Making Conversations Count for All

Benefits of improving delivery of smoking cessation interventions for different socioeconomic groups

August 2021

Together we will beat cancer

CANCER RESEARCH UK

Reference

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Cancer Research UK

Cancer Research UK is the world's largest independent cancer charity dedicated to saving lives through research. We support research into all aspects of cancer through the work of over 4,000 scientists, doctors and nurses. In 2019/2020 we spent £455 million on new and ongoing research projects. We receive no funding from Government for our research.

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HealthLumen

HealthLumen is a leading-edge health technology company. We develop innovative software and services for modelling the burden of non-communicable diseases (NCDs), and the impact of interventions. Our microsimulation-based platform generates evidence to quantify the future health and economic impact of proposed interventions on NCDs, when scaled across the population, helping decision makers to improve health outcomes.

https://www.healthlumen.com/

List of acronyms

AML	acute myeloid leukaemia
CHD	coronary heart disease
CML	chronic myelogenous leukaemia
COPD	chronic obstructive pulmonary disease
CRUK	Cancer Research UK
GP	general practitioner
HL	HealthLumen
LA	local authority
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NS-SEC	National Statistics Socio-Economic Classification
NRT	nicotine replacement therapy
ONS	Office for National Statistics
SSS	stop smoking service
VBA	Very Brief Advice

Foreword

The UK has a world-leading Health Service, with healthcare free at the point of delivery. Over the past 70 years a vast Primary Care infrastructure has been created, with an effective and large network of GP Practices, Community Pharmacists, Primary Care networks and Dentists, among many other services. The reach of our Primary Care Service is such that this is where 90% of all patient contacts in the NHS take place.

Despite this infrastructure, millions of people who are in the most financially deprived group in our society who are addicted to tobacco are not sufficiently identified, supported or treated. This has largely been the result of a failure of training, planning and funding rather than a lack of caring by the Primary Care professions.

As a result, people who smoke seen in Primary Care continue to do so and the majority inevitably develop preventable disease, disability or needlessly die from tobacco-related disease. Not treating tobacco dependency in Primary Care plunges families and children into poverty, stops people from working and exacerbates the health inequalities gap.

This report lays bare the inconvenient truth that the current approach to treatment of tobacco addiction in Primary Care and community settings is not enough. Thankfully this report suggests clear solutions. Firstly, there needs to be better delivery of systematic treatment of tobacco addiction that can be initiated in Primary Care and combined with local government Stop Smoking Services. Secondly, there needs to be a linking of patient pathways and data sets between the NHS and local government services so that treatment pathways are seamless and accessible, with good patient experience and outcomes. Thirdly, we need adequate commissioning and funding of Primary Care and locally commissioned tobacco addiction treatments and Stop Smoking Services. Finally, we need a focus on the most deprived in our communities to reduce the health inequality gap.

By initiating these changes, we will prevent the profound health and financial toll wreaked by tobacco addiction on the poorest in our society, whilst also reducing demand on our NHS and saving health and social care billions of pounds over the coming decades. This report, combined with the Royal College of Physicians report '*Smoking and Health 2021*' published in May 2021 and the All Party Parliamentary Group report on Tobacco Control published in June 2021, provide overwhelming evidence that much more needs to be done to treat tobacco addiction in Primary Care to reduce the burden of tobacco dependency amongst the poorest in our society and which we can all hope will be reflected in the upcoming Tobacco Control Plan for England.

Professor Sanjay Agrawal

Chair, Royal College of Physicians Tobacco Advisory Group

Consultant in Respiratory and Critical Care Medicine

Executive Summary

Background

Smoking remains the biggest preventable cause of cancer and death in the UK, accounting for 125,000 all-cause deaths and 54,300 cases of cancer per year (1–3). Beyond this human cost, there is considerable burden to the health service; in England alone, it is estimated that treatment of smoking-related illness costs the NHS approximately £2.4 billion per year (4).

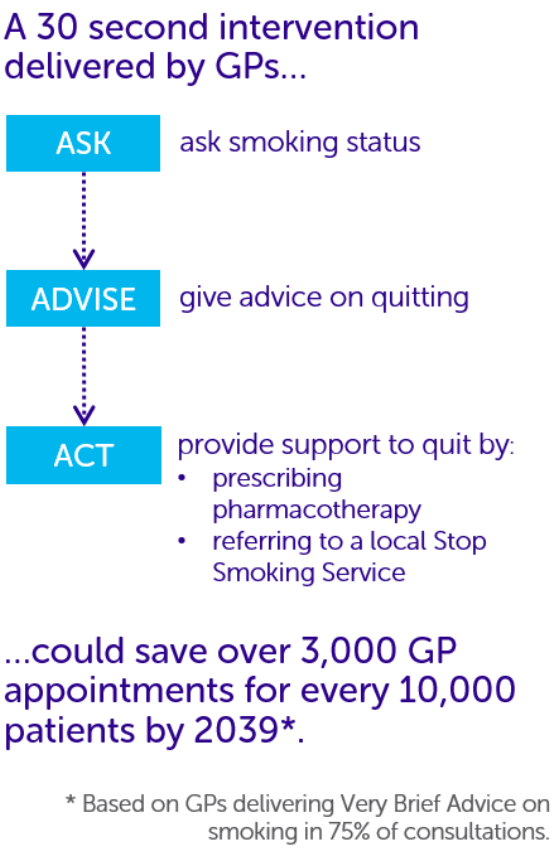
Variation in smoking prevalence across different population groups is a major driver of health inequalities in the UK. In England, variation in smoking prevalence accounts for around half the difference in life expectancy between the highest and lowest income groups (5). Decades of success in tobacco control in the UK has seen smoking rates decline from over 40% in the 1970s, to a record low of 14.1% in 2019 (6). However, despite such progress there has been no overall reduction in smoking inequalities in the UK in recent years (7).

Recent modelling from Cancer Research UK (CRUK) projected that, based on trends to 2018/19, neither England nor Scotland will reach their national smokefree ambitions (that is, adult smoking prevalence ≤ 5% by 2030 (8) and 2034 (9) in England and Scotland respectively). Crucially, more deprived groups are projected to achieve these ambitions markedly later than less deprived groups in each UK nation. This suggests inequalities across different population groups in the UK are a major barrier to achieving national smokefree ambitions.

The health service has an important role to play in providing patients with or signposting them to evidence based smoking cessation tools. Primary care services, which deal with the majority of patients, have the potential to provide this support to a large proportion of the population. The National Institute for Health and Care Excellence (NICE) recommends that primary care practitioners in England and Wales routinely deliver Very Brief Advice (VBA) on smoking cessation to patients (10). This can be delivered in 30 seconds, using an 'Ask, Advise, Act' (AAA) framework.

Despite this, more than half of GPs in the UK report having never received any training in VBA and, unsurprisingly, do not widely deliver it in consultations with patients (11).

Our 2020 report, *Making Conversations Count*, funded by CRUK and led by HealthLumen, aimed to estimate the burden of active smoking-related disease in the UK and quantify the health and economic impacts of improving the delivery within primary care over the next 20 years of:



(i) VBA with a referral to a Stop Smoking Service

(ii) VBA with a prescription for medication; or
(iii) the Ottawa Model – an alternative intervention based on the 'AAA' framework involving a structured end to end programme (12).

All three interventions were shown to improve smoking cessation for the general population. However, we must understand the impact of these interventions across socioeconomic groups in order to address smoking-related health inequalities.

This study builds on this previous work by looking at the impact of improving the delivery of these interventions on different socioeconomic groups, compared with current policy, between 2019-2039. By focusing on socioeconomic status, this study explores one component of deprivation to assess the impact of improving the delivery of these interventions on smoking related health inequalities and associated economic costs in the UK.

Key findings

Smoking rates are projected to continue to decline across all socioeconomic groups

If current trends continue, by 2039 smoking prevalence is projected to be:

- 2.5% in NS-SEC (National Statistics Socio-economic Classification) group 1 (least deprived)
- 7.7% in NS-SEC group 2
- 8.4% in NS-SEC group 3 (most deprived)

This is a sizable reduction in smoking prevalence and corresponds to a 70% reduction in prevalence over the modelled period in NS-SEC group 1, 39% reduction in group 2 and a 57% reduction in group 3.

But relative smoking inequalities are projected to widen without appropriate action

Despite reductions in smoking prevalence across all NS-SEC groups, the unequal rate at which each group's smoking prevalence reduces over the modelled period will increase relative smoking inequalities between lower and higher socioeconomic groups by 2039.

In 2019 smoking prevalence was projected to be 2.4 times higher in NS-SEC group 3 than NS-SEC group 1. This difference is projected to increase to 3.4 times higher in 2039.

This widening of smoking inequalities is even more stark for NS-SEC group 2, with the difference in smoking prevalence projected to double compared to NS- SEC group 1 in 2039 (increase from 1.5 times higher in 2019 to over 3 times higher than NS- SEC group 1 in 2039).

Consequently, lower socioeconomic groups will face a larger burden from smoking-related disease

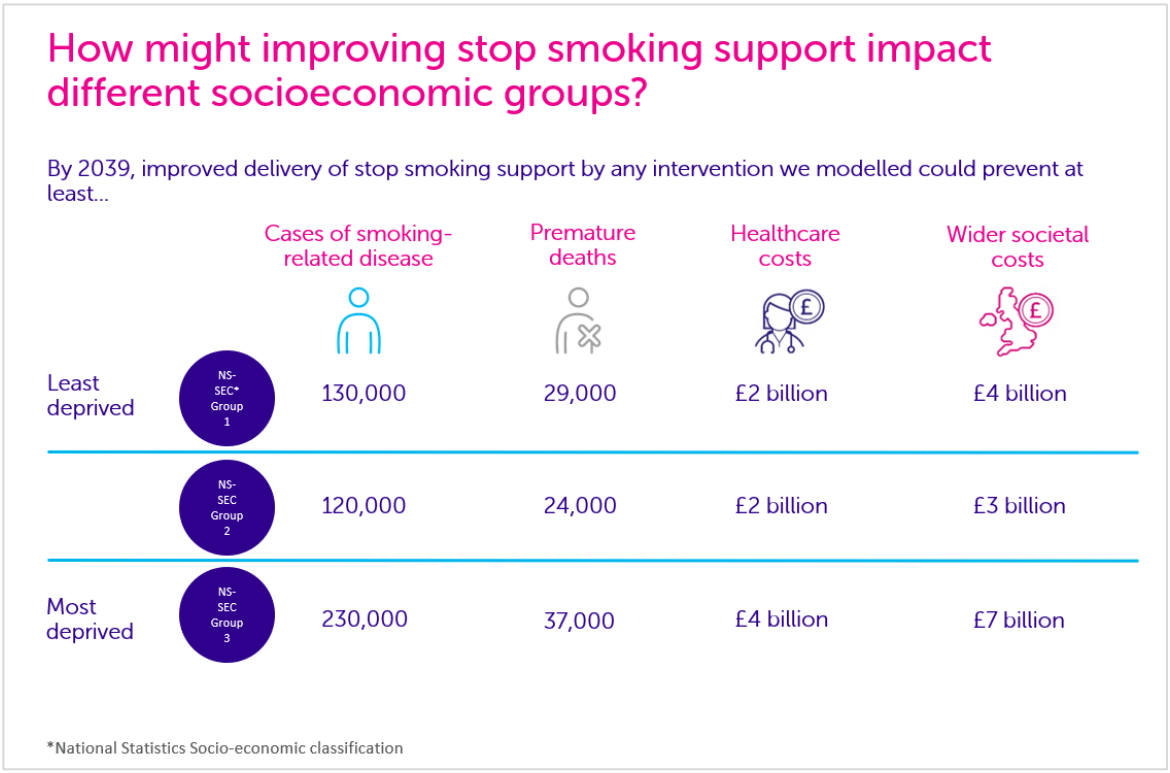
As a consequence of the existing and widening disparities in smoking rates, NS-SEC group 3 are projected to face the largest burden of smoking-related disease over the next 20 years.

The model projected that by 2039, NS-SEC group 3 will have over 1,500,000 cases of disease, and over 248,000 premature deaths attributable to smoking. In comparison, NS-SEC group 1 was projected to have over 897,000 cases of disease, and over 164,000 premature deaths. Cancers will comprise around 36-38% of smoking-attributable diseases in both groups.

Making improvements to stop smoking support is projected to see benefits across all socioeconomic groups

All three intervention scenarios resulted in substantial additional declines in smoking prevalence across all socioeconomic groups. By 2039, this would lead to a smoking prevalence of 1.8% or lower in NS-SEC group 1, 5.8% or lower in NS-SEC group 2, and 5.9% or lower in NS-SEC group 3.

None of the intervention scenarios modelled were projected to narrow or widen the increase in smoking inequalities projected in the baseline scenario. This was because all intervention scenarios were equally effective and projected a similar relative decrease in smoking prevalence in 2039 for all socioeconomic groups, that was around a quarter lower than in the baseline scenario. However, this still represents a sizable additional decline in smoking prevalence in comparison to current policy modelled in the baseline scenario.



Gains across lower socioeconomic groups offer large opportunities to positively impact health and economic outcomes in the UK

All interventions were suggested to be similarly effective across all three NS-SEC groups. However, due to the larger number of people who smoke within NS-SEC group 3, this group are projected to see the greatest number of people quitting as a result of general practice interventions.

Consequently, this group may also see the largest absolute reduction in disease and mortality, as well as the largest absolute health care savings across all socioeconomic groups.

Across all three scenarios over the 20-year modelled period, NS-SEC group 3 was projected to see:

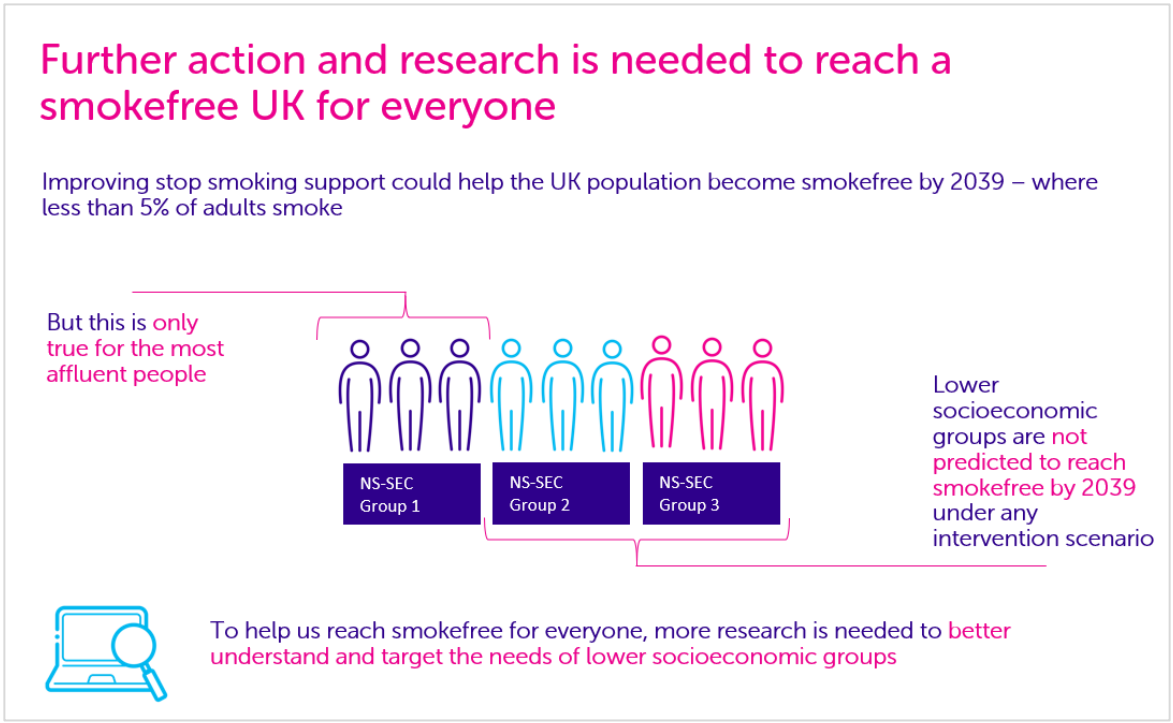
- The largest primary care savings, with an average of over £330 million and over 11 million GP appointments saved
- The largest savings in total healthcare costs with an average of £4.91 billion avoided health care costs
- The largest reduction in wider societal costs with between £7.2-8.3 billion saved over the 20 year period
- The largest reduction in hospitalisations with an average of just under 395,000 fewer hospitalisations.

