic support	CDTQ + specialist support	CDTQ	Abrupt + NCP substitute + generic support	Abrupt + NCP substitute + specialist support	Abrupt + NCP substitute	Temporary abstinence + NCP + generic support	Temporary abstinence + NCP + specialist support	Temporary abstinence + NCP	Temporary abstinence + generic support	Temporary abstinence + specialist support	Temporary abstinence	Reduce + NCP + generic support	Reduce + NCP + specialist support	Reduce + NCP	Reduce + generic support	Reduce + specialist support	Reduce	No intervention
CDTQ + NCP + generic support	£0	£162	£319	-£185	-£23	£134	£12	£174	£1,489	£87	£249	£1,686	£1,529	£1,691	£1,934	£87	£249	£1,686	£1,529	£1,691	£1,479	£1,934
CDTQ + NCP + specialist support	-£162	£0	£157	-£347	-£185	-£28	-£150	£12	£1,327	-£75	£87	£1,524	£1,367	£1,529	£1,772	-£75	£87	£1,524	£1,367	£1,529	£1,317	£1,772
CDTQ + NCP	-£319	-£157	£0	-£504	-£342	-£185	-£307	-£145	£1,170	-£232	-£70	£1,367	£1,210	£1,372	£1,615	-£232	-£70	£1,367	£1,210	£1,372	£1,160	£1,615
CDTQ + generic support	£185	£347	£504	£0	£162	£319	£197	£359	£1,674	£272	£434	£1,871	£1,714	£1,876	£2,119	£272	£434	£1,871	£1,714	£1,876	£1,664	£2,119
CDTQ + specialist support	£23	£185	£342	-£162	£0	£157	£35	£197	£1,512	£110	£272	£1,709	£1,552	£1,714	£1,957	£110	£272	£1,709	£1,552	£1,714	£1,502	£1,957
CDTQ	-£134	£28	£185	-£319	-£157	£0	-£122	£40	£1,355	-£47	£115	£1,552	£1,395	£1,557	£1,800	-£47	£115	£1,552	£1,395	£1,557	£1,345	£1,800
Abrupt + NCP substitute + generic support	-£12	£150	£307	-£197	-£35	£122	£0	£162	£1,477	£75	£237	£1,674	£1,517	£1,679	£1,922	£75	£237	£1,674	£1,517	£1,679	£1,467	£1,922
Abrupt + NCP substitute + specialist support	-£174	-£12	£145	-£359	-£197	-£40	-£162	£0	£1,315	-£87	£75	£1,512	£1,355	£1,517	£1,760	-£87	£75	£1,512	£1,355	£1,517	£1,305	£1,760
Abrupt + NCP substitute	-£1,489	-£1,327	-£1,170	-£1,674	-£1,512	-£1,355	-£1,477	-£1,315	£0	-£1,402	-£1,240	£197	£40	£202	£445	-£1,402	-£1,240	£197	£40	£202	-£10	£445
Temporary abstinence + NCP + generic support	-£87	£75	£232	-£272	-£110	£47	-£75	£87	£1,402	£0	£162	£1,599	£1,442	£1,604	£1,847	£0	£162	£1,599	£1,442	£1,604	£1,392	£1,847
Temporary abstinence + NCP + specialist support	-£249	-£87	£70	-£434	-£272	-£115	-£237	-£75	£1,240	-£162	£0	£1,437	£1,280	£1,442	£1,685	-£162	£0	£1,437	£1,280	£1,442	£1,230	£1,685
Temporary abstinence + NCP	-£1,686	-£1,524	-£1,367	-£1,871	-£1,709	-£1,552	-£1,674	-£1,512	-£197	-£1,599	-£1,437	£0	-£157	£5	£248	-£1,599	-£1,437	£0	-£157	£5	-£207	£248
Temporary abstinence + generic support	-£1,529	-£1,367	-£1,210	-£1,714	-£1,552	-£1,395	-£1,517	-£1,355	-£40	-£1,442	-£1,280	£157	£0	£162	£405	-£1,442	-£1,280	£157	£0	£162	-£50	£405
Temporary abstinence + specialist support	-£1,691	-£1,529	-£1,372	-£1,876	-£1,714	-£1,557	-£1,679	-£1,517	-£202	-£1,604	-£1,442	-£5	-£162	£0	£243	-£1,604	-£1,442	-£5	-£162	£0	-£212	£243
Temporary abstinence	-£1,934	-£1,772	-£1,615	-£2,119	-£1,957	-£1,800	-£1,922	-£1,760	-£445	-£1,847	-£1,685	-£248	-£405	-£243	£0	-£1,847	-£1,685	-£248	-£405	-£243	-£455	£0
Reduce + NCP + generic support	-£87	£75	£232	-£272	-£110	£47	-£75	£87	£1,402	£0	£162	£1,599	£1,442	£1,604	£1,847	£0	£162	£1,599	£1,442	£1,604	£1,392	£1,847
Reduce + NCP + specialist support	-£249	-£87	£70	-£434	-£272	-£115	-£237	-£75	£1,240	-£162	£0	£1,437	£1,280	£1,442	£1,685	-£162	£0	£1,437	£1,280	£1,442	£1,230	£1,685
Reduce + NCP	-£1,686	-£1,524	-£1,367	-£1,871	-£1,709	-£1,552	-£1,674	-£1,512	-£197	-£1,599	-£1,437	£0	-£157	£5	£248	-£1,599	-£1,437	£0	-£157	£5	-£207	£248
Reduce + generic support	-£1,529	-£1,367	-£1,210	-£1,714	-£1,552	-£1,395	-£1,517	-£1,355	-£40	-£1,442	-£1,280	£157	£0	£162	£405	-£1,442	-£1,280	£157	£0	£162	-£50	£405
Reduce + specialist support	-£1,691	-£1,529	-£1,372	-£1,876	-£1,714	-£1,557	-£1,679	-£1,517	-£202	-£1,604	-£1,442	-£5	-£162	£0	£243	-£1,604	-£1,442	-£5	-£162	£0	-£212	£243
Reduce	-£1,479	-£1,317	-£1,160	-£1,664	-£1,502	-£1,345	-£1,467	-£1,305	£10	-£1,392	-£1,230	£207	£50	£212	£455	-£1,392	-£1,230	£207	£50	£212	£0	£455
No intervention	-£1,934	-£1,772	-£1,615	-£2,119	-£1,957	-£1,800	-£1,922	-£1,760	-£445	-£1,847	-£1,685	-£248	-£405	-£243	£0	-£1,847	-£1,685	-£248	-£405	-£243	-£455	£0

3.3 SCENARIO ANALYSES

Because there is a high level of uncertainty surrounding many of the effectiveness parameters for each of these routes, results have been tested using a range of sensitivity analyses. These are detailed in the following sections.

3.3.1 Abrupt quitting with long-term NCP use versus no intervention

Many smokers may choose to substitute their smoking with other forms of NCP (e.g. patches, e-cigarettes, gum). In doing so, some (former) smokers may continue to use that NCP for very long-term periods. There is no existing data to suggest how long people may continue to use NCP, nor how that duration influences the effectiveness of the quit rate. Table 3.6, below, shows the net monetary benefit of long-term NCP compared against 'no intervention', for a range of combinations of duration of use and effectiveness. For this analysis, it was assumed that NCP use costs approximately £15 per week. Recall that the long-term cost of NCP is only applied to those who are abstinent from or have reduced their smoking (please note that smokers can reduce or quit in the model - see Table 2.8 for details of the rates associated with each intervention).

