

CRUK analysis brief

Projected UK cancer cases
caused by tobacco in the
current parliamentary term

November 2024

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About this document

Reference

This report should be referred to as follows:

Cancer Research UK, 2024. CRUK analysis brief: Projected UK cancer cases caused by tobacco in the current parliamentary term.

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Acknowledgements

We are grateful to the many organisations across the UK which collect, analyse, and share the data which we use, and to the patients and public who consent for their data to be used. Find out more about the sources which are essential for our statistics here <https://www.cancerresearchuk.org/health-professional/cancer-statistics/cancer-stats-explained/data-collection-implications>.

About Cancer Research UK

We're the world's leading cancer charity dedicated to saving and improving lives through research. We fund research into the prevention, detection and treatment of more than 200 types of cancer through the work of over 4,000 scientists, doctors and nurses. In the last 50 years, we've helped double cancer survival in the UK and our research has played a role in around half of the world's essential cancer drugs. Our vision is a world where everybody lives longer, better lives, free from the fear of cancer.



Cancer Research UK is a registered charity England and Wales (1089464), Scotland (SC041666), the Isle of Man (1103) and Jersey (247).

Abstract

Smoking is the biggest cause of cancer and death in the UK. Estimates of the population-level burden of smoking-attributable cancer are useful to galvanise policymakers to try to reduce smoking rates. This analysis brief presents estimates of the total number of cancer cases expected to be caused by smoking over the current parliamentary term (assumed to be July 2024 – July 2029) in the UK, and for the same time period in each of the devolved nations.

The projected number of smoking-attributable cancer cases in the UK from July 2024 – July 2029 was estimated using the well-established population attributable fractions (PAFs) method. The analysis dataset was compiled from projected cancer incidence based on gold-standard cancer registration data, representative population surveys of self-reported smoking and secondhand smoke exposure, and meta- or pooled analyses examining the relative risk of cancer in people who currently smoke, used to smoke, or have been exposed to other people's smoke, versus people who have never smoked or been exposed. Analysis was split by cancer site, sex, age-band, and UK nation, and combined to obtain UK-wide figures.

Almost 300,000 cancer cases are projected to be caused by smoking in the current parliamentary term in the UK. Around 2,800 of these cases are expected to be caused by secondhand smoke exposure in people who have never smoked.

The methods used to obtain these estimates are well-established and validated. However, due to data limitations, some assumptions in the calculations may have led to conservative estimates overall. Whilst the best available source data was used, results should be interpreted with the limitations of the source data in mind.

Introduction

Smoking is the biggest cause of cancer and death in the United Kingdom (UK), estimated to account for almost three times as many cancer cases as the next-biggest risk factor (overweight and obesity) in the UK in 2015. Tobacco was estimated to have caused around 75,800 all-cause deaths in the UK in 2021.^{1,2}

Smoking prevalence in the UK has been falling for decades, from the early 1970s when around 51% of men and 41% of women smoked, to the latest data for 2023 when smoking rates were 14% and 10% in men and women respectively.^{3,4} Despite this progress, there are still 6 million people who smoke in the UK.

Smoking causes at least 16 types of cancer.^{5,2} Cancer risk is elevated for both people who currently smoke and people who used to smoke (see Methods section for details) compared to people who have never smoked. Because of this, reductions in smoking prevalence may not translate to reductions of the same magnitude in smoking-attributable cancer cases.

Estimates of the population-level burden of smoking-attributable cancer are useful to galvanise policymakers to try to reduce smoking rates. Projecting forward to estimate the number of smoking-attributable cancer cases in the current parliamentary term further contextualises the impact of smoking.

Aims and objectives

1. To estimate the number of cancer cases which will be caused by tobacco in the current (assumed to be July 2024 to July 2029) parliamentary term for the UK and devolved nations.

Methods

Analysis

We have used the previously described methods,^{6,7,8} to calculate the population attributable fraction (PAF) of cancer incidence due to tobacco. The PAF calculation combines risk factor prevalence, relative risk (RR) of cancer in exposed versus unexposed populations, and cancer incidence.

The number of cancer cases in the current parliamentary term was estimated as the sum of the projected number of cases in the period 09/07/24 to 09/07/29 (the maximum length of the current term). For incomplete years (2024 and 2029), the annual number of projected cases was multiplied by the proportion of the relevant year included in the term. The analysis was stratified by nation, sex, cancer site and age-band, and the results were then aggregated to produce an overall summary across the UK.