Improvements to smoking cessation interventions that effectively reach lower socioeconomic groups offer a substantial opportunity to see large health and economic benefits in the UK.

More research is needed to better understand how to target the needs of lower socioeconomic status groups

All intervention scenarios were predicted to have a similar impact on all three NS-SEC groups and neither narrow nor widen health inequalities, even though the greater number of smokers in NS-SEC group 3 means this group would see the largest absolute reductions. Under all three intervention scenarios a "smokefree" ambition (≤ 5% of adults smoking) would be achieved by 2039 only in NS-SEC group 1, not in groups 2 or 3 under any scenario. This emphasises the importance of smoking cessation interventions that are tailored to effectively reach those in lower socioeconomic groups and reduce the inequality gap.

More research is needed to understand how to better meet the needs of deprived groups to encourage and support successful quit attempts through such interventions.



Policy Recommendations

Improving delivery of VBA in primary care to support cessation across all groups

Improving delivery of smoking cessation support in primary care will accelerate a decline in smoking prevalence across all socioeconomic groups. Services for all individuals must be improved in order to reach smokefree targets and reduce smoking prevalence amongst the most deprived communities.

Enhancing identification and engagement of people who smoke

- Across practices, people's smoking status should be digitally recorded and updated at every opportunity.
- To facilitate an integrated smoking cessation pathway across the healthcare system, datasets should be shared across primary and secondary care, along with commissioned services.

Ensuring services are equipped and funded sustainably to support people to stop smoking

- The UK Government should look into sourcing increased and sustainable funding for recurring costs of tobacco control.
- Primary care professionals should be able to routinely prescribe the most effective forms of pharmacotherapy to all patients who smoke.
- Follow up protocols for patients prescribed pharmacotherapy should be developed to aid adherence and increase uptake of referrals to stop smoking services.

Addressing smoking inequalities across the UK

Despite the accelerated decline in smoking prevalence that would be seen if smoking cessation support was improved across primary care, this report shows that relative smoking inequalities will continue to widen – unless further action is taken. In addition to improving smoking cessation support, more must be done if we are to narrow the inequality gap.

Identifying and engaging people who smoke from more deprived groups

- More research is needed on both how to better identify people from more deprived groups who smoke and on interventions which could specifically promote cessation among these groups.
- Local stop smoking services should proactively promote and target their service offer to people in the most deprived groups, for example through advertising, social marketing and media campaigns.

Ensuring primary care professionals discuss using e-cigarettes to stop smoking

- Primary care professionals should discuss and recommend using e-cigarettes as one of a range of tools that can help patients – including those from more deprived groups – to stop smoking.

Contents

1 Introduction

Smoking remains the largest cause of preventable illness, including smoking-related cancers, and avoidable death in the UK (2). In England alone, smoking costs the NHS around £2.4 billion annually (13). Nearly 500,000 hospitalisations were attributable to smoking in 2017–18 (14).

Because smoking is so damaging to health, the varying rates of smoking among different groups of the population mean that smoking is also a major driver of health inequalities. In England, variation in smoking prevalence has been estimated to account for around half the difference in life expectancy between the highest and lowest income groups (5). Deprivation is a measurement that encompasses multiple domains, including income, employment, education and skills, health and disability, crime, barriers to housing and services and living environment (15). Socioeconomic status – the focus of this report - is one important component of deprivation, measuring education, income and occupation (16), that holds a relationship to smoking inequalities in the UK. A recent analysis found that out of various measures of inequality, area deprivation, housing and occupation played the biggest role in likeliness of smoking (17). Moreover, smoking prevalence is estimated to be around two and a half times higher among routine and manual workers compared to those in managerial and professional occupations (18).

Decades of success in tobacco control in the UK means that smoking rates have declined from a high of over 40% in the 1970s, to a low of 14.1% (13.9% for England, 15.4% for Scotland, 15.5% for Wales, and 15.6% for Northern Ireland) in 2019 (6). However there have been no overall reductions in smoking inequalities in the UK in recent years (7). There have been commitments to make England smokefree (that is, adult smoking prevalence ≤ 5%) by 2030 (8) and Scotland tobacco-free (synonymous with smokefree) by 2034 (9). However, recent modelling from Cancer Research UK (CRUK) has projected that, based on current trends, smokefree will not be reached until 2037 in England, after 2050 in Scotland, 2037 in Wales and late 2040s in Northern Ireland. Across each UK nation, projections also showed those in more deprived groups will be substantially slower to achieve these smokefree ambitions, suggesting inequalities across different population groups in the UK are a major barrier to achieving national smokefree targets. More must be done to ensure that national governments set and meet targets to make smoking obsolete across each and every socioeconomic group.

The best way for individuals to mitigate the harmful consequences of smoking on their health is to stop. Early intervention is crucial, as the sooner people quit smoking, the better for their health and life expectancy (20). Quit attempts using a stop smoking service (SSS), combining pharmacotherapy and specialist behavioural support, are around three times more likely to be successful than unaided attempts (19). The UK is considered a global leader in tobacco control, with all four nations offering free SSS to support people in quitting. The health service has an important role to play in providing patients with, or signposting to, evidence-based smoking cessation tools and services to provide people who smoke with the best chance of quitting. Primary care services, who see the majority of patients, have the potential to provide this smoking cessation support to a large proportion of the population before they have developed serious smoking-related disease.

Recent guidance from NICE recommends that primary care practitioners in England and Wales deliver Very Brief Advice (VBA) on smoking (10), whereby they **(i) ask** their patients about their

smoking status, **(ii) advise** their patients on how they can stop smoking, and **(iii) act** by referring the patient to a local SSS, prescribing pharmacotherapy or discussing e-cigarettes. Despite this, barriers to VBA exist. These include lack of time and training; more than half of GPs in the UK report to have never received any training in VBA (11) and, unsurprisingly, do not widely deliver it in consultations with patients (21). The Ottawa Model of Smoking Cessation, from Canada, is another approach to supporting smoking cessation in primary care that is more intensive, incorporating clinical staff training, outreach facilitation visits, standardised staff and patient tools, real time prompts and electronic medical record tools, as well as follow-up support and counselling (22).

Understanding the impact of stop smoking interventions across socioeconomic groups is an important avenue of exploration if we wish to understand how to best support successful quit attempts and drive down smoking prevalence. This report expands on research funded by CRUK and led by HealthLumen, which aimed to determine to what extent increasing delivery of smoking cessation interventions by GPs would affect smoking rates and smoking related health and economic outcomes across the UK. Using a microsimulation model over the period 2019 to 2039, a current practice 'baseline' scenario was compared to the improved delivery of (i) VBA with a referral to a SSS, (ii) VBA with a prescription for medication or (iii) the Ottawa Model delivered within primary care (12). The study estimated that any of the three interventions alone could lead to substantial reductions in smoking-attributable disease, mortality, healthcare costs, and wider societal costs from sick days or deaths. Additionally, all three interventions alone would – for the population as a whole – achieve smokefree ambitions by 2039.

However, whilst these three interventions have been shown to improve smoking cessation for the general population, the impact of these interventions across socioeconomic groups and their possible contribution toward smoking-related health inequality has not been quantified. This study builds on this previous work by looking at the impact of these interventions on different socioeconomic groups. By focusing on socioeconomic status, this study explores one component of deprivation in order to assess the impact of improving the delivery of these interventions on smoking-related health inequalities and associated economic costs in the UK.

2 Research aims and objectives

This study aims to quantify the impact of improving GP delivery of smoking cessation interventions across National Statistics Socioeconomic Classification (NS-SEC) groups (23) and builds on the approach used in Corbould et al. (2020) (12). A microsimulation model was used to quantify: smoking prevalence, disease incidence, premature mortality, and cost savings to the health service and wider UK society, stratified across four socioeconomic groups to assess the contribution of socioeconomic differences in intervention referrals and subsequent quit success to health inequalities.

The four scenarios modelled in the study are:

1. Current general practice ("baseline") – trends continue assuming no future change in policy

Majority (75%) of people who smoke either:

2. Visit their GP and are assumed to receive VBA on smoking including a referral to specialist SSS ("VBA + referral")
3. Visit their GP and are assumed to receive VBA on smoking including a prescription of smoking cessation pharmacotherapy with brief advice ("VBA + prescription")
4. Visit their GP and are assumed to receive the Ottawa Model for smoking cessation in primary care ("Ottawa")

These scenarios are described in detail in Section 3.22 and the socioeconomic groups are described in detail in Section 3.33.

3 Methods

3.1 HealthLumen Microsimulation model

This study used the HealthLumen (HL) Microsimulation model, which models the impact of interventions upon non-communicable diseases and the related economic effects in a virtual population of 100 million individuals. This is a single integrated mathematical model used to generate a range of outputs. Each individual modelled has a specified age (in this simulation, people who smoke are aged 20 years or older, based on five year age groups), sex, and smoking status (i.e. current smoker, ex-smoker, never smoker) based on known population statistics across the UK. The HL Microsimulation model (12) is made up of multiple modules which are described in more detail in the appendix.

3.2 Scenario overview

The scenarios included in this study are based on our previous modelling of smoking cessation support in general practice (12), however in this instance the simulated values included at each stage were stratified by socioeconomic group (Figure 1).

The five scenarios included:

1. Baseline – smoking trends continue as though no change in smoking policy into the future
2. VBA with referral
3. VBA with prescription
4. The Ottawa Model
5. Attributable scenario

Scenario 1 followed current smoking trends, as projected from the Annual Population Survey data (years 2010 to 2017) (25) using a multinomial regression model. This could be considered a continuation of current clinical practice with continued population-level policy change, including some implementation of stop smoking support by GPs.

Scenarios 2 to 4 introduced routine smoking cessation support during an individual's visit to their GP. Smoking cessation was modelled in multiple steps:

- In step (i), a proportion of people who smoke are assumed to visit their GP at least once a year
- In step (ii), the intervention is delivered by the GP. This is one of: VBA on smoking including referral to a specialist SSS (VBA with referral), VBA on smoking including prescription of pharmacotherapy with brief advice (VBA with prescription), or advice as part of the Ottawa Model (Ottawa). For prescription of pharmacotherapy, we assumed no one medication in particular – this may encapsulate single- or dual-form nicotine replacement therapy (NRT), and/or non-NRT pharmacotherapy such as bupropion or varenicline. Delivery of VBA + referral assumes that specialist behavioural support is offered universally across the UK, and all intervention scenarios assume that GPs are able to prescribe appropriate pharmacotherapies and that they are being used by people who smoke for the prescribed time.
- In step (iii), the intervention is taken up by the patient. For VBA with referral and VBA with prescription, this means attending a SSS or receiving a prescription, and using

pharmacotherapy as prescribed, respectively. For the Ottawa Model, this is modelled in two stages – uptake of pharmacotherapy, and attendance at counselling (22).

- Steps (iv) and (v) represented quit and reuptake rates, respectively.

The attributable scenario is calculated by modelling the impact of a scenario where there was 100% reduction in smoking prevalence. The difference between baseline and attributable scenario equals the smoking-related attributable cases. The number of cases avoided as a proportion of the attributable cases were calculated.

3.3 Socioeconomic groups

Socioeconomic classifications in this study were made according to National Statistics Socio-economic Classification (NS-SEC), which classifies individuals into three groups plus 'never worked/unclassified groups' according to employment/occupation (Table 1).

Population data by NS-SEC group were taken from census 2011, since census 2021 was not available at the time of analysis. These figures were imposed on 2019 total population data to get the same population size disaggregated by census proportions.

Microsimulation outputs for NS-SEC groups 1-3 are included in the results with estimates for NS-SEC group 4 included in Appendix. NS-SEC 4 has high heterogeneity, so interpretation of results should be made with caution. The high heterogeneity means that this group is not representative of a socioeconomic group but rather a disparate collection of those who do not fit other groups within the classification.

It should be noted that limited data availability required assumptions to be made on NS-SEC population distributions. Data were also not always available around differential impacts by socio-economic status, meaning assumptions were made (for instance, a universal reuptake rate of 30% across NS-SEC groups was assumed) (Figure 1).

Table 1. Employment groups comprising each NS-SEC group.

Employment status groups	Collapsed groups	Group number
Higher managerial and professional Lower managerial and professional	Higher managerial, administrative and professional qualifications	Group 1
Intermediate occupations Small employers and own account workers	Intermediate occupations	Group 2
Lower supervisory and technical Semi-routine occupations Routine occupations	Routine and manual occupations	Group 3
Never worked, unemployed, not elsewhere classified	Never-worked and long-term unemployed, not elsewhere classified	Group 4

3.3.1 Scenario data by NS-SEC

A literature review was conducted to identify published references which included estimates by NS-SEC group for each stage of the smoking cessation intervention or by some other socioeconomic stratification metric which could be mapped on or adapted to fit the NS-SEC four-group classification. The review also attempted to identify data to stratify each stage specifically for each scenario, however scenario-specific estimates for each stage, stratified by

appropriate socioeconomic measures, were not available. Therefore, the overall scenario-specific estimates for each stage used in Corbould et al. (2020) (12) were redistributed according to the socioeconomic estimates identified for each stage. These estimates are described in Appendix 3.