Table 3.6: Sensitivity analysis for long-term NCP use (cost per QALY)

		Duration of use							
		6m	12m	18m	24m	3y	4y	5y	10y
Effectiveness (quit rate)	0%	No ben	No ben	No ben	No ben	No ben	No ben	No ben	No ben
	2%	No ben	No ben	No ben	No ben	No ben	No ben	No ben	No ben
	4%	£10425	£11818	£13212	£14606	£17393	£20180	£22967	£36903
	6%	£4600	£5530	£6459	£7388	£9246	£11104	£12962	£22252
	8%	£2659	£3433	£4207	£4982	£6530	£8078	£9627	£17369
	10%	£1688	£2385	£3082	£3779	£5172	£6566	£7959	£14927
	12%	£1106	£1756	£2407	£3057	£4358	£5658	£6959	£13462
	14%	£718	£1337	£1956	£2576	£3814	£5053	£6292	£12485
	16%	£440	£1037	£1635	£2232	£3426	£4621	£5815	£11788
	18%	£232	£813	£1394	£1974	£3135	£4297	£5458	£11265
	20%	£70	£638	£1206	£1774	£2909	£4045	£5180	£10858

The table above demonstrates that the use of NCP (even if paid for by the NHS) is a cost-effective use of resources for almost all scenarios (i.e. falling below NICE's £20,000 per QALY threshold). Only when NCP is provided for more than 5 or 10 years *and* the quit rate is less than 6% do the costs potentially outweigh the benefits.

3.3.2 Trade off between quitters and reducers

As was discussed in 2.8.6, it is anticipated that there may be some trade-off between the number of quitters and the number of reducers, associated with different approaches. For example, by offering services to help people to reduce their smoking intake, it is plausible that this may have a negative effect on some people who may otherwise have chosen (or attempted) to quit. Section 3.1 demonstrated the benefits associated with quitting smoking and reducing smoking for a 50 year-old person. That analysis is replicated below, with a more detailed modelling approach (i.e. allowing for relapse, natural quitting and producing a weighted average outcome for all age groups). This is shown in Table 3.7.

Table 3.7: Benefits of quitting smoking and reducing tobacco intake

	QALYs	Extra QALYs	Cost	Extra cost
Continuing to smoke	14.00	-	£7,066	-
Reducing tobacco intake	14.45	0.45	£6,299	-£767
Quitting smoking	14.84	0.84	£5,654	-£1,412

It can be seen, therefore, that an intervention that achieves one additional 'reducer', will provide an additional 0.45 QALYs to society, and will save the NHS approximately £767 over the patient's lifetime. An intervention that achieves one *quitter*, however, will gain 0.84 QALYs and will save £1,412 over the same period.

Whilst it is clear that it would be better to gain one quitter than one reducer, it is argued that, by offering services to help people to cut down their tobacco intake, a greater population may present for treatment. This would, of course, lead to additional benefits to society. At present, there is no strong evidence to estimate the likely additional number of people that may benefit from the introduction of 'cut down' services.

3.3.3 Discount rates and time preference

In the model, future costs and health outcomes are 'discounted' at a rate of 3.5% per annum. That means that, for each year in the future that an event occurs, it is 'worth' 3.5% less from today's perspective. One consequence of this is that interventions with costs up front and benefits in the future are likely to be penalised, since many of the benefits will be discounted quite substantially.

Two additional scenarios were run through the model. The first, shown in Table 3.8, below, uses 3.5% discounting for costs, and 1.5% for benefits), The second, in Table 3.9, uses 0% discounting for both costs and benefits.

Table 3.8: Results (with 3.5% discounting for costs and 1.5% for benefits)

#	Intervention	Overall cost	Overall QALYs	Overall LYs	ICER (cost per QALY) versus no treatment
1	CDTQ + NCP + generic support	£7,132	19.070	30.769	£462
2	CDTQ + NCP + specialist support	£7,294	19.070	30.769	£1,588
3	CDTQ + NCP	£7,111	19.046	30.739	£377
4	CDTQ + generic support	£6,947	19.070	30.769	Dominant
5	CDTQ + specialist support	£7,109	19.070	30.769	£302
6	CDTQ	£6,926	19.046	30.739	Dominant
7	Abrupt + NCP substitute + generic support	£7,384	19.092	30.808	£1,922
8	Abrupt + NCP substitute + specialist support	£7,546	19.092	30.808	£2,900
9	Abrupt + NCP substitute	£7,321	18.977	30.660	£5,006
10	Temporary abstinence + NCP + generic support	£7,139	19.064	30.760	£531
11	Temporary abstinence + NCP + specialist support	£7,301	19.064	30.760	£1,708
12	Temporary abstinence + NCP	£7,218	18.955	30.630	£5,364
13	Temporary abstinence + generic support	£7,081	18.957	30.634	£478
14	Temporary abstinence + specialist support	£7,243	18.957	30.634	£5,735
15	Temporary abstinence	£7,066	18.926	30.594	No benefit
16	Reduce + NCP + generic support	£7,139	19.064	30.760	£531
17	Reduce + NCP + specialist support	£7,301	19.064	30.760	£1,708
18	Reduce + NCP	£7,218	18.955	30.630	£5,364
19	Reduce + generic support	£7,081	18.957	30.634	£478
20	Reduce + specialist support	£7,243	18.957	30.634	£5,735
21	Reduce	£7,031	18.957	30.634	Dominant
22	No intervention	£7,066	18.926	30.594	n/a

Table 3.9: Results (with zero discounting for costs and benefits)

#	Intervention	Overall cost	Overall QALYs	Overall LYs	ICER (cost per QALY) versus no treatment
1	CDTQ + NCP + generic support	£14,625	25.223	30.769	Dominant
2	CDTQ + NCP + specialist support	£14,787	25.223	30.769	£709
3	CDTQ + NCP	£14,618	25.189	30.739	Dominant
4	CDTQ + generic support	£14,440	25.223	30.769	Dominant
5	CDTQ + specialist support	£14,602	25.223	30.769	Dominant
6	CDTQ	£14,433	25.189	30.739	Dominant
7	Abrupt + NCP substitute + generic support	£14,860	25.257	30.808	£917
8	Abrupt + NCP substitute + specialist support	£15,022	25.257	30.808	£1,606
9	Abrupt + NCP substitute	£14,868	25.094	30.660	£3,088
10	Temporary abstinence + NCP + generic support	£14,635	25.214	30.760	Dominant
11	Temporary abstinence + NCP + specialist support	£14,797	25.214	30.760	£800
12	Temporary abstinence + NCP	£14,779	25.062	30.630	£3,373
13	Temporary abstinence + generic support	£14,640	25.066	30.634	Dominant
14	Temporary abstinence + specialist support	£14,802	25.066	30.634	£3,601
15	Temporary abstinence	£14,644	25.022	30.594	No benefit
16	Reduce + NCP + generic support	£14,635	25.214	30.760	Dominant
17	Reduce + NCP + specialist support	£14,797	25.214	30.760	£800
18	Reduce + NCP	£14,779	25.062	30.630	£3,373
19	Reduce + generic support	£14,640	25.066	30.634	Dominant
20	Reduce + specialist support	£14,802	25.066	30.634	£3,601
21	Reduce	£14,590	25.066	30.634	Dominant
22	No intervention	£14,644	25.022	30.594	No benefit

3.3.4 Including the impact of secondhand smoke

In the base case, the model does not consider the impact of secondhand smoke. In this scenario analysis, however, the costs and lost QALYs associated with additional cases of CHD and lung cancer are included in the analysis. Please note that these effects are included *in addition to* those already modelled for the smoker. The results are presented below, in Table 3.10.