The multiple components of the PAF calculation inherently create multiple sources of possible bias that could not all be accounted for in a traditional confidence interval calculation. Therefore, confidence intervals are not presented for this work so as not to imply precision.

Analysis was conducted using R version 4.3.1, utilising the tidyverse package version 2.0.0⁹ for data manipulation.

Data

Cancer incidence and included sites

Cancer sites classified by the International Agency for Research on Cancer (IARC)⁵ as having 'sufficient' evidence of a causal association with smoking were included: oral cavity, pharynx, nasopharynx, oesophagus adenocarcinoma (AC), oesophagus squamous cell carcinoma (SCC), stomach, colon, rectum, liver, pancreas, lung (also causal association with secondhand smoke exposure), breast, cervix, mucinous ovarian, bladder, kidney, acute myeloid leukaemia. Breast cancer was also included due to growing evidence of a causal association since the last IARC review, and in line with more recent reviews by Global Burden of Disease (GBD) and World Cancer Research Fund (WCRF).^{2,10,11}

International Classification of Diseases version 10 (ICD-10) codes for all included sites are in Table S1 (Appendix A).

Counts of the total number of cases of cancer for selected sites for 2024–2029 were taken from projections produced by the Cancer Intelligence team at Cancer Research UK. The projections were based on the age-period cohort (APC) modelling approach with attenuation¹² and used cancer incidence data for England, Scotland, Wales, and Northern Ireland from NHS England, Public Health Scotland, Public Health Wales, and the Northern Ireland Cancer Registry.^{13,14,15,16}

In the case of a subsite or specific morphological type of cancer associated with tobacco, then the incidence of this subtype was estimated based on the last available observed ratio between the incidence of the subtype and the broader cancer site, applied to the projected incidence of the broader cancer site.

Tobacco exposure prevalence

In this analysis, population-level smoking prevalence is assumed to affect cancer incidence 10 years following exposure (for example, the cancer cases associated with smoking in the population of persons smoking aged 25–34 in 2014 is studied in persons aged 35–44 in 2024). Therefore, data were gathered on prevalence of current smoking, former smoking, and secondhand smoke exposure in people who have never smoked, in the four nations of the UK by sex and 10-year age band for years 2014–2019. Exposure prevalence data was mostly collected from large-scale representative self-report surveys managed by each nation.^{17,18,19,20,21}

In instances of missing data, additional calculations were performed to estimate the missing values based on ratios to the closest available data. Specifically, calculated estimates were used for former smoking and secondhand smoke exposure in Northern Ireland in 2014, 2015 and 2019, and for secondhand smoke exposure in Wales in 2017 and 2019.

Relative risks

RR values used in the calculations were obtained from a systematic literature review of published, peer-reviewed, meta- or pooled analyses. The search was conducted using PubMed and specific RRs were extracted for cancers of the lung,^{22,23} larynx,²⁴ bladder,²⁵ pharynx,²⁶ oesophagus,^{27,28,29} liver,³⁰ cervix,³¹ nasopharynx,³² pancreas,³³ stomach,³⁴ oral cavity,³⁵ kidney,³⁶ bowel,³⁷ leukaemia,³⁸ breast,³⁹ and ovary.⁴⁰ For all cancer sites, a separate RR was extracted for current smoking, and for former smoking. For lung cancer, a third RR was extracted for secondhand smoking.

When more than one potential source was identified, we prioritised selection based on research characteristics such as the inclusion of cohort studies, recency of the analyses, follow-up time, sample size, adjustment for potential confounders, relevance of the population to the UK, and the availability of sex breakdowns where

literature suggests marked sex differences. Where the selected source provided multiple RRs, we prioritised the most relevant, high-quality breakdown. RR values used in the calculations are presented in Table S1 (Appendix A).

Results

It is projected that there will be almost 300,000 new cancer cases caused by smoking in the UK in the current parliamentary term (assumed to be from July 2024 to July 2029), if current trends continue. Of these, around 2,800 cases are estimated to be caused by secondhand smoking in people who have never smoked. The projected number of new cancer cases caused by smoking in each of the devolved nations is shown in Table 1.