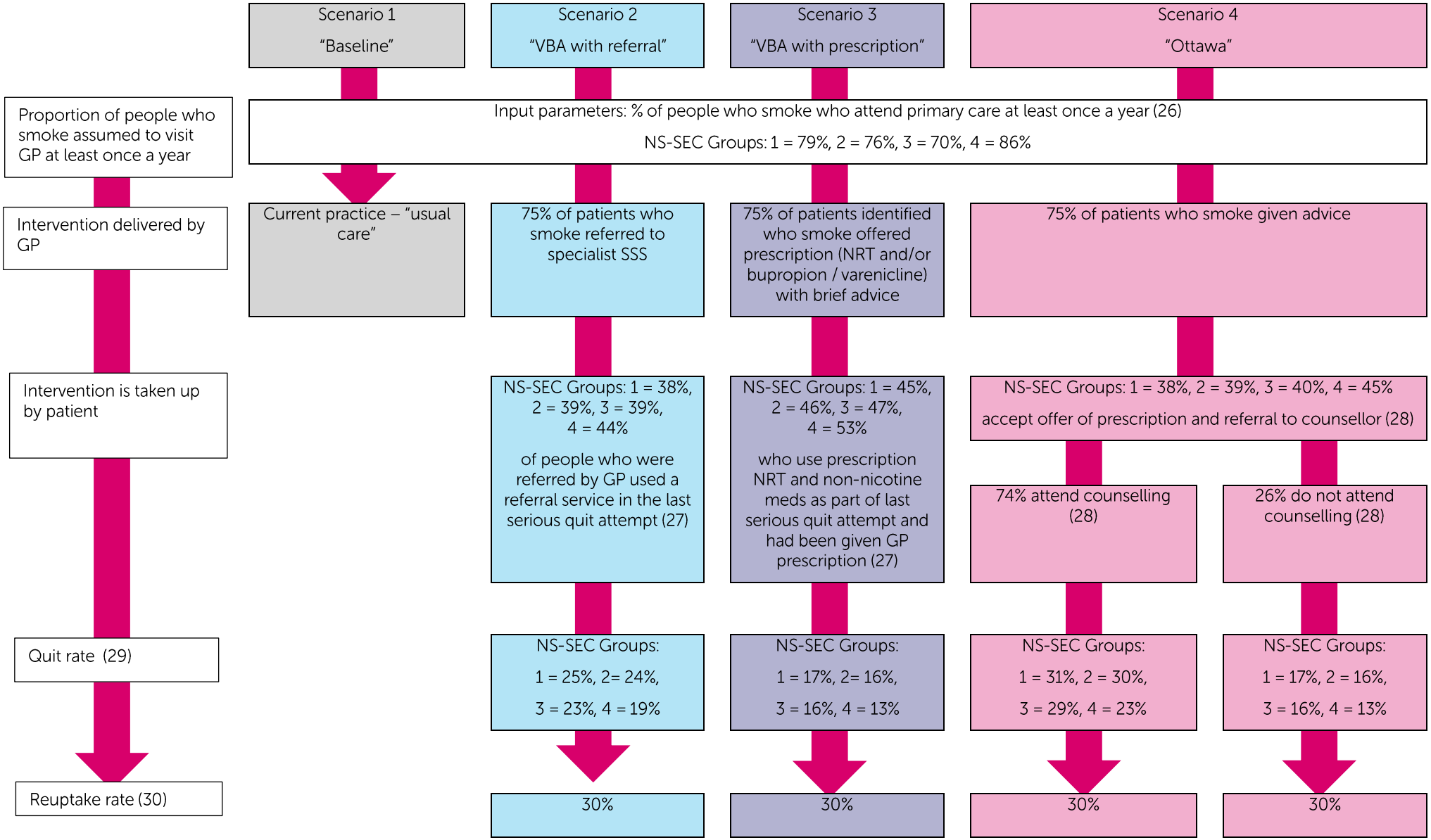


Figure 1: Flow diagram of scenarios modelled

3.4 Smoking-related diseases

Fourteen smoking-related cancers were included in the model: acute myeloid leukaemia (AML), bladder cancer, cervical cancer, chronic myelogenous leukaemia (CML), colorectal cancer, gastric cancer, kidney cancer, liver cancer, lung cancer, laryngeal cancer, lip, oral cavity and pharynx cancer, oesophageal cancer, ovarian cancer, and pancreatic cancer. To show the wider impact of the interventions, non-cancers related to smoking were also included: chronic heart disease (CHD), chronic obstructive pulmonary disease (COPD), type 2 diabetes, depression, and stroke. Due to data availability, this study also did not include all smoking-related conditions, so some impacts may be slightly underestimated.

3.5 Data input

For each disease, publicly available datasets were used to source data on incidence (31–36), prevalence (37–39) and mortality by age and sex, survival, relative risk, utility, hospitalisation rate, and health care costs (40–49). Primary care costs were available for a subset of diseases[i] only and are therefore underestimated. Where data were unavailable for incidence and survival, data manipulations were made based on other available data. A detailed break-down of data sources by disease, as well as detail on data manipulations, can be found in the Technical Appendix.

Population data, including age and sex distributions, total fertility rate and mortality rate were obtained from 2016-based National Population Projections from ONS (50).

3.6 Health economics

Health care costs (40–49) were sourced from the literature and more details of the costs and sources used are provided in the Technical Appendix. Total health service costs, as well as primary care costs specifically, were sourced. A cost per disease case was calculated and inputted into the model. GP appointments avoided were estimated by dividing primary care savings by the average cost of a GP appointment—assumed to be £30 (51).

Wider societal costs were calculated using a method which takes a human capital approach that measures productivity loss resulting from premature morbidity and mortality (52). The mortality cost is obtained by summing the gross annual income from age of death to 65 years old, which represents the current retirement age in the UK. Lost earnings due to premature mortality by age and sex are based on data obtained from ONS (2016). Productivity loss attributable to premature morbidity refers to the loss of potential earnings incurred when an individual develops a disease which impacts their productivity. These data are based on data from the Annual Survey of Hours and Earnings (ASHE) (53) and the Labour Force Survey (LFS) (54), which is available from the UK Data Service.

The aim of the project was to project the future epidemiological and financial benefits of smoking cessation interventions being delivered by GPs across socioeconomic groups, rather than the upfront investment required to deliver the interventions. Therefore, discounting was not applied since a cost-benefit analysis was not carried out.

[i] Data was available for CHD, COPD, type 2 diabetes, lung cancer, colorectal cancer and stroke

3.7 Data output

For each scenario, the following outputs were generated for each of the four NS-SEC groups:

- smoking prevalence by age and sex
- smoking-related disease incidence
- smoking-related premature mortality cases
- scenario-related health care costs, by disease
- scenario-related wider societal costs (from morbidity and mortality)
- smoking- and scenario-related primary care costs and hospitalisations

For each intervention scenario, cases and costs avoided were calculated by subtracting intervention scenario outcomes from the baseline outcomes. Attributable cases avoided were calculated by subtracting the cases and costs avoided for each scenario from the total attributable cases. All outputs were rescaled from rates per 100,000 (as output by the model) to a 2019 UK population disaggregated by NS-SEC group proportions from Census 2011.

Confidence intervals, presented in square brackets within this report, are Monte Carlo errors and represent the accuracy of the microsimulation as opposed to the confidence of the input data itself. Errors around the input data were not available.

4 Results

4.1 Smoking prevalence by NS-SEC group

4.1.1 Smoking prevalence in the baseline scenario

Smoking prevalence projections for adults aged 20+ in NS-SEC groups 1 to 3 in the baseline scenario are shown in Figure 1. Estimates for NS-SEC group 4 (the lowest socioeconomic group, but also the most heterogeneous group) are shown in Appendix 2. Given the heterogeneity of this group, interpretation of results should be made with caution.

For NS-SEC group 1, it was predicted that smoking prevalence would fall 5.8 percentage points, from 8.3% [±<0.01] in 2019 to 2.5% [±<0.01] in 2039. This represents a 70% reduction in smoking prevalence over the modelled period.

For NS-SEC group 2, it was predicted that smoking prevalence would fall 5.0 percentage points from 12.7% [±<0.01] in 2019 to 7.7% [±<0.01] in 2039. This represents a 39% reduction in smoking prevalence over the modelled period.

For NS-SEC group 3, it was predicted that smoking prevalence would fall 11.3 percentage points from 19.7% [±<0.01] in 2019 to 8.4% [±<0.01] in 2039. This represents a 57% reduction in smoking prevalence over the modelled period.

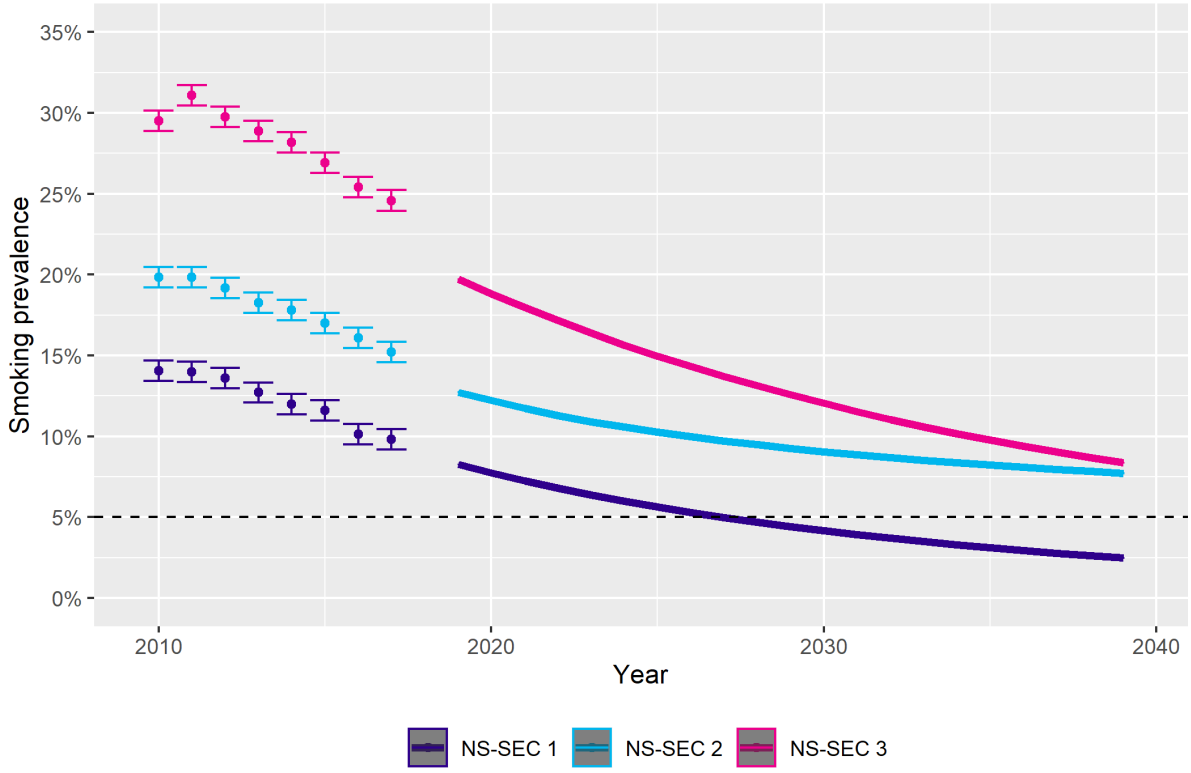


Figure 1. Proportion of adults (age 20+) who smoke in the UK, projected for 2019–2039 by the HL Microsimulation model, by socioeconomic (NS-SEC) group[ii]

Empirical data is from ONS[28]. *Dotted line = 5% smoking, below which is a "smokefree" generation.*

Despite reductions in smoking prevalence across all NS-SEC groups, the unequal rate at which each group's smoking prevalence reduces over the modelled period will increase relative smoking inequalities between these socioeconomic groups by 2039. NS-SEC group 3's smoking prevalence has the largest absolute reduction in smoking prevalence over the modelled period. However, the relative reduction is greater in NS-SEC group 1, which widens the relative prevalence gap between the two groups (70% reduction NS-SEC group 1 versus 57% reduction NS-SEC group 3). In 2019, smoking prevalence was projected to be 2.4 times higher in NS-SEC group 3 than NS-SEC group 1, whereas this difference was predicted to increase to 3.4 times higher in 2039. Moreover, this widening of inequality would not just be seen between the highest and lowest socioeconomic groups. If current trends continue, it is projected that NS-SEC group 2 would see the difference in smoking prevalence increase, from 1.5 times higher to over 3 times higher than NS-SEC group 1 in 2039.

Analysing these projections through the lens of "smokefree" (≤5% smoking prevalence) ambitions highlights these continuing (and worsening) inequalities. Whereas NS-SEC group 1 is predicted to be smokefree as early as 2027 across the UK in the baseline scenario, NS-SEC groups 2 and 3 would not become smokefree by 2039, the end of the microsimulation.

Smoking prevalence projections disaggregated by sex generally showed similar trends (Figure 2). From 2019 to 2039 the smoking prevalence in the NS-SEC group 1 was projected to similarly

[ii] Smoking prevalence was recorded to increase in NS-SEC group 3 from 2010-11 in the Annual Population Survey (APS); no change was made to the data collection tool which would explain this increase.

drop from 8.99% [±<0.01] to 2.6% [±<0.01] and from 7.66% [±<0.01] to 2.4% [±<0.01] in males and females respectively. In the NS-SEC group 3, the prevalence was projected to similarly drop from 21.11% [±0.01] to 8.7% [±<0.01] and from 18.33% [±0.01] to 8.0% [±<0.01] in males and females respectively. Notably, the decline in smoking prevalence from 2019 to 2039 for NS-SEC group 2 was predicted to be much less in females (9.88% [±<0.01] to 7.2% [±<0.01]) than males (16.44% [±0.01] to 8.4% [±<0.01]), narrowing a prior inequality within this socioeconomic group. Overall, widening of relative health inequalities in smoking is expected to affect both sexes similarly – smoking prevalence in NS-SEC group 3, which in 2019 was projected to be ~2.4 times higher than in NS-SEC group 1 for both males and females, was projected to be 3.4 (males) and 3.3 (females) times higher than NS-SEC group 1 in 2039.