Table 3.10: Results (including the impact of secondhand smoke)

#	Intervention	Overall cost	Overall QALYs	Overall LYs	ICER (cost per QALY) versus no treatment
1	CDTQ + NCP + generic support	£7,462	14.085	30.769	£383
2	CDTQ + NCP + specialist support	£7,624	14.085	30.769	£1,996
3	CDTQ + NCP	£7,445	14.068	30.739	£261
4	CDTQ + generic support	£7,277	14.085	30.769	Dominant
5	CDTQ + specialist support	£7,439	14.085	30.769	£154
6	CDTQ	£7,260	14.068	30.739	Dominant
7	Abrupt + NCP substitute + generic support	£7,697	14.099	30.808	£2,401
8	Abrupt + NCP substitute + specialist support	£7,859	14.099	30.808	£3,822
9	Abrupt + NCP substitute	£7,664	14.020	30.660	£6,881
10	Temporary abstinence + NCP + generic support	£7,471	14.081	30.760	£499
11	Temporary abstinence + NCP + specialist support	£7,633	14.081	30.760	£2,181
12	Temporary abstinence + NCP	£7,569	14.004	30.630	£7,405
13	Temporary abstinence + generic support	£7,430	14.006	30.634	£304
14	Temporary abstinence + specialist support	£7,592	14.006	30.634	£7,940
15	Temporary abstinence	£7,423	13.985	30.594	No benefit
16	Reduce + NCP + generic support	£7,471	14.081	30.760	£499
17	Reduce + NCP + specialist support	£7,633	14.081	30.760	£2,181
18	Reduce + NCP	£7,569	14.004	30.630	£7,405
19	Reduce + generic support	£7,430	14.006	30.634	£304
20	Reduce + specialist support	£7,592	14.006	30.634	£7,940
21	Reduce	£7,380	14.006	30.634	Dominant
22	No intervention	£7,423	13.985	30.594	No benefit

3.3.5 Excluding differences in quality of life for smokers and non-smokers

In the base case model, the quality of life for smokers, low-level smokers and former smokers is 0.841, 0.863 and 0.867 respectively. However, it might be argues that the differences in quality of life may actually be explained by differences in the level of co-morbidities (which are already included in the model). As such, an alternative scenario is included below (Table 3.11), where the immediate quality of life benefits of reducing or quitting smoking are not included. For the purposes of this analysis, it was assumed that all three states have a utility of 0.857 (i.e. the average of all three states).

Table 3.11: Results (constant quality of life for all states)

#	Intervention	Overall cost	Overall QALYs	Overall LYs	ICER (cost per QALY) versus no treatment
1	CDTQ + NCP + generic support	£7,132	14.152	30.769	£928
2	CDTQ + NCP + specialist support	£7,294	14.152	30.769	£3,186
3	CDTQ + NCP	£7,111	14.140	30.739	£756
4	CDTQ + generic support	£6,947	14.152	30.769	Dominant
5	CDTQ + specialist support	£7,109	14.152	30.769	£607
6	CDTQ	£6,926	14.140	30.739	Dominant
7	Abrupt + NCP substitute + generic support	£7,384	14.166	30.808	£3,745
8	Abrupt + NCP substitute + specialist support	£7,546	14.166	30.808	£5,652
9	Abrupt + NCP substitute	£7,321	14.107	30.660	£9,755
10	Temporary abstinence + NCP + generic support	£7,139	14.149	30.760	£1,072
11	Temporary abstinence + NCP + specialist support	£7,301	14.149	30.760	£3,445
12	Temporary abstinence + NCP	£7,218	14.095	30.630	£10,586
13	Temporary abstinence + generic support	£7,081	14.097	30.634	£932
14	Temporary abstinence + specialist support	£7,243	14.097	30.634	£11,176
15	Temporary abstinence	£7,066	14.081	30.594	No benefit
16	Reduce + NCP + generic support	£7,139	14.149	30.760	£1,072
17	Reduce + NCP + specialist support	£7,301	14.149	30.760	£3,445
18	Reduce + NCP	£7,218	14.095	30.630	£10,586
19	Reduce + generic support	£7,081	14.097	30.634	£932
20	Reduce + specialist support	£7,243	14.097	30.634	£11,176
21	Reduce	£7,031	14.097	30.634	Dominant
22	No intervention	£7,066	14.081	30.594	No benefit

3.3.6 No benefits associated with low-level smoking

In this scenario analysis, it is assumed that there are no benefits associated with low-level smoking. That is, the risk of each co-morbidity is the same for low-level smokers and high-level smokers. Please note that benefits are still accrued for people who successfully quit smoking. The outcomes for this scenario are shown in Table 3.12, below.

Table 3.12: Results (no benefits for low-level smoking)

#	Intervention	Overall cost	Overall QALYs	Overall LYs	ICER (cost per QALY) versus no treatment
1	CDTQ + NCP + generic support	£7,439	13.981	30.403	£1,450
2	CDTQ + NCP + specialist support	£7,601	13.981	30.403	£3,480
3	CDTQ + NCP	£7,409	13.967	30.380	£1,302
4	CDTQ + generic support	£7,254	13.981	30.403	Dominant
5	CDTQ + specialist support	£7,416	13.981	30.403	£1,162
6	CDTQ	£7,224	13.967	30.380	Dominant
7	Abrupt + NCP substitute + generic support	£7,609	14.025	30.521	£2,301
8	Abrupt + NCP substitute + specialist support	£7,771	14.025	30.521	£3,604
9	Abrupt + NCP substitute	£7,568	13.939	30.344	£6,406
10	Temporary abstinence + NCP + generic support	£7,457	13.972	30.383	£1,862
11	Temporary abstinence + NCP + specialist support	£7,619	13.972	30.383	£4,125
12	Temporary abstinence + NCP	£7,477	13.920	30.302	£8,115
13	Temporary abstinence + generic support	£7,332	13.924	30.313	£380
14	Temporary abstinence + specialist support	£7,494	13.924	30.313	£7,377
15	Temporary abstinence	£7,323	13.901	30.266	No benefit
16	Reduce + NCP + generic support	£7,457	13.972	30.383	£1,862
17	Reduce + NCP + specialist support	£7,619	13.972	30.383	£4,125
18	Reduce + NCP	£7,477	13.920	30.302	£8,115
19	Reduce + generic support	£7,332	13.924	30.313	£380
20	Reduce + specialist support	£7,494	13.924	30.313	£7,377
21	Reduce	£7,282	13.924	30.313	Dominant
22	No intervention	£7,323	13.901	30.266	No benefit

3.3.7 Cost of NCP

In the final scenario analyses, in those interventions where NCP is used, the cost of e-cigarettes is applied, in place of the base case cost of NCP (see Table 3.13) and, secondly, a higher cost of £25 per week is applied (see Table 3.14).