CANCER CASES CAUSED BY SMOKING			
	All smoking	Current and former smoking	Secondhand smoke exposure in never-smokers
UNITED KINGDOM	296,661	293,815	2,846
ENGLAND	243,045	240,770	2,275
SCOTLAND	29,365	29,067	298
WALES	15,161	15,018	143
NORTHERN IRELAND	9,090	8,960	130

Table 1. The total number of cancer cases (ICD-10: C00–C06, C09–C10, C11, C12–C14, C15 subtypes, C16, C18, C20, C22, C25, C32, C33–C34, C50, C53, C56–C57.4, C64–C66, C68, C67, C91–C95) estimated to be caused by smoking over the assumed current Westminster parliamentary term (09/07/2024 – 09/07/2029), split by current and former smoking (all cancer sites above) and secondhand smoke exposure among never-smokers (ICD-10 C33–C34 only)

Discussion

Summary of results

Despite a fall in adult smoking prevalence in the UK, our analysis estimates that there will be almost 300,000 cases of cancer caused by smoking in the current parliamentary term in the UK if current trends continue. These figures give a sense of the impact of smoking on cancer in the UK today and in the future, despite falling smoking prevalence over recent decades.

Strengths and limitations

PAFs were calculated using the widely-accepted and validated PAF formula, as previously described.^{6,7,8} Calculations were performed at the granular level; by age-band, sex, nation, year, and cancer site, and included a built-in 10-year lag from exposure to incidence. Methods and relevant data inputs across all data years were held constant where possible.

The PAF method is the best available for estimating population burden. However, the estimates should be interpreted with the limitations of the source data in mind. The RRs used were selectively chosen based on characteristics relevant to the evidence – such as inclusion of UK-relevant populations, and adjustment for potential confounding. However, each of the selected values carry their own methodological strengths and limitations. It should be noted that the output would be different if different RRs were selected.

Exposure prevalence data used in these calculations are based on surveys conducted on a sample of the population designed to be nationally representative.^{17,18,19,20,21} These calculations assume that the samples accurately represent the population of each nation. Estimates are also naturally subject to self-report bias, and some further estimation was required to fill gaps where data were unavailable.

The multiple components of the PAF calculation inherently create multiple sources of possible bias that could not all be accounted for in a traditional confidence interval calculation. Therefore, confidence intervals are not presented for this work so as not to imply precision.

The 10-year lag may underestimate the full impact of smoking, if the true gap from tobacco exposure to the development of cancer is longer. However, the availability of relative risk estimates with long and complete follow-up limits the possibility of extending the lag: most of the relative risk sources used here included a follow-up of around ten years. The relative risk and exposure prevalence elements of the calculations are therefore well-matched. A previous iteration of this study found that using a 20-year lag for smoking produces only a 1 percentage point increase in the PAF compared with the 10-year lag.¹

Cancer incidence projections used to inform these calculations were modelled using an APC model for each permutation of cancer site, sex, age-band, and UK nation. APC models like this are well-established and validated,⁴¹ however projections are by their nature uncertain, and the figures presented here should be interpreted with some caution.

Our calculations include an estimate for the number of lung cancer cases caused by secondhand smoking. This calculation assumes that lung cancer risk associated with secondhand smoking is only present in people who have never smoked, and we have applied no such risk to people who currently smoke or people who used to smoke. It is likely in reality that there would be some multiplicative effect for people exposed to active smoking as well as secondhand smoking,²³ so our calculations are likely to produce an underestimate of the true total number of cancer cases caused by smoking.

For some of the nations and years included, there were no reliable estimates available for the explicit proportion of never-smokers exposed to secondhand smoking. In these instances, we have assumed that exposure to secondhand smoke is constant across groups of different smoking status (currently smoke, used to smoke, never smoked). This is likely to overestimate exposure to secondhand smoking in never-smokers. However, due to our assumptions about risk detailed above, we expect that our analysis still gives conservative estimates overall.

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¹² Cancer Research UK, Our calculations explained: Age-period cohort models for projecting cancer incidence and mortality. Available from: <https://www.cancerresearchuk.org/health-professional/cancer-statistics/cancer-stats-explained/our-calculations-explained#heading-Zero>

¹³ England data were provided by the National Cancer Registration and Analysis Service (NCRAS), part of the National Disease Registration Service (NDRS) in NHS England, on request through the Office for Data Release, January 2023. Similar data can be found here: <https://www.cancerdata.nhs.uk/>

¹⁴ Scotland data were provided by the Scottish Cancer Registry, Public Health Scotland (PHS) on request, May 2021. Similar data can be found here: <https://publichealthscotland.scot/publications/show-all-releases?id=20468>

¹⁵ Welsh data were published by the Welsh Cancer Intelligence and Surveillance Unit (WCISU), Health Intelligence Division, Public Health Wales <https://phw.nhs.wales/services-and-teams/welsh-cancer-intelligence-and-surveillance-unit-wcisu/cancer-reporting-tool-official-statistics/> June 2022.