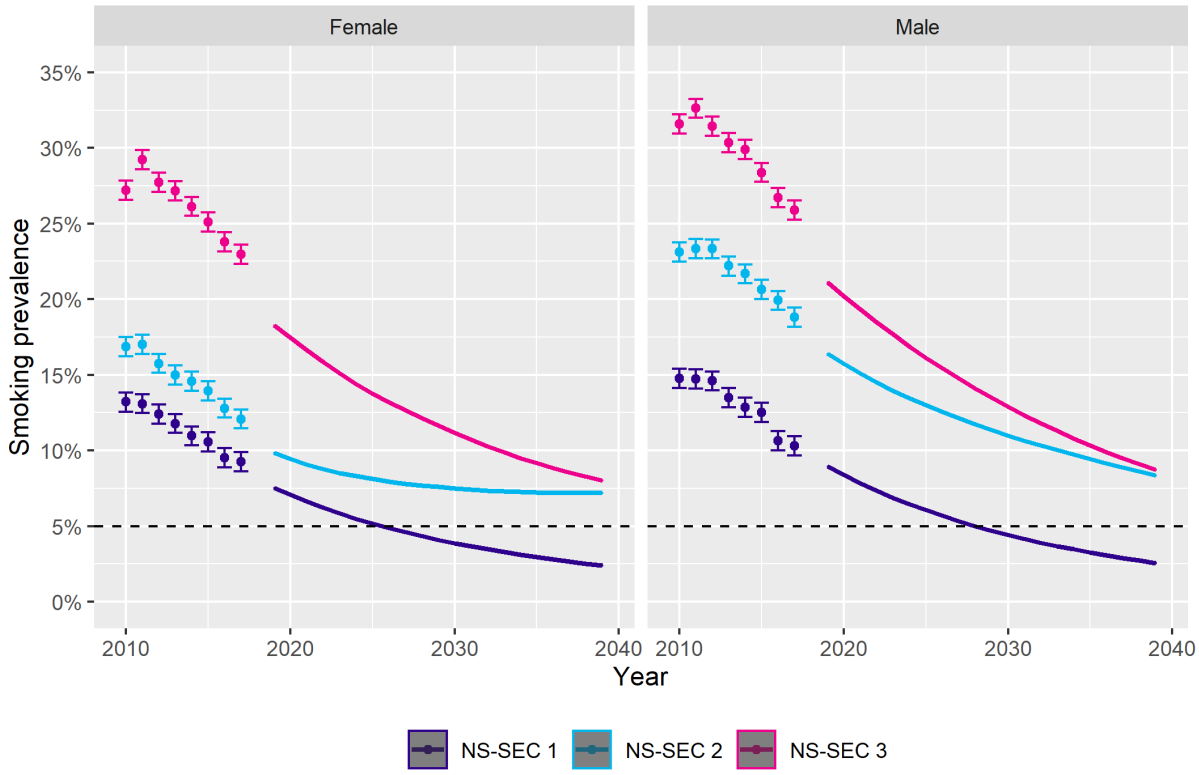


Figure 2. Proportion of adult female (left) and male (right) (age 20+) who smoke in the UK, projected for 2019–2039 by the HL Microsimulation model, by socioeconomic (NS-SEC) group

Empirical data is from ONS[28]. *Dotted line = 5% smoking, below which is a "smokefree" generation.*

The absolute and relative drop in smoking prevalence for female and male adults from 2019 to 2039 was projected to be similar for both sexes in the NS-SEC group 1 and group 3. The drop in NS-SEC group 2 females (2.6 points decrease, 27% relative drop in smoking prevalence) was projected to be much smaller than the drop in NS-SEC group 2 males (8.1 points decrease, 49% relative drop in prevalence) (Table 2).

Table 2. Absolute and relative drop in smoking prevalence of adults disaggregated by sex (age 20+), projected from 2019 to 2039 by the HL Microsimulation model, by socioeconomic (NS-SEC) group

NS-SEC group	Female		Male	
	Absolute drop in smoking prevalence	Relative drop in smoking prevalence	Absolute drop in smoking prevalence	Relative drop in smoking prevalence
NS-SEC group 1	5.2 points	68%	6.4 points	71%
NS-SEC group 2	2.6 points	27%	8.1 points	49%
NS-SEC group 3	10.3 points	56%	12.4 points	59%

Disaggregating the baseline scenario projections by broad age group showed that, in 2039, smoking prevalence was predicted to be highest (12.1%) in NS-SEC group 3 males aged 20-39 years. Smoking prevalence in NS-SEC group 2 females 60 years and over was considerably higher in 2039 than for other age groups and for group 2 males in this age group (Figure 3). The reason for this is unclear – it is possible that this is because the APS is not designed to measure this outcome with this level of stratification. Splitting this group into females 60-69 years and 70 years or above showed a consistent downward trend amongst those 60-69 years, with a less consistent trend in those 70 years or above, likely due to small numbers of smokers in the latter group being included in estimates in the input data. Figure 3 also highlights that ex-smokers tend to be in the older age groups, regardless of NS-SEC group, largely driven by lower smoking incidence among young people and higher quit rates in older people. Thus, in baseline, the majority of smokers are in the working age population.

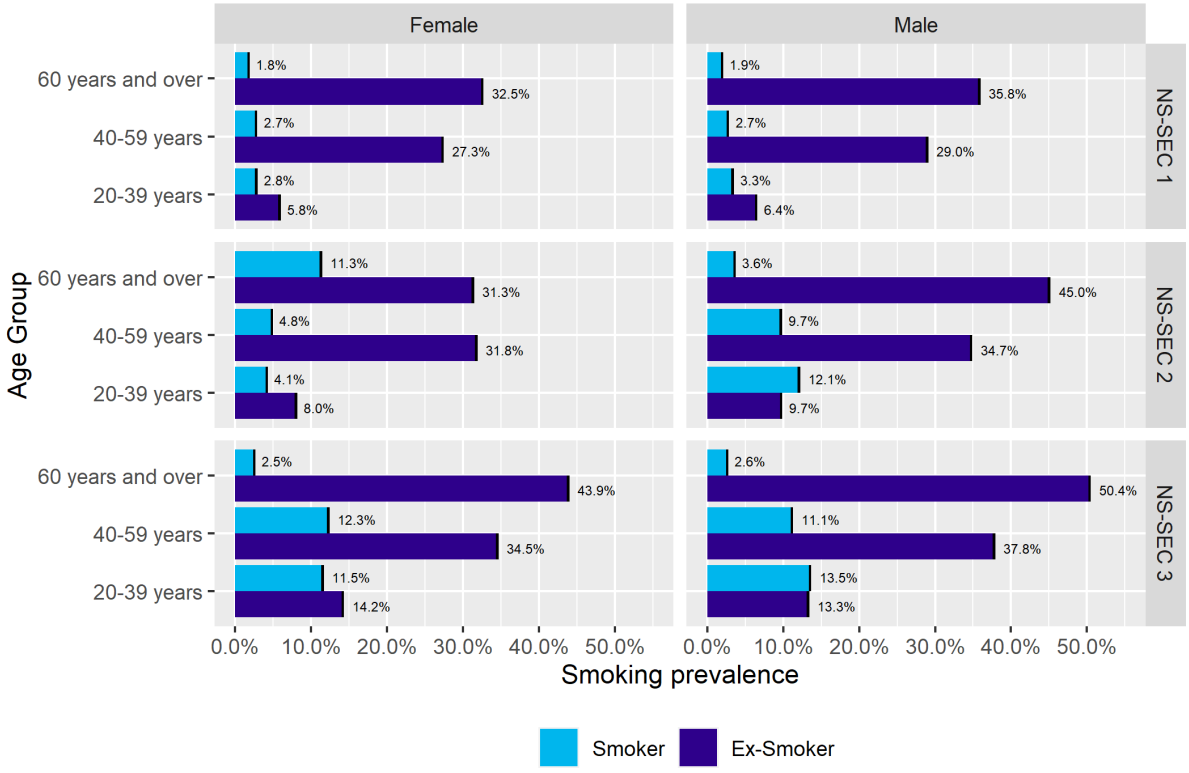


Figure 3. Proportion of people who smoke in the UK in 2039 under the baseline scenario, by NS-SEC group, age and sex.

4.1.2 Smoking prevalence in the intervention scenarios

All three intervention scenarios predicted significant additional declines in smoking prevalence across all socioeconomic groups compared with the baseline scenario. Smoking prevalence projections for NS-SEC groups 1 to 3 in these scenarios are shown in Figure 4. Estimates for NS-SEC group 4 are shown in Appendix 2.

For NS-SEC group 1, the intervention scenarios resulted in a 2039 smoking prevalence of 1.7% [±<0.01], 1.8% [±<0.01], and 1.6% [±<0.01] for VBA + Referral, VBA + Prescription, and the Ottawa Model, respectively. These predictions are all at least 0.7 percentage points lower than, and represent at least 28% lower prevalence than the baseline scenario.

For NS-SEC group 2, the intervention scenarios resulted in a 2039 smoking prevalence of 5.5% [±0.01], 5.8% [±0.01], and 5.3% [±0.01] for VBA + Referral, VBA + Prescription, and the Ottawa Model, respectively. These predictions are all at least 1.9 percentage points lower than, and represent at least 24% lower prevalence than, the baseline scenario.

For NS-SEC group 3, the intervention scenarios resulted in a 2039 smoking prevalence of 5.5% [±0.01], 5.9% [±0.01], and 5.2% [±0.01] for VBA + Referral, VBA + Prescription, and the Ottawa Model, respectively. These predictions are all at least 2.5 percentage points lower than, and represent at least 29% lower prevalence than, the baseline scenario.

For all intervention scenarios and for all NS-SEC groups, 2039 smoking prevalence was around a quarter lower than the baseline scenario, suggesting that these interventions would not significantly narrow or widen inequalities in smoking between these groups above the levels

projected in the baseline scenario. It was predicted that the interventions would benefit a higher proportion of the population classified as NS-SEC group 3 than NS-SEC groups 1 and 2 (additional reductions of at least 2.5 percentage points, compared with 0.7 and 1.9, respectively) – but this is likely due to the higher starting smoking prevalence in this socioeconomic group.

A summary of projections for all scenarios is presented in

Table 3.

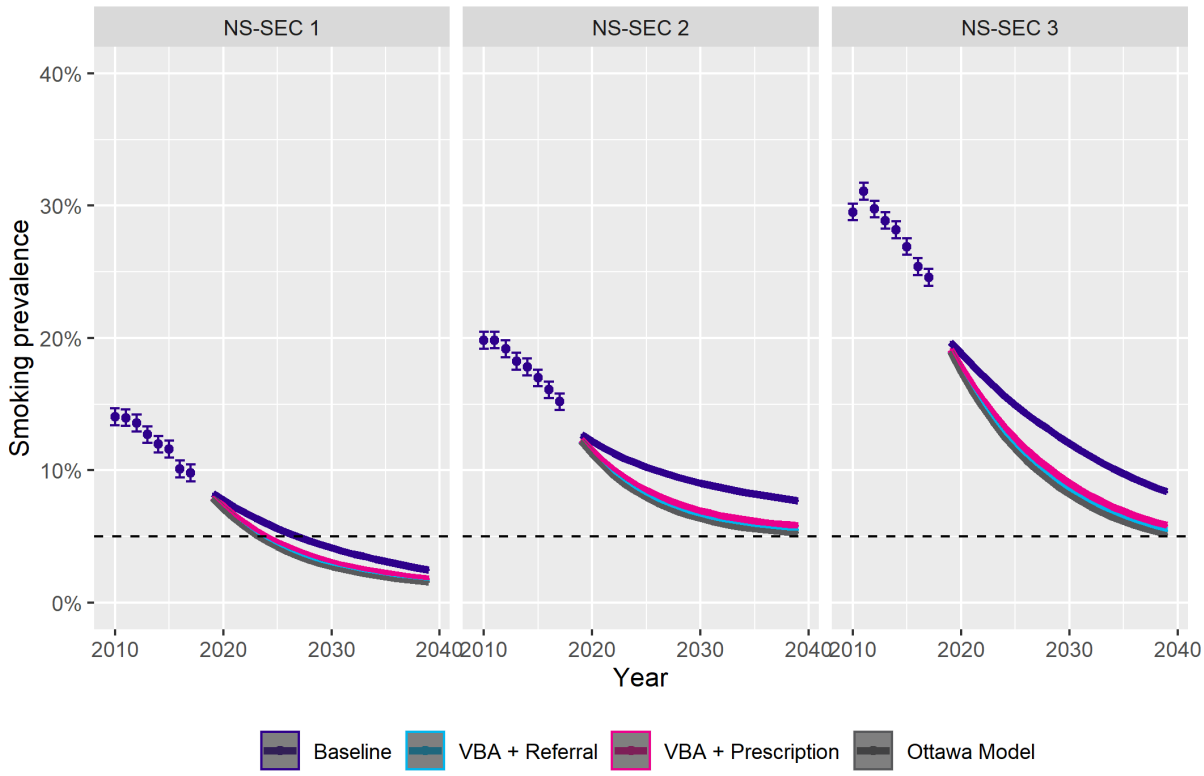


Figure 4. Proportion of adults (age 20+) who smoke in the UK, projected for 2019–2039 by scenario and NS-SEC group.

Empirical data is from ONS[28]. *Dotted line = 5% smoking, below which is a "smokefree" generation.*

Table 3. Proportion of adults (age 20+) who smoke in the UK in 2019 and 2039, and change over time, as projected by the HL Microsimulation model, for each scenario by NS-SEC group

		NS-SEC Group 1		NS-SEC Group 2		NS-SEC Group 3	
	Year	Proportion of adults who smoke	MC error* [±]	Proportion of adults who smoke	MC error* [±]	Proportion of adults who smoke	MC error* [±]
Baseline	2019	8.3	0.01	12.7	0.01	19.7	0.01
	2039	2.5	<0.01	7.7	0.01	8.4	0.01
	Change	5.8	-	5	-	11.3	-
	Relative change	70.0%	-	39.3%	-	57.5%	-
VBA + Referral	2019	8.0	0.01	12.3	0.01	19.0	0.01
	2039	1.7	<0.01	5.5	0.01	5.5	0.01
	Change	6.3	-	6.8	-	13.6	-
	Relative change	79.0%	-	55.0%	-	71.3%	-
VBA + Prescription	2019	8.0	0.01	12.3	0.01	19.2	0.01
	2039	1.8	<0.01	5.8	0.01	5.9	0.01
	Change	6.2	-	6.5	-	13.3	-
	Relative change	77.7%	-	52.8%	-	69.4%	-
Ottawa Model	2019	7.9	0.01	12.2	0.01	19.0	0.01
	2039	1.6	<0.01	5.3	0.01	5.2	<0.01
	Change	6.3	-	6.9	-	13.8	-
	Relative change	79.9%	-	56.6%	-	72.3%	-

*MC error: Monte Carlo error

4.2 Disease incidence by NS-SEC group

4.2.1 Disease incidence attributable to smoking

In the baseline scenario, it was predicted that there will be 897,265 [±3,365] (4,266 per 100,000) cases of disease attributable to smoking in the UK between 2019 and 2039 in NS-SEC group 1, 955,551 [±2,648] (5,773 per 100,000) in NS-SEC group 2, and 1,541,837 [±3,650] (6,759 per 100,000) in NS-SEC group 3. Lung cancer, chronic obstructive pulmonary disease (COPD) and coronary heart disease (CHD) contributed the largest share of attributable disease in all three NS-SEC groups (Figure 5). Collectively, cancers were predicted to comprise 38.1% (341,996) of smoking-attributable diseases in NS-SEC group 1, 38.1% (364,311) in NS-SEC group 2 and 36.5% (563,219) in NS-SEC group 3.