Table 3.13: Results (cost of e-cigarettes applied)

#	Intervention	Overall cost	Overall QALYs	Overall LYs	ICER (cost per QALY) versus no treatment
1	CDTQ + NCP + generic support	£7,099	14.099	30.769	£329
2	CDTQ + NCP + specialist support	£7,261	14.099	30.769	£1,955
3	CDTQ + NCP	£7,077	14.082	30.739	£136
4	CDTQ + generic support	£6,947	14.099	30.769	Dominant
5	CDTQ + specialist support	£7,109	14.099	30.769	£437
6	CDTQ	£6,926	14.082	30.739	Dominant
7	Abrupt + NCP substitute + generic support	£7,301	14.111	30.808	£2,091
8	Abrupt + NCP substitute + specialist support	£7,463	14.111	30.808	£3,535
9	Abrupt + NCP substitute	£7,264	14.034	30.660	£5,729
10	Temporary abstinence + NCP + generic support	£7,105	14.095	30.760	£412
11	Temporary abstinence + NCP + specialist support	£7,267	14.095	30.760	£2,105
12	Temporary abstinence + NCP	£7,184	14.019	30.630	£6,102
13	Temporary abstinence + generic support	£7,081	14.020	30.634	£706
14	Temporary abstinence + specialist support	£7,243	14.020	30.634	£8,464
15	Temporary abstinence	£7,066	13.999	30.594	No benefit
16	Reduce + NCP + generic support	£7,105	14.095	30.760	£412
17	Reduce + NCP + specialist support	£7,267	14.095	30.760	£2,105
18	Reduce + NCP	£7,184	14.019	30.630	£6,102
19	Reduce + generic support	£7,081	14.020	30.634	£706
20	Reduce + specialist support	£7,243	14.020	30.634	£8,464
21	Reduce	£7,031	14.020	30.634	Dominant
22	No intervention	£7,066	13.999	30.594	No benefit

Table 3.14: Results (cost of £25 per week applied)

#	Intervention	Overall cost	Overall QALYs	Overall LYs	ICER (cost per QALY) versus no treatment
1	CDTQ + NCP + generic support	£7,247	14.099	30.769	£1,822
2	CDTQ + NCP + specialist support	£7,409	14.099	30.769	£3,448
3	CDTQ + NCP	£7,226	14.082	30.739	£1,934
4	CDTQ + generic support	£6,947	14.099	30.769	Dominant
5	CDTQ + specialist support	£7,109	14.099	30.769	£437
6	CDTQ	£6,926	14.082	30.739	Dominant
7	Abrupt + NCP substitute + generic support	£7,669	14.111	30.808	£5,372
8	Abrupt + NCP substitute + specialist support	£7,831	14.111	30.808	£6,816
9	Abrupt + NCP substitute	£7,516	14.034	30.660	£13,029
10	Temporary abstinence + NCP + generic support	£7,254	14.095	30.760	£1,967
11	Temporary abstinence + NCP + specialist support	£7,416	14.095	30.760	£3,660
12	Temporary abstinence + NCP	£7,333	14.019	30.630	£13,769
13	Temporary abstinence + generic support	£7,081	14.020	30.634	£706
14	Temporary abstinence + specialist support	£7,243	14.020	30.634	£8,464
15	Temporary abstinence	£7,066	13.999	30.594	No benefit
16	Reduce + NCP + generic support	£7,254	14.095	30.760	£1,967
17	Reduce + NCP + specialist support	£7,416	14.095	30.760	£3,660
18	Reduce + NCP	£7,333	14.019	30.630	£13,769
19	Reduce + generic support	£7,081	14.020	30.634	£706
20	Reduce + specialist support	£7,243	14.020	30.634	£8,464
21	Reduce	£7,031	14.020	30.634	Dominant
22	No intervention	£7,066	13.999	30.594	No benefit

Section 4: Discussion

The economic model has demonstrated that there are significant benefits associated with quitting or reducing smoking, in terms of both health benefits and saved costs. Therefore, any relatively inexpensive therapies that are successful in promoting tobacco harm reduction and/or smoking cessation are likely to be cost-effective. The economic and health costs of smoking are so great that reducing it, even moderately, produces substantial benefits. Compared with 'smokers' a 25 year old who reduces their smoking levels will live for an additional 2.00 years, gain an additional 0.38 QALYs over their lifetime, and will save £882 to the NHS. A 25 year old smoker who quits will live an additional 3.79 years, gain an extra 1.41 QALYs, and will save £1,592 of the NHS's money. These figures can, of course, be multiplied by the total number of smokers who may benefit from treatment. For example, if 100,000 smokers quit due to the intervention, this could potentially lead to a gain of 379,000 life years, 141,000 QALYs and save £159 million to the NHS.

Cost-effectiveness estimates for interventions have not yet been produced, but are likely to show that most interventions are cost-effective when compared against 'no intervention'.

As with any economic evaluation, there are a number of limitations inherent within the model. A lack of data on how co-morbidities varied with smoking status made it impossible to categorise former smokers as achieving either 'recent' or 'long-term' abstinence and the impact of this on our findings is unclear. If, at some point after permanently stopping smoking, the probability of developing some or all of the model co-morbidities returns to that of non-smokers, the model will have overestimated the numbers of people with co-morbidities and, hence, co-morbidity costs, resulting in an underestimation of each interventions' cost effectiveness.

The model assumes that smokers use only one type of cessation intervention in any one quit attempt but, in 'real life', some smokers try stopping smoking repeatedly and some use many different cessation methods. However, the incorporation of a background quit rate into the model addresses this limitation, and sensitivity analysis demonstrated that relapse prevention interventions appeared effective across a wide range of different background rates.

Model estimates for the effectiveness of interventions were taken from the best sources available. However, there is a great deal of heterogeneity between studies and, as such; head-to-head comparisons of different treatments should be treated with caution. Unfortunately, the model cannot investigate these issues in the absence of sufficient empirical trial data.

Again, due to a lack of available data, the model assumed that, when a person had multiple co-morbidities, their quality of life was equivalent to that experienced with the most severe of these. From the perspective of interventions' impact, this is a conservative assumption as each intervention, by encouraging abstinence from smoking, is likely to reduce the prevalence of *combinations* of co-morbidities (e.g. lung cancer and CHD would both become less likely in the event of smoking cessation). Improvements in the quality of life experienced by some of those people with more than one co-morbidity who remain abstinent would, therefore, be greater than the model predicts, QALY gains from eliminating such co-morbidity combinations would be greater than predicted within the model and interventions would appear even more cost-effective. It is thought that this will have only a very small impact on the model's results.

One interesting aspect of this model is that, as recommended by the UK Treasury, all future costs and health outcomes have been discounted at 3.5% per year. However, it should be noted that the cost of a tobacco harm reduction programme interventions is borne in the immediate future (i.e. undiscounted), whilst the benefits are likely to be accrued in the long-term future. With discounting at 3.5% rate, one QALY today is equivalent to around 0.25 QALYs in 40 years' time and health gains (and cost savings) experienced at this future time are, therefore, reduced fourfold. Recommended discount rates vary between different countries and even within countries over time; NICE's recommended rate for health outcomes was 1.5% until 2003 and, therefore, that value was included in a sensitivity analysis. Because the costs of the interventions are accrued in the short-term and the benefits (i.e. reduced co-morbidities) occur in the future, the results of this analysis will underestimate the undiscounted outcomes, which are also shown in the results section.

It should, finally, be noted that the following potential benefits associated with tobacco harm reduction were *not* included in the analysis:

- Increased productivity, due to averted absenteeism from the workplace;
- Reduction in other smoking-related diseases;
- Improved recovery from other healthcare interventions;
- Impact on other people's smoking behaviour.