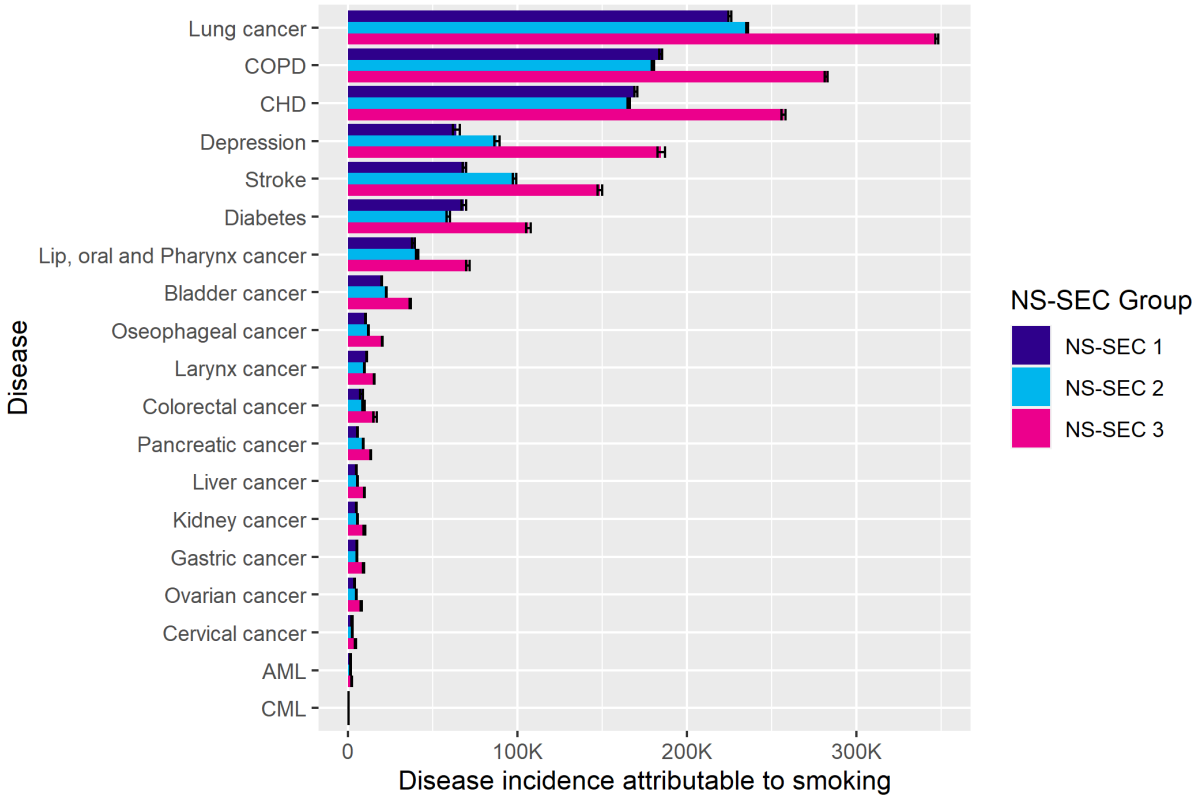


Figure 5. Cumulative disease incidence (millions of cases) in the UK attributable to active smoking by disease, as estimated by subtracting a 0% smoking prevalence scenario from in the baseline scenario, 2019–2039, by NS-SEC group.
Error bars = Monte Carlo error.

4.2.2 Disease incidence in intervention scenarios

All three intervention scenarios predicted large reductions in smoking-related disease incidence across all NS-SEC groups as detailed below. See Table 4 for a summary of cumulative disease incidence by scenario and NS-SEC group.

For NS-SEC group 1, all three interventions were predicted to avoid at least 130,000 diseases (over 600 per 100,000 adults) by 2039. The Ottawa Model predicted the largest reduction in disease incidence at 139,028 [±3,365] (661 per 100,000), with the VBA with referral and VBA with prescription scenarios predicting reductions of 136,293 [±3,365] (648 per 100,000) and 134,400 [±3,365] (639 per 100,000), respectively. However, these differences are not statistically significant. The diseases where most cases were avoided in the intervention scenarios included lung cancer, stroke, COPD, depression, lip, oral and pharynx cancer and diabetes (Figure 6). Under all three interventions, over 75,000 cancer cases were predicted to be avoided in NS-SEC group 1 over the 20-year modelled period.

For NS-SEC group 2, all three intervention scenarios were predicted to avoid at least 120,000 diseases (over 750 per 100,000 adults) by 2039. Again, the Ottawa Model predicted the largest reduction in disease incidence at 133,906 [±2,648] (809 per 10-0,000), with the VBA with referral and VBA with prescription scenarios predicting reductions of 131,092 [±2,648] (792 per 100,000) and 125,630 [±2,648] (759 per 100,000), respectively. As for NS-SEC group 1, the diseases where most cases were avoided in the intervention scenarios include lung cancer, stroke, COPD, depression, lip, oral and pharynx cancer and diabetes (Figure 6). Under all three interventions, between 68,000 and 70,000 cancer cases were avoided in NS-SEC group 2 over the 20-year modelled period.

NS-SEC group 3 was predicted to see the greatest reductions in disease incidence from the interventions, both in terms of absolute number of cases and cases per 100,000 adults. All three interventions were predicted to avoid at least 230,000 diseases (over 1000 per 100,000 adults) in NS-SEC group 3 by 2039. The Ottawa Model predicted the largest reduction in disease incidence at 244,541 [±3,878] (1,072 per 100,000), with the VBA with referral and VBA with prescription scenarios predicting reductions of 241,347 [±3,878] (1,058 per 100,000) and 233,819 [±3,878] (1,025 per 100,000), respectively. The diseases where most cases were avoided in the intervention scenarios include lung cancer, depression, stroke, COPD, lip, oral and pharynx cancer and diabetes (Figure 6). Under all three interventions, over 116,000 cancer cases were predicted to be avoided over the modelled 20-year period for those classified as NS-SEC group 3.

Table 4. Cumulative disease incidence (2019-2039) by scenario and NS-SEC group

		NS-SEC Group 1			NS-SEC Group 2			NS-SEC Group 3		
		Total	Per 100,000	% change	Total	Per 100,000	% change	Total	Per 100,000	% change
	Attributable to smoking (baseline)	897,265 [±3,365]	4,266	-	955,551 [±2,648]	5,773	-	1,541,837 [±3,650]	6,759	-
Reduction relative to baseline	VBA with Referral	136,293 [±3,365]	648	15.2	131,092 [±2,648]	792	13.7	241,347 [±3,878]	1,058	15.7
	VBA with Prescription	134,400 [±3,365]	639	15.0	125,630 [±2,648]	759	13.1	233,819 [±3,878]	1,025	15.2
	Ottawa Model	139,028 [±3,365]	661	15.5	133,906 [±2,648]	809	14.0	244,541 [±3,878]	1,072	15.9

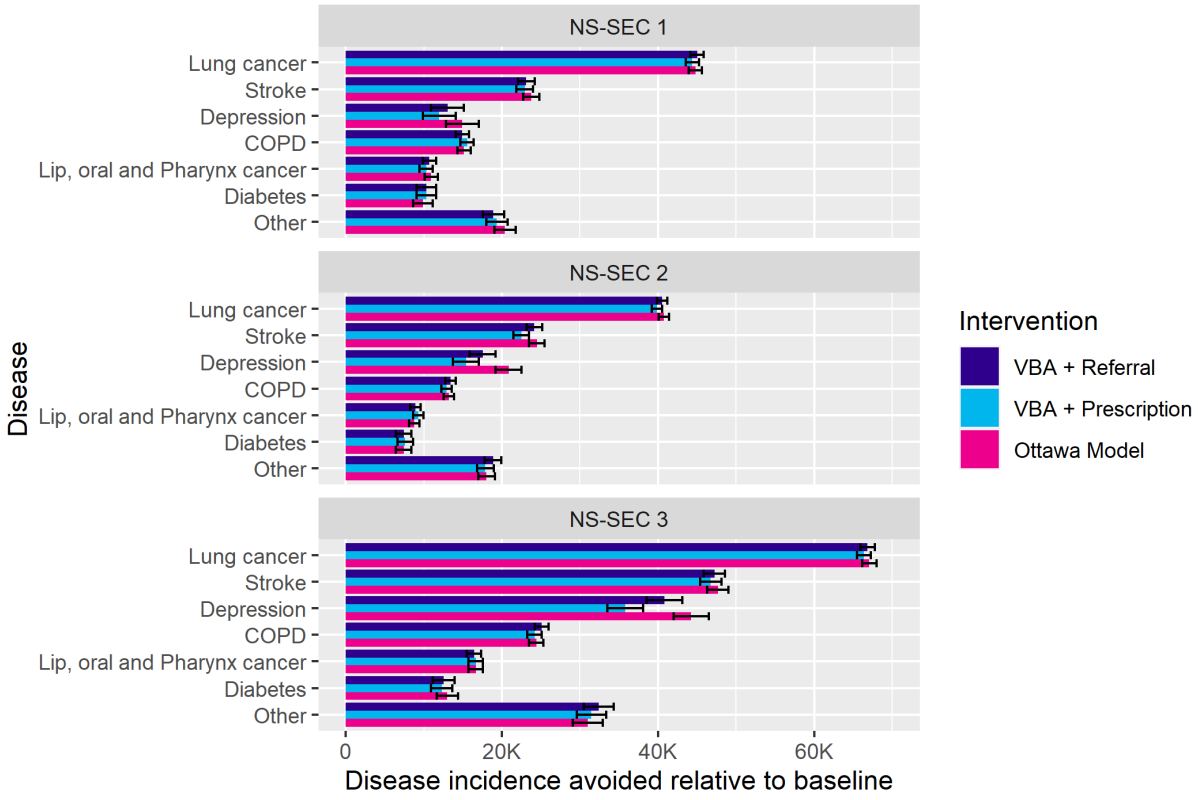


Figure 6. Cumulative disease incidence avoided in intervention scenarios relative to baseline, by disease and NS-SEC group, 2019–2039.

Only most incident diseases shown for each scenario. For a full disease breakdown, see Appendix 4. Error bars = Monte Carlo error.

4.3 Premature mortality by NS-SEC

4.3.1 Premature mortality attributable to smoking

Should trends continue, 164,037 [±2,791] (806 per 100,000) premature deaths (death before the age of 75) could be attributed to smoking between 2019 and 2039 in NS-SEC group 1, 155,237 [±2,197] (969 per 100,000) in NS-SEC group 2 and 248,901 [±3,231] (1,129 per 100,000) in group 3.

4.3.2 Premature mortality reduction in intervention scenarios

For NS-SEC group 1, all intervention scenarios were predicted to avoid at least 29,000 premature deaths (over 140 per 100,000) (Figure 7). The VBA with referral and VBA with prescription scenarios were predicted to avoid 32,044 [±2,791] (156 per 100,000) and 31,828 [±2,791] (155 per 100,000) premature deaths, respectively, with the Ottawa Model predicted to avoid 32,462 [±2,791] (158 per 100,000) premature deaths between 2019 and 2039.

For NS-SEC group 2, all interventions were predicted to avoid at least 24,000 premature deaths (over 140 per 100,000). The VBA with referral and VBA with prescription scenarios were predicted to avoid 26,344 [±2,197] (163 per 100,000) and 26,319 [±2,197] (163 per 100,000) premature deaths, respectively. The Ottawa Model was predicted to avoid 26,816 [±2,197] (166 per 100,000) premature deaths between 2019 and 2039.

NS-SEC group 3 was predicted to see the greatest reductions in premature mortality, with all interventions predicted to avoid at least 37,000 premature deaths (over 160 per 100,000). The VBA with referral and VBA with prescription scenarios were predicted to avoid 40,294 [±3,231] (181 per 100,000) and 40,480 [±3,231] (182 per 100,000) premature deaths, respectively. The Ottawa Model was predicted to avoid 40,971 [±3,231] (184 per 100,000) premature deaths between 2019 and 2039.

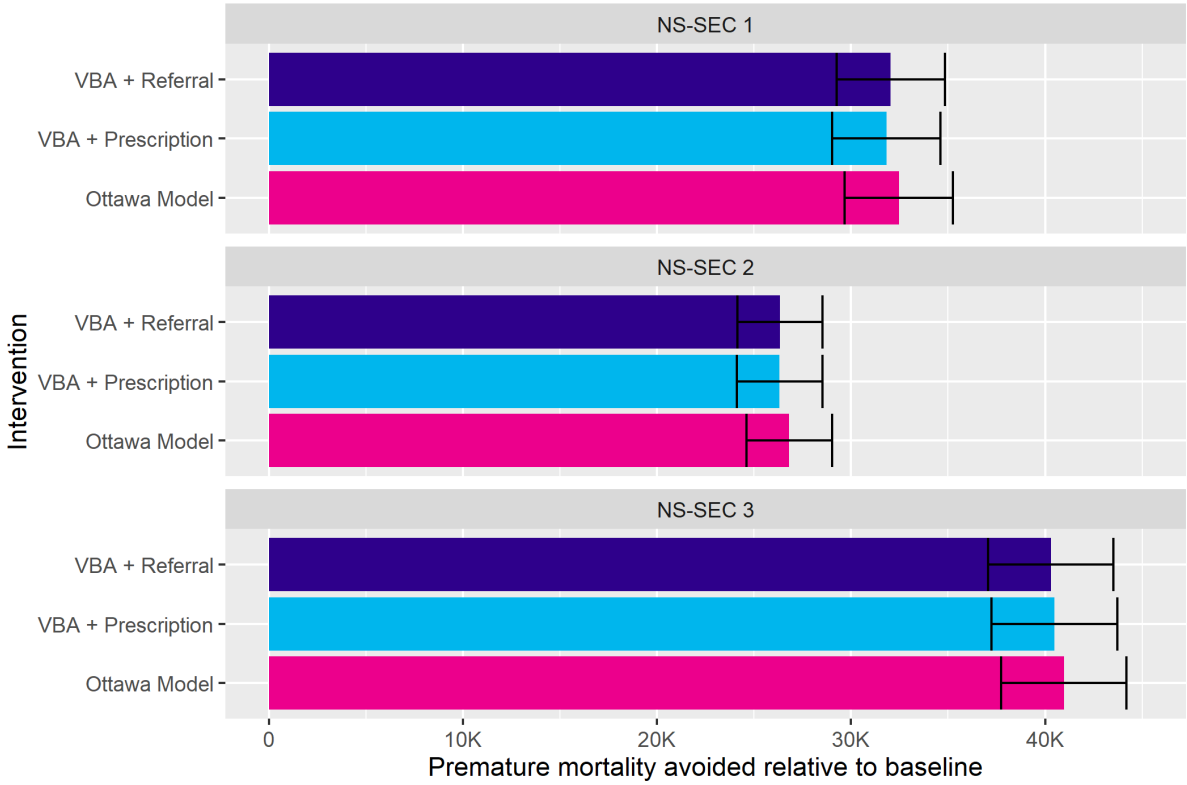


Figure 7. Premature mortality (death before age 75 years) avoided in intervention scenarios relative to baseline, by NS-SEC group, 2019-2039.
Error bars = Monte Carlo error.