The exclusion of these factors (due to a lack of reliable data) suggests that the current analysis may be underestimating the real benefits of reducing and quitting smoking. If, for example, it were to be assumed that a smoker will lose, on average, two days of productivity per year (relative to a former smoker), then this will amount to close to £4,000 of lost productivity over a period of 30 years (including discounting at 3.5% per year). There is currently no evidence to suggest the likely impact of *reducing* tobacco intake upon absenteeism. However, it is likely that such productivity gains may be made observed to some degree.

Section 5: Conclusions

This analysis has used analytical modelling techniques to estimate the lifetime costs and health outcomes associated with a range of interventions for tobacco harm reduction. The model used inputs from existing epidemiological studies to predict the long-term outcomes associated with different levels of smoking status. By combining the effectiveness of different interventions, with those long-term outcomes, the model is able to predict the costs and benefits of each intervention.

In general, all interventions in the model were demonstrated to be highly cost-effective when compared against 'no intervention'. Various scenario analyses were undertaken, to explore the relative benefits of different routes of approach. It was noted that, whilst it is possible that offering services for people to reduce their smoking level *may* have a detrimental impact upon those who wish to quit smoking, the benefits of reducing are approximately half those of quitting. Therefore, for each 'quitter' drawn into reducing instead, any intervention would need to achieve at least two additional reducers to offset that loss.

The results of the model show that an intervention that achieves one additional 'reducer', will provide an additional 0.45 QALYs to society, and will save the NHS approximately £767 over the patient's lifetime. Using a net monetary approach, one reducer is 'worth' around £10,000 to society. Many interventions, however, need to treat *many* patients in order to achieve one reducer. If a treatment costs (say) £200, then the number needed to treat in order to achieve one quitter would be required to be 50 (i.e. a 2% 'reduce' rate). In approximate terms, society should be willing to pay approximately £100 per 1% increase in the number of people reducing their smoking intake.

Likewise, an intervention that achieves one *quitter* will produce 0.84 QALYs (NB: this is an average across all ages in the model, and also accounts for natural quitting and other factors) and will save £1,412 over the person's lifetime. This is 'worth' approximately £20,000 to society. This translates to a willingness to pay of around £200 per additional 1% of *quitters*.

This can be interpreted as meaning that if an intervention has a *quit* rate of (say) 4%, then, as long as that intervention cost less than £800 (i.e. 4 x £200), then it would be likely to be cost-effective. If an intervention had a '*reduce*' rate of (say) 7%, then it would be cost-effective as long as its cost was below £700 (i.e. 7 x £100).

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APPENDIX A

Input Summary

Set-up

In the basecase model the following settings were used.

Discount rates	
Costs	3.5%
Benefits	3.5%

Cohort size	1,000

Starting age	25

Natural quit rate (annual)	
Smoker	2.0%
Low-level smoker	2.0%
Natural 'reduction' rate (annual)	
Smoker	2.0%

Number of other people affected per smoker	0.5
Increased risk of CHD	28.0%
Increased risk of lung cancer	24.0%

Effectiveness

The effectiveness inputs for the probability of quitting and reducing, for each intervention, are shown below in Table A.1.

Table A.1: Effectiveness inputs

	P(quit) 12m	Source	P(reduce) 12m	Source
No intervention	2.00%	Assumption	2.00%	Assumption
CDTQ + NRT + BS (generic)	9.00%	Hughes (2010). Odds ratio for gradual versus abrupt quitting	10.18%	Reduction rate assumed equal to Reduce + NRT + BS (generic), minus quit rate
CDTQ + NRT + BS (specialist)	9.00%	Hughes (2010). Odds ratio for gradual versus abrupt quitting	10.18%	Reduction rate assumed equal to Reduce + NRT + BS (specialist), minus quit rate
CDTQ + NRT	7.80%	Shiffman (2009). Average of odds ratio for NRT vs. placebo for 4mg and 2mg	8.82%	Assumed equal relationship to CDTQ + NRT + BS (specialist) as for quit rate
CDTQ + BS (generic)	9.00%	Assumed equal to CSTQ + NRT + BS (generic)	10.18%	Assumed equal to CSTQ + NRT + BS (generic)
CDTQ + BS (specialist)	9.00%	Assumed equal to CSTQ + NRT + BS (specialist)	10.18%	Assumed equal to CSTQ + NRT + BS (specialist)
CDTQ	7.80%	Odds ratios from Hughes (2010) for gradual vs. abrupt quitting applied to CDTQ without NRT or BS, vs. no intervention	8.82%	Assumed equal relationship to CDTQ + BS (specialist) as for quit rate
Abrupt quit + NRT substitute + BS (generic)	15.00%	Parrott (1994)	2.00%	Assumed equal to no intervention
Abrupt quit + NRT substitute + BS (specialist)	15.00%	Parrott (1994)	2.00%	Assumed equal to no intervention
Abrupt quit + NRT substitute	6.00%	Parrott (1994)	2.00%	Assumed equal to no intervention
Temporary abstinence + NRT + BS (generic)	7.97%	Assumed equal to Reduce + NRT + BS (generic)	11.21%	Chan (2011). CO validated 50% reduction rate minus CO validated quit rate
Temporary abstinence + NRT + BS (specialist)	7.97%	Assumed equal to Reduce + NRT + BS (specialist)	11.21%	Chan (2011). CO validated 50% reduction rate minus CO validated quit rate
Temporary abstinence + NRT	3.86%	Assumed equal to Reduce + NRT	2.70%	Assumed equal to Reduce + NRT
Temporary abstinence + BS (generic)	4.42%	Assumed equal to Reduce + BS (generic)	2.00%	Assumed equal to Reduce + BS (generic)

Temporary abstinence + BS (specialist)	4.42%	Assumed equal to Reduce + BS (specialist)	2.00%	Assumed equal to Reduce + BS (specialist)
Temporary abstinence	2.00%	Assumed equal to no intervention	2.00%	Assumed equal to no intervention
Reduce + NRT + BS (generic)	7.97%	Chan (2011). CO validated cessation	11.21%	Chan (2011). CO validated 50% reduction rate minus CO validated quit rate
Reduce + NRT + BS (specialist)	7.97%	Chan (2011). CO validated cessation	11.21%	Chan (2011). CO validated 50% reduction rate minus CO validated quit rate
Reduce + NRT	3.86%	Evidence statement 3.1e meta-analysis. Cessation risk ratio	2.70%	Evidence statement 3.1b meta-analysis. RR for NRT vs placebo
Reduce + BS (generic)	4.42%	Chan (2011). CO validated cessation	2.00%	Assumed equal to no intervention
Reduce + BS (specialist)	4.42%	Chan (2011). CO validated cessation	2.00%	Assumed equal to no intervention
Reduce	4.42%	Chan (2011). CO validated cessation	2.00%	Assumed equal to no intervention

Quality of Life

The utilities used for each health state in the model are outlined below in Table A.2.

Table A.2: Health state utility inputs

Health state utilities		Source
High-level smoker	0.8414	Vogl (2012)
Low-level smoker	0.8629	
Former smoker	0.8669	
Never smoked	0.8839	

Utilities for each co-morbidity were used to calculate the disutility associated with each co-morbidity when the patient was in each health state, as shown below in Table A.3.