4.4 Healthcare costs by NS-SEC group

4.4.1 Primary care costs and GP appointments

Attributable to smoking

Assuming current trends continue, in NS-SEC group 1, £2.63 [±0.01] billion worth of primary care costs, corresponding to 87,589,042 GP appointments, were projected to be attributable to smoking between 2019 and 2039. In NS-SEC group 2, this figure was £2.51 [±<0.01] billion, corresponding to 83,649,798 GP appointments, and in NS-SEC group 3 £4.14 [±0.01] billion, corresponding to 137,913,151 GP appointments. Note that, as primary care costs were only available for a subset of modelled diseases, the total costs are likely to be underestimated.

Intervention scenarios

For NS-SEC group 1, primary care cost savings for the VBA with referral, VBA with prescription, and Ottawa Model scenarios were £212.7 [±5.9] million, £224.1 [±5.9] million, and £213.3 [±5.9] million, respectively. This could be disaggregated to a saving of 7,090,059, 7,470,144, and 7,110,032 GP appointments for each intervention scenario, respectively. The largest savings would be for COPD at over £171 million for all scenarios.

For NS-SEC group 2, these savings were £180.9 [±4.8] million in the VBA with referral scenario, £182.9 [±4.8] million in the VBA with prescription scenario, and £179.5 [±4.8] million in the Ottawa Model scenario, corresponding to a saving of 6,031,578, 6,098,310, and 5,982,594 GP appointments for each intervention scenario, respectively. Again, COPD would see the largest primary care savings, at over £150 million for all scenarios.

NS-SEC group 3 was predicted to see the largest primary care savings across all scenarios. These savings were £339.4 [±6.8] million in the VBA with referral scenario, £332.0 [±6.8] million in the VBA with prescription scenario, and £321.5 [±6.8] million in the Ottawa Model scenario, corresponding to savings of 11,312,821, 11,065,139, and 10,717,876 GP appointments for each intervention scenario, respectively. As for both other NS-SEC groups, the largest savings would be for COPD, at over £282 million under the two VBA scenarios and £267 million under the Ottawa Model scenario.

4.4.2 Hospitalisations

Attributable to smoking

Following current trends, it was predicted that, in NS-SEC group 1, 1,197,738 [±3,340] hospitalisations would be attributed to smoking between 2019 and 2039 (5,853.15 hospitalisations per 100,000 population), with 1,296,566 [±2,733] attributable hospitalisations in NS-SEC group 2 (8,051.37 hospitalisations per 100,000 population) and 2,082,552 [±3,843] in NS-SEC group 3 (9,379.77 hospitalisations per 100,000 population). Lung cancer was predicted to be the greatest cause of hospitalisation, with stroke, COPD and bladder cancer also causing a large number of hospitalisations across all NS-SEC groups (Figure 8).

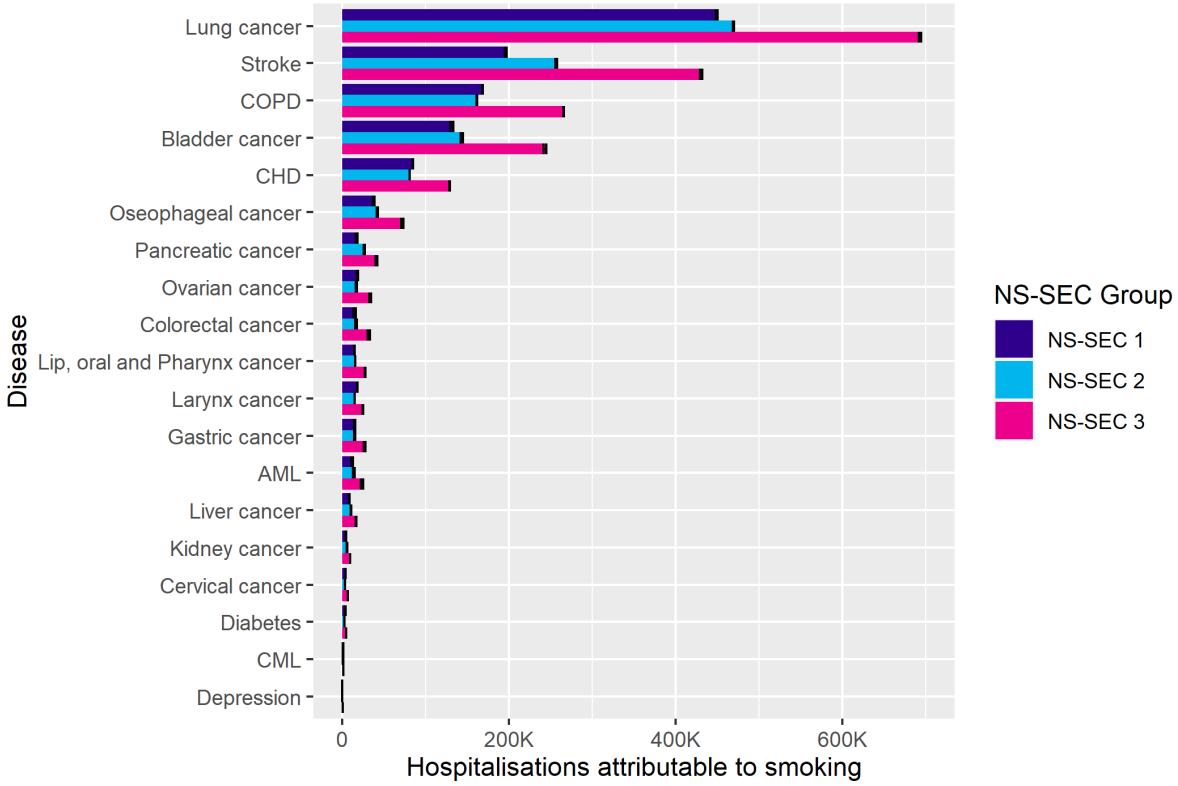


Figure 8. Smoking-attributable hospitalisations, by disease, as estimated by subtracting a 0% smoking prevalence scenario from the baseline scenario, 2019–2039, by NS-SEC group.

Error bars = Monte Carlo error.

Intervention scenarios

In NS-SEC group 1, the Ottawa Model scenario showed the greatest reduction in hospitalisations over the modelled period at 245,503 [±3,455] fewer than baseline. In the VBA with referral and VBA with prescription scenarios, it was predicted that 241,406 [±3,455] and 239,951 [±3,455] hospitalisations would be avoided, respectively. The largest number of reductions were in lung cancer (VBA+referral: 91,017 [±1,244]; VBA+prescription: 89,979 [±1,245]; 90,412 [±1,245]) under all scenarios, followed by stroke (VBA+referral: 50,780 [±1,346]; VBA+prescription: 60,049 [±1,346]; Ottawa 61,935 [±1,346]) and bladder cancer (VBA+referral: 36,131 [±1,592]; VBA+prescription: 36,423 [±1,592]; Ottawa 38,543 [±1,590]) (Figure 9).

In NS-SEC group 2, the VBA with referral scenario showed the greatest reduction in hospitalisations, at 226,840 [±2,862], with 214,111 [±2,864] fewer hospitalisations estimated for VBA with prescription and 218,268 [±2,864] for the Ottawa Model. As for NS-SEC group 1, under all scenarios lung cancer (VBA+referral: 81,523 [±1,092]; VBA+prescription: 80,398 [±1,092]; Ottawa 81,729 [±1,092]) saw the largest reduction in hospitalisations, followed by stroke and bladder cancer(Figure 9).

NS-SEC group 3 was predicted to see the largest reduction in hospitalisations from all three interventions. VBA with referral showed the greatest reduction amongst these, at 401,365 [±4,039] fewer hospitalisations, with 386,903 [±4,041] and 396,595 [±4,040] fewer hospitalisation estimated for VBA with prescription and the Ottawa Model, respectively. Again, under all scenarios lung cancer saw the largest reductions in hospitalisation (VBA+referral: 132,723 [±1,507]; VBA+prescription: 130,167 [±1,508]; Ottawa 132,801 [±1,507]), followed by stroke (VBA+referral: 115,868 [±1,585]; VBA+prescription: 113,550 [±1,586]; Ottawa 116,945 [±1,585]) and bladder cancer (VBA+referral: 62,157 [±1,840]; VBA+prescription: 60,645 [±1,840]; Ottawa 64,197 [±1,838])(])Figure 9).

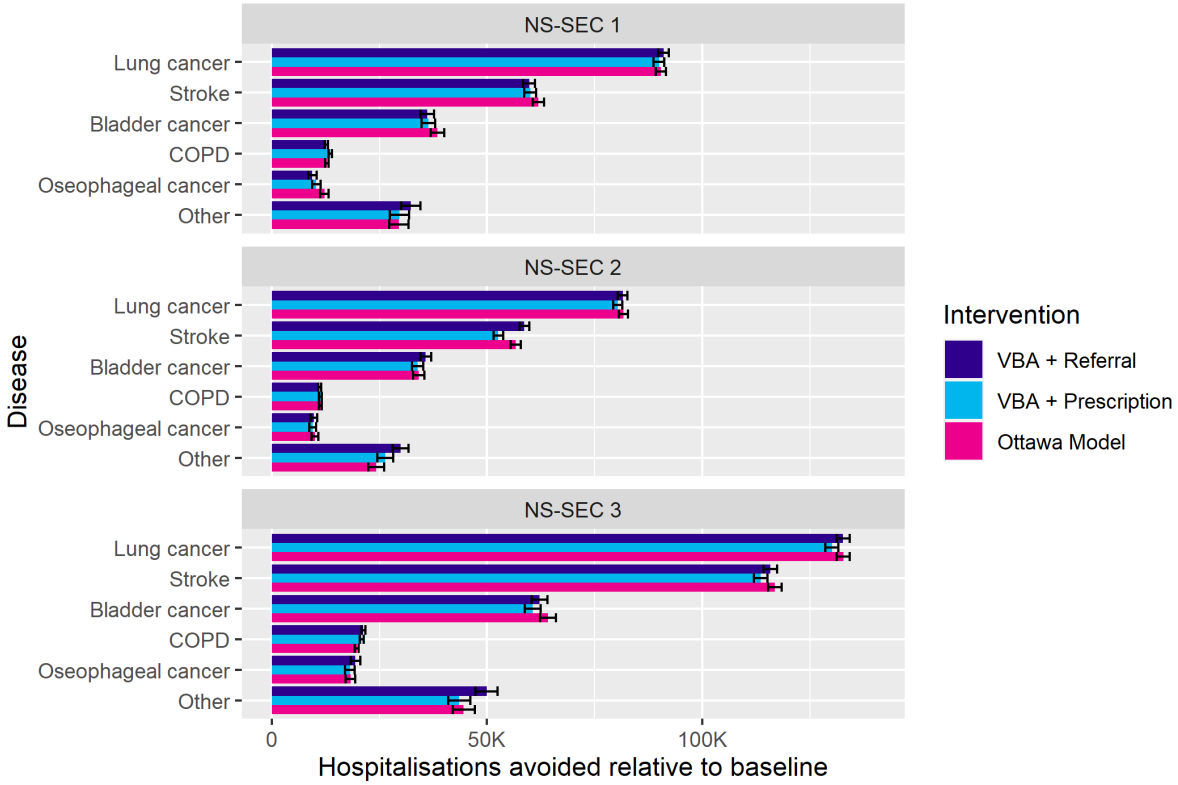


Figure 9. Smoking-attributable hospitalisations, by scenario, disease and NS-SEC group, in intervention scenarios relative to baseline, 2019–2039.
Error bars = Monte Carlo error.

4.4.3 Total healthcare costs

Attributable to smoking

In the baseline scenario, it was projected that £17.1 [±0.05] billion in total healthcare costs would be attributable to smoking in the UK over the next 20 years for NS-SEC group 1. For NS-SEC group 2, this cost was estimated at £18.1 [±0.04] billion, and for NS-SEC group 3 it was estimated at £31.4 [±0.06] billion. This reflects over 1.8 and 1.7 times the cost of NS-SEC group 1 and 2 respectively. COPD was predicted to contribute most to costs across all NS-SEC groups, at £5.2 billion for NS-SEC group 1, £4.7 billion for NS-SEC group 2 and £7.5 billion NS-SEC group 3. Cancers were predicted to collectively contribute £6.6 billion, £6.9 billion, and £11.2 billion of total costs for NS-SEC groups 1–3 respectively (Figure 10).

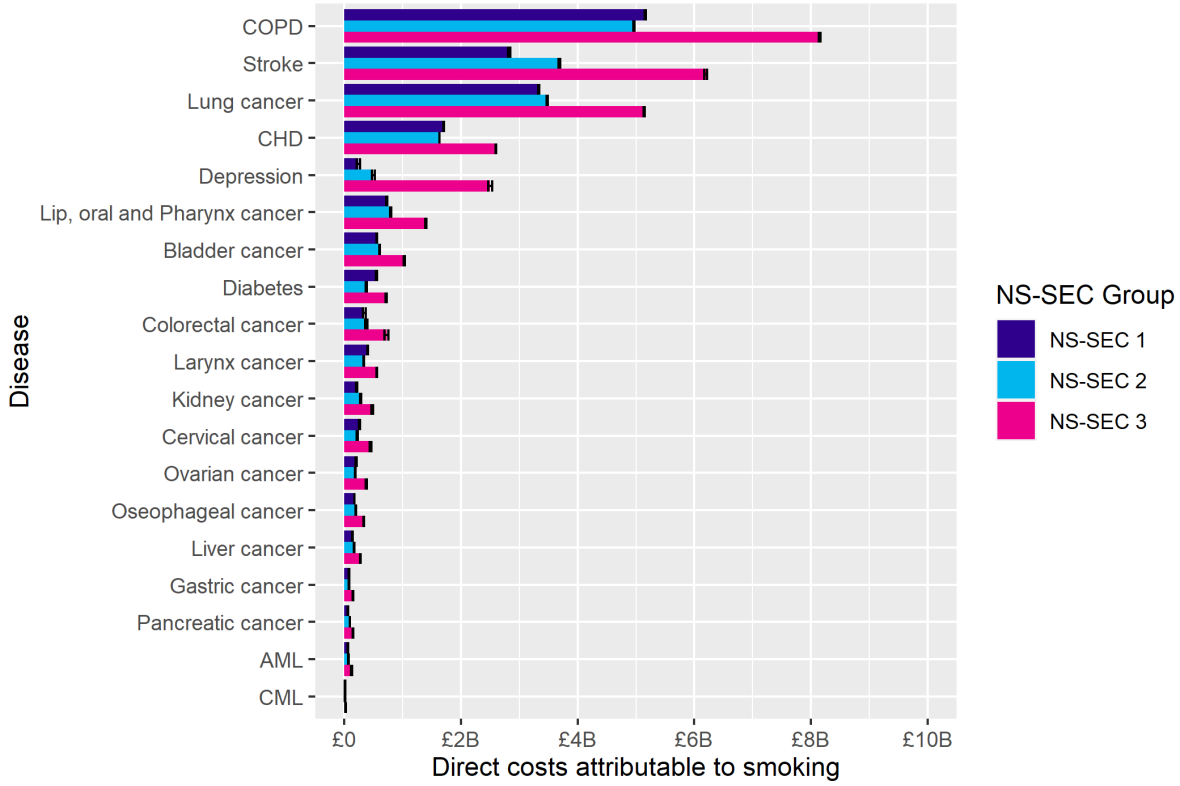


Figure 10. Smoking-attributable direct healthcare costs, by disease, as estimated by subtracting a 0% smoking prevalence scenario from the baseline scenario, 2019–2039, by NS-SEC group.