Table A.3: Comorbidity disutility inputs

		Comorbidity disutilities			
Comorbidity	Utility	Smoker	Low-level smoker	Former smoker	Never smoked
Lung cancer	0.61	0.23	0.2529	0.2569	0.2739
Stroke	0.48	0.3614	0.3829	0.3869	0.4039
CHD	0.80	0.0414	0.0629	0.0669	0.0839
MI	0.80	0.0414	0.0629	0.0669	0.0839
COPD	0.73	0.1114	0.1329	0.1369	0.1539

Costs

The intervention unit costs used in the model are shown below in Table A.4. In the basecase the NRT (typical) cost was used. The total intervention costs over time are shown below in Table A.6, combining both the NRT and behavioural support.

Table A.4: Intervention unit costs

	Per week	Source
Behavioural support (generic)	£25.00	PSSRU 2011
Behavioural support (specialist)	£106.00	PSSRU 2011
Self help	£0.00	Assumption
NRT (typical)	£15.42	PSSRU 2011
NRT (e-cigarette)	£12.60	Average of daily cost for E Lites, Streamlite and VIP e-cigarette refills, assuming switched for 20 cigarettes per day.
NRT (patch)	£9.07	British National Formulary 63 (2012).
NRT cost for model	£15.42	
Long-term duration of NRT use (years)	2	

The comorbidity costs used in the model are shown below in Table A.5.

Table A.5: Comorbidity costs

Comorbidity	Cost (per year)	Source
Lung cancer	£5,908	Taylor (2010) Inflated to 2012 costs
Stroke	£2,213	
CHD	£1,142	
MI	£2,336	
COPD	£994	

Table A.6: Total intervention costs

	Help	Total number of 'help' units	NRT	Duration of NRT (weeks)	Total cost	Long-term use of NRT?
No intervention	£0	0	£0.00	0	**£0**	N
CDTQ + NRT + BS (generic)	£25	2	£15.42	12	**£235**	N
CDTQ + NRT + BS (specialist)	£106	2	£15.42	12	**£397**	N
CDTQ + NRT	£0	0	£15.42	12	**£185**	N
CDTQ + BS (generic)	£25	2	£0.00	0	**£50**	N
CDTQ + BS (specialist)	£106	2	£0.00	0	**£212**	N
CDTQ	£0	0	£0.00	0	**£0**	N
Abrupt quit + NRT substitute + BS (generic)	£25	2	£15.42	104	**£1,653**	Y
Abrupt quit + NRT substitute + BS (specialist)	£106	2	£15.42	104	**£1,815**	Y
Abrupt quit + NRT substitute	£0	0	£15.42	104	**£1,603**	Y
Temporary abstinence + NRT + BS (generic)	£25	2	£15.42	12	**£235**	N
Temporary abstinence + NRT + BS (specialist)	£106	2	£15.42	12	**£397**	N
Temporary abstinence + NRT	£0	0	£15.42	12	**£185**	N
Temporary abstinence + BS (generic)	£25	2	£0.00	0	**£50**	N
Temporary abstinence + BS (specialist)	£106	2	£0.00	0	**£212**	N
Temporary abstinence	£0	0	£0.00	0	**£0**	N
Reduce + NRT + BS (generic)	£25	2	£15.42	12	**£235**	N
Reduce + NRT + BS (specialist)	£106	2	£15.42	12	**£397**	N
Reduce + NRT	£0	0	£15.42	12	**£185**	N
Reduce + BS (generic)	£25	2	£0.00	0	**£50**	N
Reduce + BS (specialist)	£106	2	£0.00	0	**£212**	N
Reduce	£0	0	£0.00	0	**£0**	N

Co-morbidities and mortality

The annual risk of each comorbidity was varied by age and can be seen in Figures A.1 to A.6 below.

Figure A.1: Annual risk of lung cancer, by age and smoking status

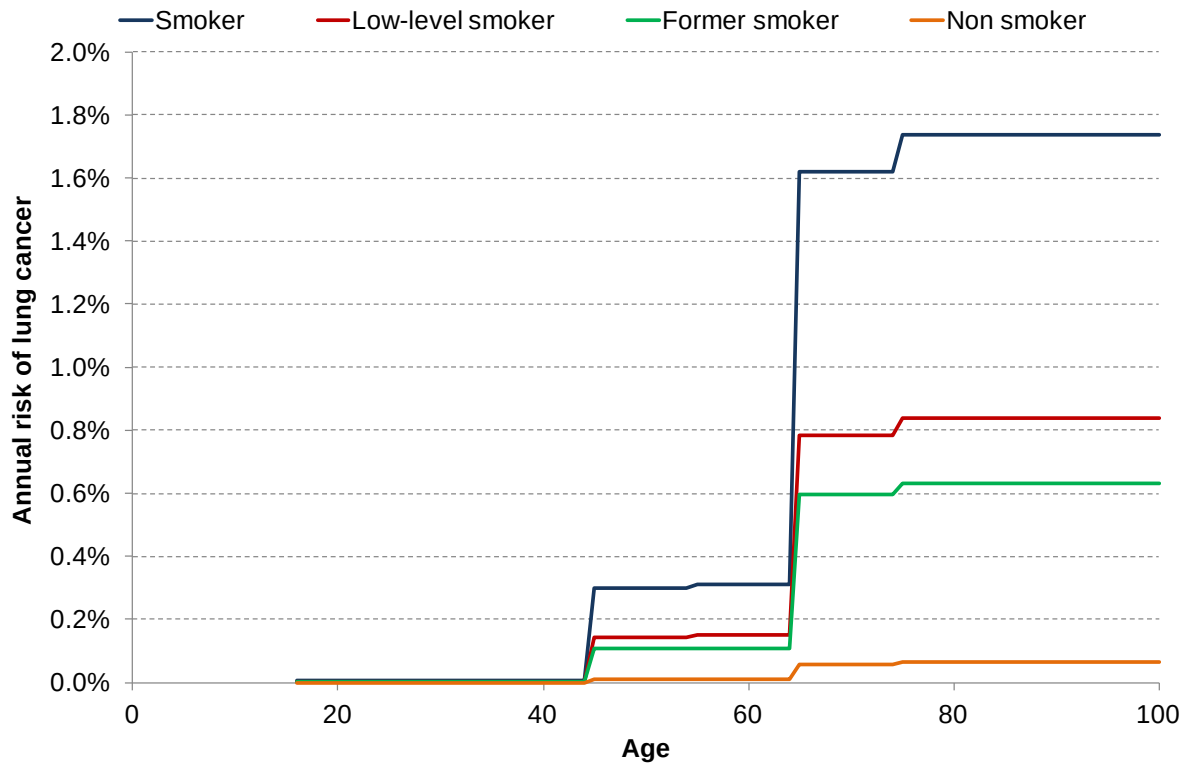


Figure A.2: Annual risk of myocardial infarction, by age and smoking status

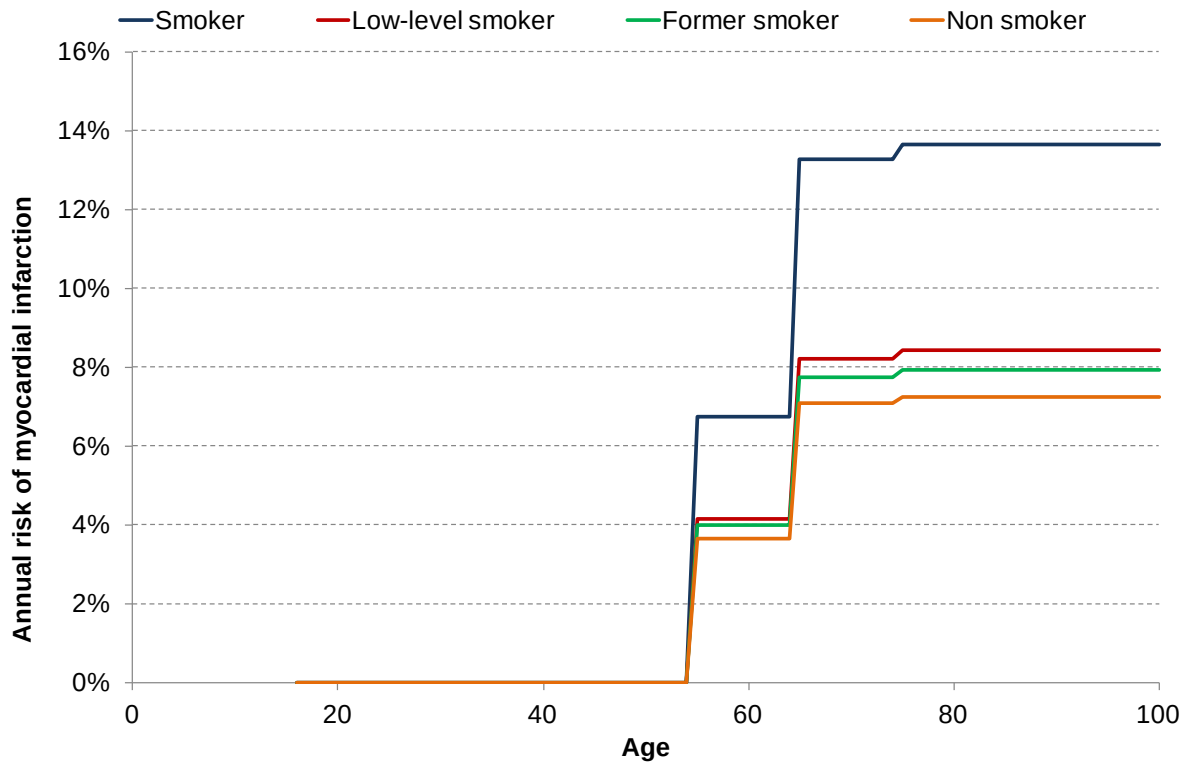


Figure A.3: Annual risk of coronary heart disease, by age and smoking status

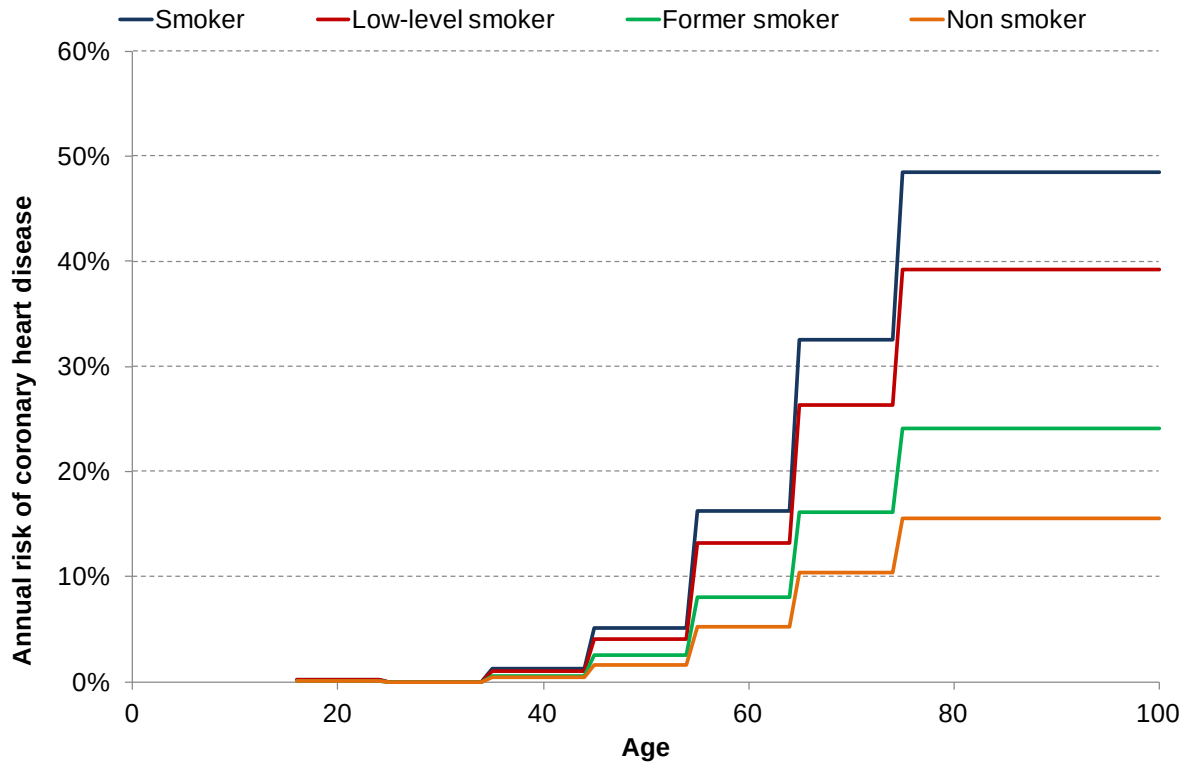


Figure A.4: Annual risk of chronic obstructive pulmonary disease, by age and smoking status