Error bars = Monte Carlo error.

Intervention scenarios

All three interventions resulted in vast reductions in total healthcare costs across all NS-SEC groups.

For NS-SEC group 1, the VBA with referral and VBA with prescription scenarios were projected to save the health service £2.87 [±0.05] billion and £2.89 [±0.05] billion in healthcare costs over the 20-year modelled period, respectively. The Ottawa Model was predicted to give the greatest reduction in total healthcare costs at £3.01 [±0.05] billion over the 20-year modelled period. For all interventions the largest costs avoided were for stroke and lung cancer (Figure 11).

Total health care savings were predicted to be similar for NS-SEC group 2. In the VBA with referral and VBA with prescription scenarios, the model predicted avoided healthcare costs of £2.62 [±0.04] billion and £2.45 [±0.04] billion, respectively, over the 20-year modelled period. The Ottawa Model was predicted to avoid £2.53 [±0.04] billion of total healthcare costs for NS-SEC group 2 over the 20-year period. For all interventions the largest costs avoided were for stroke and lung cancer (Figure 11).

NS-SEC group 3 was predicted to show the largest savings in total healthcare costs across all scenarios. In the VBA with referral and VBA with prescription scenarios, the model predicted avoided healthcare costs of £5.01 [±0.06] billion and £4.74 [±0.06] billion, respectively, over the 20-year modelled period. The Ottawa Model was predicted to avoid £4.98 [±0.06] billion of total healthcare costs for NS-SEC group 3 over the 20-year period. As with NS-SEC groups 1 and 2, for all interventions the largest costs avoided were for stroke and lung cancer (Figure 11).

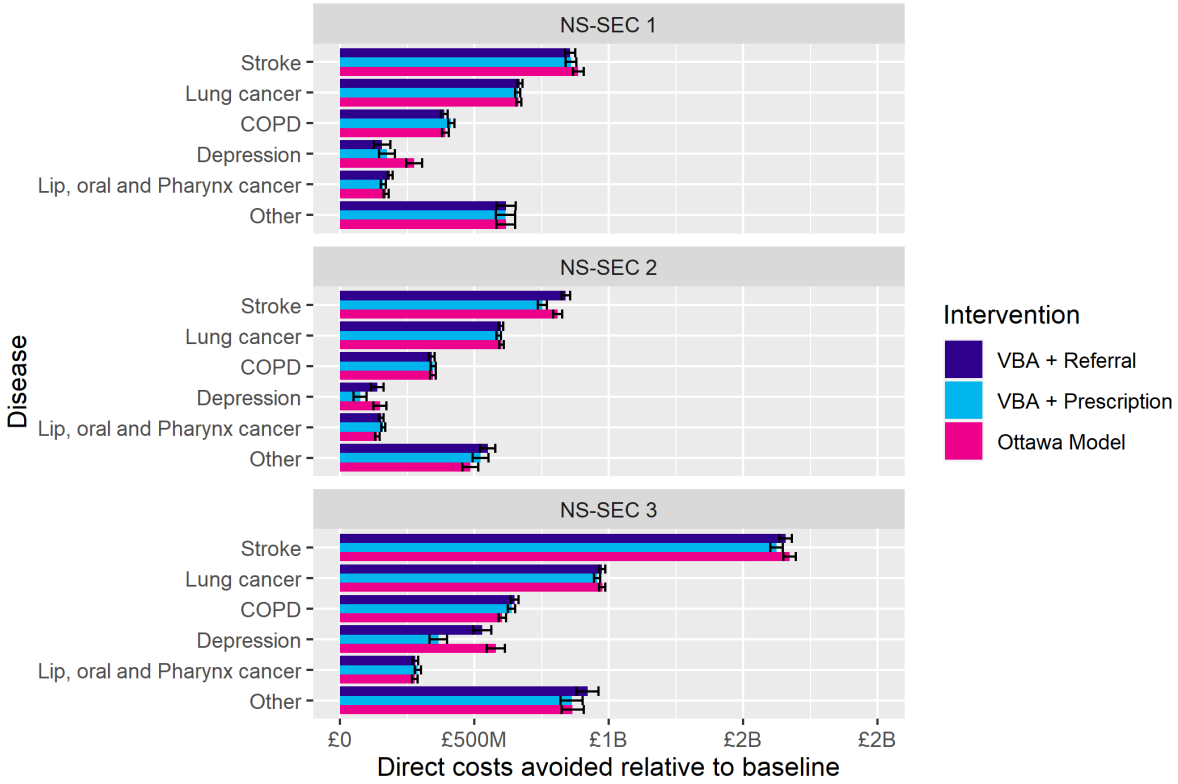


Figure 11. Direct health service healthcare costs avoided in intervention scenarios relative to baseline, by disease and NS-SEC group, 2019–2039.

Only most incident diseases shown for each scenario. For a full disease breakdown, see Appendix 4. Error bars = Monte Carlo error.

4.5 Wider societal costs

4.5.1 Wider societal costs attributable to smoking

Smoking presents additional costs to the healthcare system and society through premature mortality and morbidity. Indirect costs to society were calculated using a human capital approach.

For NS-SEC group 1 £26.9 [±0.3] billion in total wider societal costs were predicted to be attributable to smoking over the next 20 years, should trends continue. Of these, £23.8 billion (88.2%) was from morbidity costs, with the remaining £3.2 billion from mortality costs (Figure 12). In NS-SEC group 2, £27.2 [±0.3] billion were attributable to smoking (£24.4 billion in morbidity costs and £2.8 billion in mortality costs). NS-SEC group 3 was predicted to see the greatest wider societal costs, at £50.2 [±0.4] billion (£45.9 billion in morbidity costs and £4.2 billion in mortality costs) (Figure 12).

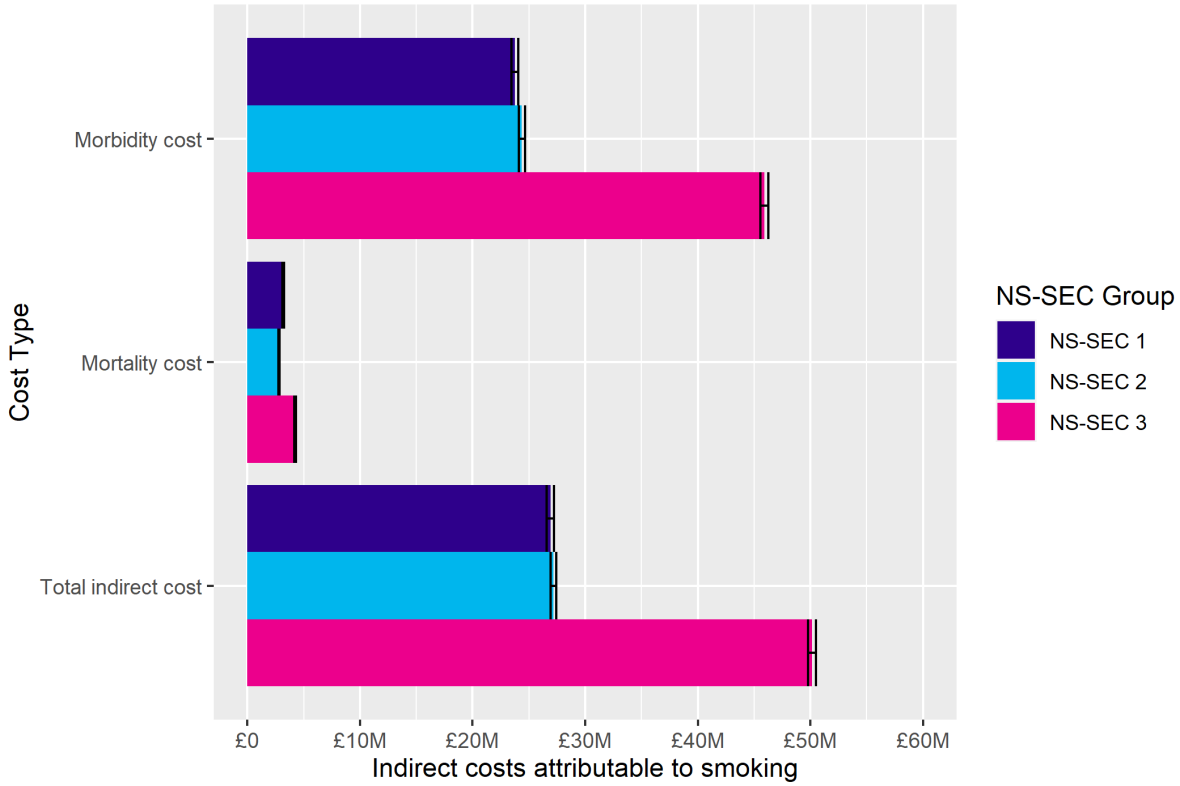


Figure 12. Wider societal costs avoided in each NS-SEC group under the baseline scenario, 2019–2039.
Error bars = Monte Carlo error.

4.5.2 Wider societal costs avoided in intervention scenarios

The model predicted millions of pounds of avoided wider societal costs for all NS-SEC groups in all interventions (Figure 13).

In NS-SEC group 1, each scenario avoided between £4.44 [±0.3] and £4.7 billion [±0.3] in wider societal costs over the 20 years of the simulation, with morbidity costs accounting for 86-87% of these costs.

In NS-SEC group 2 each scenario avoided between £3.7 and 3.8 [±0.3] billion in wider societal costs over the 20 years of the simulation, with morbidity costs accounting for 88% of these costs.

NS-SEC group 3 saw the greatest reductions in wider societal costs under all three scenarios over the 20-year period. Each scenario avoided between £7.2-£8.3 [±0.4] billion in wider societal costs with morbidity costs accounting for 90-91%% of these costs.

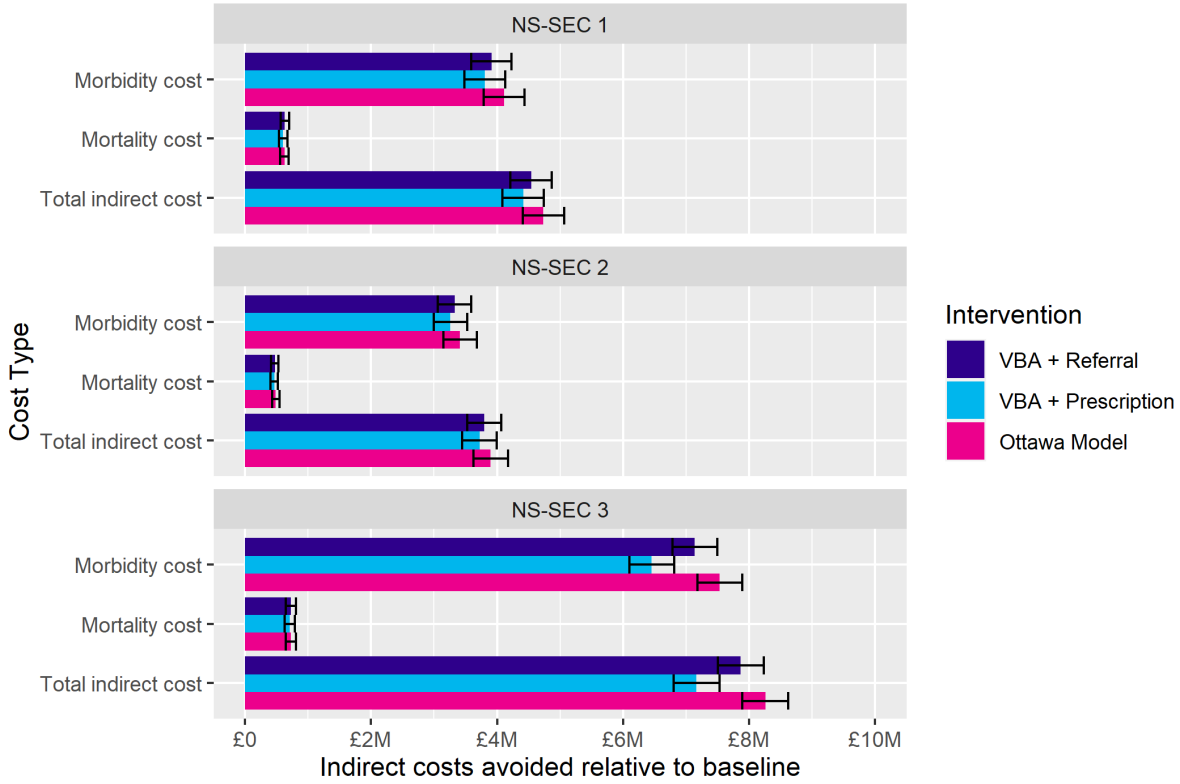


Figure 13. Wider societal costs avoided under each scenario by NS-SEC group, 2019–2039.

Error bars = Monte Carlo error.

5 Discussion

Understanding how to reduce smoking related health inequalities is a key issue we need to address if we are to reach smokefree targets in the UK. This study estimated the impact on socioeconomic inequality, in terms of health and associated economic costs, under different scenarios of improved provision of smoking cessation support in general practice in the UK compared with current policy. Using a microsimulation model, a current practice 'baseline' scenario was compared to three scenarios, modelled across three socioeconomic groups, as defined by the NS-SEC occupational classification: the first two modelled GPs more frequently implementing VBA for smoking cessation and either prescribing people who smoke with smoking cessation pharmacotherapies or referring them to a specialist SSS, and the third modelled GPs providing patients with the Ottawa Model of smoking cessation. By focusing on socioeconomic status, this study explores one component of deprivation to assess the impact of improving the delivery of these interventions on smoking related health inequalities and associated economic costs in the UK.

Smoking rates will continue to decline across all socioeconomic groups

The baseline scenario was interpreted here as a scenario where tobacco control policy and clinical practice continues to be implemented, and corresponding smoking prevalence continues to decline, at the rate seen previously (2010 to 2017). This study predicts that in such a scenario, adult smoking prevalence would reach 2.5% in 2039 in NS-SEC group 1, 7.7% in group 2 and 8.4% in group 3. This corresponds to a 70% reduction in smoking prevalence over the modelled period in NS-SEC group 1, 39% reduction in group 2 and a 57% reduction in group 3. This is a sizable reduction in smoking prevalence across all 3 groups.

But relative smoking inequalities will widen without appropriate action

Despite reductions in smoking prevalence in all NS-SEC groups, the unequal rate at which each group's smoking prevalence reduces over the modelled period will increase relative smoking inequalities between these socioeconomic groups by 2039. This would see the difference in smoking prevalence increase from 2.5 times higher prevalence in NS-SEC group 3 compared to NS-SEC group 1 in 2019, to 3.4 times higher prevalence in 2039. Moreover, this widening of inequality would not just be seen for the lowest socioeconomic group. If current trends continue, it is projected that NS-SEC group 2 would see smoking prevalence increase from 1.5 times higher to over 3 times that of NS-SEC group 1 by 2039. This widens the gap between the highest and lower socioeconomic groups over the modelled 20-year period; aggravating current socioeconomic inequality of smoking prevalence.

Consequently, the lowest socioeconomic groups will face the largest burden from smoking-related disease

Even if smoking prevalence continues to decline at current pace, smoking will continue to place a huge burden on our health service and the health of all groups. However, the lowest socioeconomic groups will shoulder this cost disproportionately, with the highest cases of disease and premature deaths attributable to smoking between 2019 and 2039 seen in NS-SEC group 3. Over 248,000 premature deaths and over 1, 500, 000 cases of disease are projected to be seen in NS-SEC group 3 over the 20-year period. This is in comparison to over 164,000 premature deaths and over 897,000 cases of disease in NS-SEC group 1.

Due to the higher smoking prevalence in the lower socioeconomic groups, we would expect to

see these higher rates of associated disease and premature death. However, this only emphasises the need to focus efforts to help those from the most deprived backgrounds to quit, to ensure we improve health outcomes for all groups across the UK.

Making improvement to stop smoking support is projected to see benefits across all socioeconomic groups

All three intervention scenarios resulted in significant additional declines in smoking prevalence across all socioeconomic groups, leading to ≤ 1.8%, ≤ 5.8% and ≤ 5.9% smoking prevalence in NS-SEC group 1, NS-SEC group 2 and NS-SEC group 3 respectively by 2039. This is in comparison to a smoking prevalence of 2.5%, 7.7% and 8.4% in NS-SEC group 1, NS-SEC group 2 and NS-SEC group 3 respectively in the baseline scenario. For all intervention scenarios and all NS-SEC groups, 2039 smoking prevalence was around a quarter lower than the baseline scenario. This suggests that these interventions would not significantly narrow or widen the increase in smoking inequalities projected between these groups if current trends were to continue. However, this reduction represents a sizable additional decline in smoking prevalence and associated health benefits, across all three socioeconomic groups in comparison to current policy modelled in the baseline scenario.

Gains across lower socioeconomic groups offer large opportunities to positively impact health and economic outcomes in the UK

NS-SEC group 3 were not projected to benefit to any greater degree than other socioeconomic groups by improvements made to smoking cessation interventions across any of the scenarios modelled. However, due to the large number of people within this group, improvements to smoking cessation interventions that effectively reach lower socioeconomic groups offer a substantial opportunity to see large health and economic benefits in the UK.

Due to the greater number of people who smoke in NS-SEC group 3, this group were projected to see the greatest number of people stopping smoking as a result of general practice interventions. Consequently, this group may also see the largest absolute reduction in disease and mortality, with all three interventions projecting at least an additional 230,000 avoided incidences of disease in NS-SEC group 3, relative to baseline and at least 37,000 further premature deaths avoided relative to baseline by 2039.

Moreover, this group may also see the largest absolute heath care savings across all socioeconomic groups. Across all three scenarios over the 20-year modelled period NS-SEC group 3 were projected to see the largest primary care savings, with an average of over 330 million saved and an average of over 11 million GP appointments saved. NS-SEC group 3 were also projected to see the largest savings in total healthcare costs, with an average of 4.91 billion avoided healthcare costs and the largest reduction in wider societal costs, with between £7.2-8.3 billion saved over the 20-year period.

This is in comparison to the baseline scenario in which it was projected that NS-SEC group 3 alone would account for £31.4 billion in total healthcare costs attributable to smoking in the UK over the next 20 years. Smoking cessation interventions that can reach lower socioeconomic groups therefore represent a large opportunity to see substantial health and economic benefits in the UK.

However, more must be done to reach those in lower socioeconomic status groups and to better understand the needs of these groups.

Under all three intervention scenarios, a smokefree ambition would be achieved by 2039 in NS-SEC group 1, but not in NS-SEC groups 2 or 3 under any scenario. In NS-SEC group 1 this ambition

would be met before 2030 under all scenarios, three years earlier than under the baseline scenario. In NS-SEC groups 2 and 3 the ambition would not be reached before the end of the simulation under any scenario and it is unclear when, or if, the ambition would be reached after 2039. All three interventions did not differ in their effectiveness across NS-SEC groups, so we need interventions tailored to lower socioeconomic groups to effectively reach these groups and reduce the inequality gap.

Strengths and limitations

A strength of this study is that it adapts an existing microsimulation model to project the health and economic impacts of a range smoking cessation services on different socio-economic groups. This is important for providing evidence for practice before any large scale, potentially expensive implementation. The model is well validated and peer-reviewed, and is flexible enough to take new data when it becomes available.

However, the model is only as good as the data input, and the present study was limited in data around NS-SEC population distributions. Also, data was not always available around differential impacts by socio-economic status where some data manipulations were required, or assumptions had to be made. For instance, a universal relapse rate of 30% across NS-SEC groups was assumed. NS-SEC group 4 was analysed but included in the supplementary appendix because this group is highly heterogeneous making interpretation of the findings challenging. This study also did not include all smoking-related conditions, so some impacts may be slightly underestimated. Nevertheless, all highly prevalent conditions were included. The present study only included NS-SEC groups, however, we acknowledge that health inequalities driven by smoking among other groups of the population (i.e. people with mental illness, LGBTQI) are an important area for further research.

The APS data used for smoking trends may underestimate smoking prevalence amongst lower groups, as full sample weighting is not applied relative to national survey data in each UK nation. Therefore, smoking prevalence among lower SES groups is likely higher in reality. Wider societal costs for all three NS-SEC groups were calculated using the same economic value, however an average of salaries for each NS-SEC group was included. Therefore, differences in costs between groups may be underestimated.

Future work

This study focussed on NS-SEC groups, but understanding health inequalities driven by smoking among other population groups and what interventions may work best with different groups is a key avenue for further research. This study highlights the need for good quality surveillance data for diseases and their risk factors by socio-economic and demographic characteristics in order to make accurate estimates of future health disparities. Further work should focus on ensuring data are presented by a standardised metric of socio-economic status so that health inequalities are considered across all research. While there is some evidence on tailored interventions that may offer greater success among more disadvantaged groups, further research is needed to identify the mechanisms through which these might operate and to better understand their effectiveness (7). Remote consultations and SSS, introduced during COVID-19, may provide a wider reach for SSS and should be evaluated in terms of their impacts relative to face-face consultations. Further research is therefore needed to understand how to better meet the needs of deprived groups to encourage and support successful quit attempts.

6 Policy Recommendations

The first report from part one of this study, "Making Conversations Count", published in 2020, aimed to determine the extent to which increasing delivery of different smoking cessation interventions would affect smoking rate and smoking-related health and economic outcomes across the UK. The three cessation interventions were the same ones as modelled in this report.

All three scenarios of delivering smoking cessation interventions in general practice resulted in significant and similar improvements to health and economic outcomes compared to current practice.

Subsequently, Making Conversations Count recommended systematically introducing Very Brief Advice (VBA) on smoking into primary care. This can be easily integrated into the UK health system, given it is already recommended through NICE in England and Wales. In addition, smoking cessation interventions (including pharmacotherapies and specialist SSS) are widely available across the UK and can be used as standard.

Given the findings of this report from the second phase of the study, the recommendations made in the Making Conversations Count report, still stand, which included:

Primary care professionals across the UK (including GPs, practice nurses and pharmacists) should systematically deliver smoking cessation interventions to patients who smoke. In line with NICE guidance for England and Wales, this means they should:

- Undertake training in delivering VBA on smoking
- Routinely deliver VBA on smoking in consultations with patients who smoke
- Offer evidence-based interventions to patients to support them to stop smoking, including systematically referring them to a local SSS for ongoing support where available, or prescribing pharmacotherapy for smoking cessation with brief advice.

Smoking remains the biggest preventable cause of cancer. Despite the introduction of tobacco control policies and declining smoking prevalence across the UK, continued action is needed across local and national governments and the health service to support people who smoke to quit.

Primary care professionals come into contact with the majority of patients. This makes them well positioned in the health service to provide smoking cessation support to a large proportion of the population. This report clearly demonstrates that improving GP delivery of smoking cessation support will help to accelerate declines in smoking prevalence across all socioeconomic groups equitably, reducing illness, premature mortality and saving the health service and society substantially.

Across the UK disproportionately high rates of smoking among more deprived groups translate to different rates of ill-health or mortality among these groups, or health inequalities. This report focuses on one important component of deprivation, socioeconomic status, that holds an important relationship to smoking inequalities in the UK. It supports what is already well-established in the literature; the clear socioeconomic gradient in smoking rates, combined with

the slower rate of smoking prevalence decline, means smoking will disproportionately impact more deprived groups of the population and continue to drive health inequalities unless concerted action is taken to address this gap. Because smoking rates are higher in more deprived groups, a larger absolute number of people from this group will be affected by the interventions laid out in this report. This will mean that these groups will see the greatest absolute cost savings from improvements to smoking cessation interventions, both in terms of primary care costs and wider societal costs.

It is therefore crucial that GP delivery of smoking cessation support is maintained and strengthened to accelerate decline in smoking prevalence – including amongst the most deprived - across the UK.

Improving delivery of VBA in primary care

This report shows that improving delivery of smoking cessation support in primary care accelerates decline in smoking prevalence across all socioeconomic groups equitably, including the most deprived. In order to reach smokefree targets, services for all individuals who smoke must be improved. This will also help reduce prevalence amongst the most deprived groups.

Identifying and engaging people who smoke

Primary care practices, including general practices, pharmacies and dentists, have a great platform to identify and engage people who smoke and ensure they receive the support they need to stop. Therefore, Cancer Research UK recommend:

1. To help practices identify people who smoke, **people's smoking status should be digitally recorded and updated at every opportunity to ensure it is up-to-date and accurate.**
2. Primary care practices should ensure they are **sharing datasets with secondary care and locally commissioned services to effectively identify people who smoke at all possible interaction points with health professionals.** If information is shared between sources, this will enable better identification of patients who smoke, and therefore practices may be able to better support patients from more deprived groups who are disproportionately represented among smokers.
3. Local health systems should **promote communication and collaboration between primary care staff across all services (including pharmacists, general practitioners, dentists, and nurses), secondary care, and locally commissioned services. This should ensure that there is an integrated smoking cessation pathway across all services to support continuity of care** for patients identified as people who smoke. This will help make sure that nobody is left behind in attempts to reduce smoking prevalence.

Ensuring services are equipped and funded sustainably to support people to stop smoking

When people who smoke attend primary care services, they must be provided with the best, most effective interventions to treat their tobacco dependency. In line with NICE clinical guidance in England and Wales, this report has shown the utility of delivering VBA and either referring patients to stop smoking services or prescribing pharmacotherapy to patients to reducing smoking rates across all socioeconomic groups.

However, the modelling in this report assumes that stop smoking services and prescriptions are

universally available. We know that unfortunately this is not the case - primarily due to funding cuts. In England for instance, funding for local, regional and national tobacco control activities has been significantly cut in recent years. Research also shows that absolute cuts in the ten most deprived local authorities in England have been around six times larger than in the ten least deprived (54). Smokefree targets will not be achieved without increased and sustainable funding to tobacco control services. The UK Government should look at ways to sustainably fund smoking cessation services, including through the implementation of a tobacco control fund to pay for the recurring costs of tobacco at a local, regional and national level.

4. **The UK Government should look into sourcing increased, stable and sustainable funding for the recurring costs of tobacco control at a local, regional and national level. Funding for regional and local tobacco control should be awarded in line with population weighted by smoking prevalence and inequalities indicators.**

In addition, we know that unfortunately effective pharmacotherapy is not universally available for primary care professionals to prescribe. Evidence-based interventions must be available and used as intended to improve quit rates. To this end, Cancer Research UK recommend the following:

5. **Primary care professionals should be able to routinely prescribe people, including those from more deprived groups, with the most effective forms of pharmacotherapy** (that is, varenicline) **to improve the chance of quitting successfully.** Commissioners should ensure that restrictions placed on clinicians prescribing these pharmacotherapies are repealed as a priority so that full the range of pharmacology is available to prescribe.
6. Where not already in place, **primary care GP practices should develop and implement follow up protocols and procedures that aim to improve patient adherence to any prescribed pharmacotherapies and increase uptake of referrals to stop smoking services.**

Addressing smoking inequalities across the UK

This report demonstrates that improving the delivery of cessation support in primary care would help to reduce smoking rates across socioeconomic groups and would benefit a larger absolute number of people from the lower SES group. However, despite this, the report also shows that relative smoking inequalities will continue to widen – unless further appropriate action is taken. Consequently, this will mean the lowest socioeconomic groups will continue to face the largest burden from smoking-related disease. More must be done to accelerate the decline in smoking rates among people in the most deprived groups to reduce health inequalities related to smoking.

Identifying and engaging people who smoke from more deprived groups

More must be done by primary care to identify and engage people from more deprived groups who smoke, to offer them effective support to quit.

This report demonstrates that relative smoking inequalities will continue to widen unless further measures are implemented that specifically target and increase the proportion of people from lower SES groups who effectively stop smoking. CRUK therefore believes that:

7. **More research is needed, including from the UK Government, on how to identify and engage people from more deprived groups who smoke, and support primary care to get them into the healthcare system.**
8. **More research is needed, including from the UK Government, to identify interventions which could specifically promote cessation among more deprived groups to improve smoking equity.** This research need is outlined in Future work.

This report suggests that the widening of inequalities will be even starker for NS-SEC group 2 than group 3. In developing tailored interventions, it will be important to consider that more deprived groups include heterogenous communities and therefore the same interventions may not work for all groups.

The modelling in this report has also shown that VBA with a referral to a stop smoking service offers proportionate but substantial improvements in quit rates across all socioeconomic groups. However, most stop smoking services in the UK do not require a referral from a clinician, meaning people can proactively attend these services should they wish to use them to quit. To improve uptake of these services and success of quitting among people in more deprived groups:

9. **Service planners and commissioners of local stop smoking services should require them to proactively promote and target their service offer to people in the most deprived groups, for example through advertising, social marketing and media campaigns,** to improve engagement and uptake of these evidence-based, effective services.

Whilst not the focus of this modelling, evidence suggests that e-cigarettes are far less harmful than combustible tobacco and can be an effective quitting tool. Data from England shows they are popular across all socioeconomic groups, but evidence suggests people from lower socioeconomic groups have lower overall odds of e-cigarette use compared with the highest (55). E-cigarettes are also substantially cheaper than tobacco, with smoking costing more than 2.5 times as much as using e-cigarettes. In fact, in Great Britain 9% of e-cigarette users who used to smoke reported they did so to save money (56). For these reasons, e-cigarettes represent a potential tool to support people from more deprived groups to quit. In line with NICE guidance in England and Wales, we therefore recommend:

10. **Primary care professionals should discuss and recommend using e-cigarettes as one of a range of tools that can help patients to stop smoking.**

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