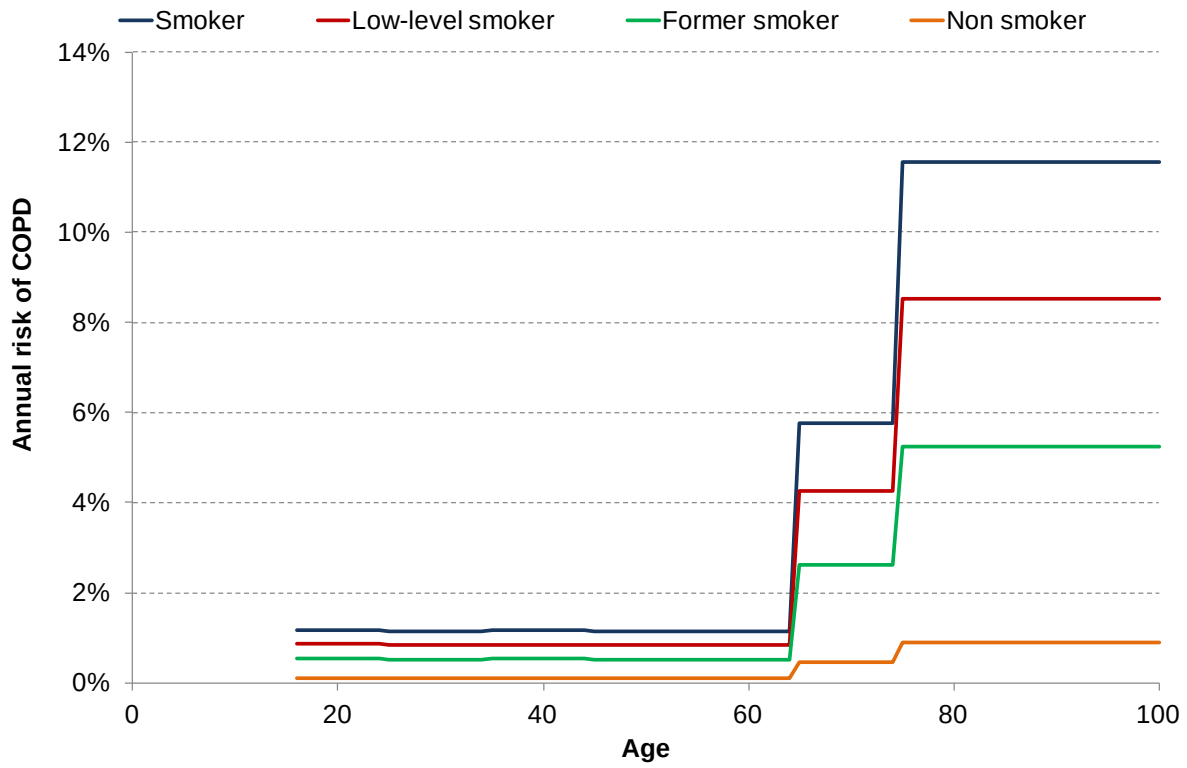


Figure A.5: Annual risk of stroke, by age and smoking status

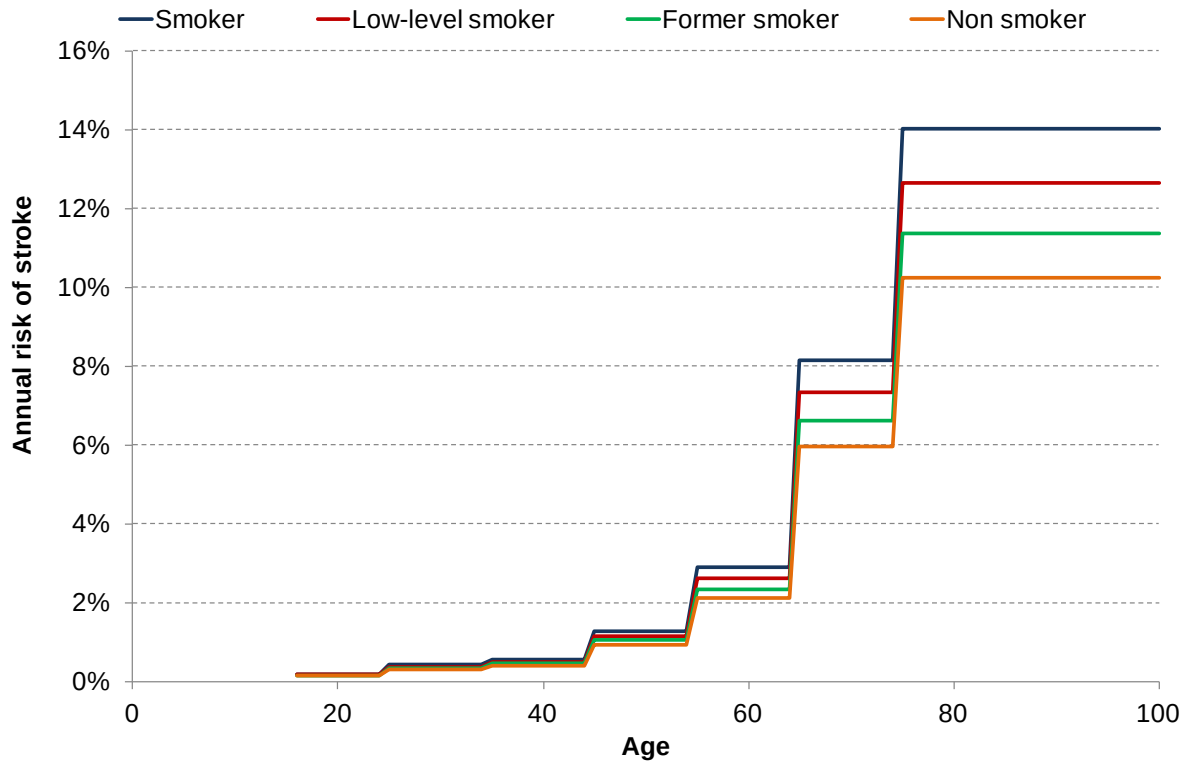
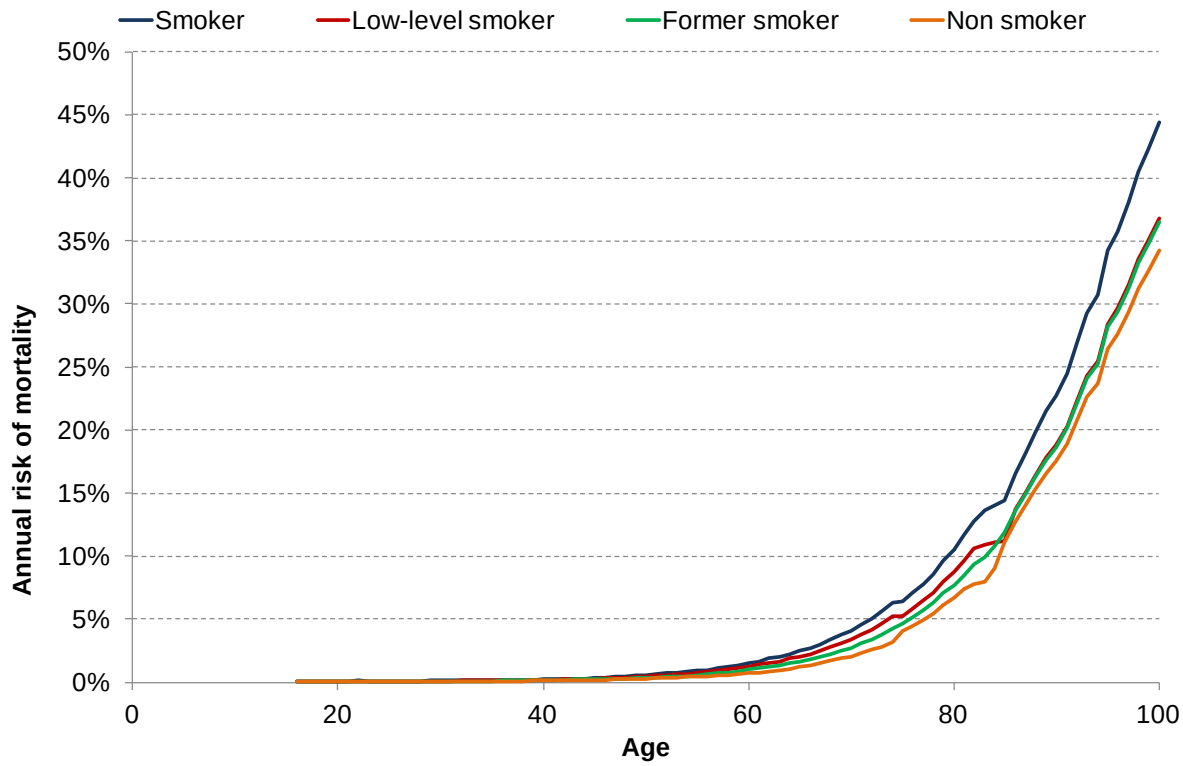


Figure A.6: Annual risk of all-cause mortality, by age and smoking status



YORK
Health Economics
CONSORTIUM

INVESTORS IN PEOPLE

University of York
Market Square
Vanbrugh Way
Heslington
YORK YO10 5NH

Tel: +44 (0) 1904 323620
Fax: +44 (0) 1904 323628
Email: yhec@york.ac.uk
Web: www.yhec.co.uk

THE UNIVERSITY of York