¹⁶ Northern Ireland data were provided by the Northern Ireland Cancer Registry (NICR) on request, October 2021. Similar data can be found here: <https://www.qub.ac.uk/research-centres/nicr/>

¹⁷ NHS England, Health Survey for England (HSE). Available from: <https://digital.nhs.uk/data-and-information/areas-of-interest/public-health/health-survey-for-england---health-social-care-and-lifestyles#survey-dataset> and <https://ukdataservice.ac.uk/>. Data were used from HSE 2014, 2015, 2016, 2017, 2018 and 2019.

¹⁸ Scottish Government, Scottish Health Survey (SHeS). Available from: <https://www.gov.scot/collections/scottish-health-survey/>. Data were used from SHeS 2014, 2015, 2016, 2017, 2018 and 2019.

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<https://www.gov.wales/national-survey-wales> Data were used from NSW 2016–17, 2017–18, 2018–19 and 2019–20.

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Appendix

Appendix A: Methodology supplement

CANCER SITE (ICD-10 CODES)	RR – CURRENT SMOKING		RR – FORMER SMOKING		RR – SECONDHAND SMOKING	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
LUNG (C33–C34)^{22,23}	7.33	6.99	3.13	3.14	1.27	1.27
LARYNX (C32)²⁴	7.01	7.01	2.37	2.37	–	–
BLADDER (C67)²⁵	3.44	3.56	1.92	2.04	–	–
PHARYNX (C09–C10, C12–C14)²⁶	3.43	3.43	1.00*	1.00*	–	–
OESOPHAGUS (C15)						
OESOPHAGUS AC²⁷	2.32	2.32	1.62	1.62	–	–
OESOPHAGUS SCC^{28,29}	4.21	4.21	2.18	2.18	–	–
LIVER (C22)³⁰	1.66	1.66	1.51	1.51	–	–
CERVIX (C53)³¹	–	1.80	–	1.41	–	–
NASOPHARYNX (C11)³²	1.59	1.59	1.36	1.36	–	–
PANCREAS (C25)³³	1.90	1.90	1.20	1.20	–	–
STOMACH (C16)³⁴	1.63	1.30	1.42	1.00*	–	–
ORAL CAVITY (C00–C06)³⁵	1.91	1.91	1.00*	1.00*	–	–
KIDNEY (C64–C66, C68)³⁶	1.57	1.27	1.29	1.20	–	–
BOWEL (C18–C20)						
COLON (C18)³⁷	1.11	1.11	1.15	1.15	–	–
RECTUM (C20)³⁷	1.44	1.44	1.11	1.11	–	–
LEUKAEMIA (C91–C95)³⁸	1.52	1.52	1.45	1.45	–	–
BREAST (C50)³⁹	1.00*	1.80	1.00*	1.41	–	–
OVARY (C56–C57.4)⁴⁰	–	1.44	–	1.00*	–	–

Table S1. Relative risk values used in calculations

**Where RR values were non-significant, they were inputted into calculations as 1 (i.e. no elevated risk)*

Appendix B: Additional calculations

Cancer Research UK uses the smoking-attributable cancer cases estimates presented here, in a range of further calculations. Details of these calculations are presented below.

Projected cancer cases caused by tobacco in the current parliamentary term – broken down by English region

The projected number of cancer cases caused by tobacco in the current parliamentary term in England was used to estimate the number caused in each region of England across the same period.

For each incidence year included in the calculations, the distribution of smoking prevalence by region in England ten years prior was applied to the estimated number of cancer cases caused by tobacco in England, using data from the Annual Population Survey.⁴ For example, 5.5% of people who smoked in England in 2015 lived in the North East, so it was assumed that 5.5% of cancer cases caused by smoking in England in 2025 would be in the North East. For incomplete years (2024 and 2029), cases for the relevant portion of the year were distributed in the same way, based on whole-year average smoking prevalence ten years prior. Estimates for each year (2024–2029) were then summed to give a total estimate across the period.

The distribution percentages were calculated as the proportion of people who smoke in each region multiplied by the weighted count in the region, over the total number of people who smoke in England, for each exposure year (2014–2019).

Table S2 presents the estimated number of cancer cases caused by smoking in each region of England in the current parliamentary term.

Due to a lack of available input data, it was not possible to perform the PAF calculations from scratch at regional level. Therefore, the estimates presented here assume that the age- and sex-profile of smoking prevalence and cancer incidence is constant across regions.

**CANCER CASES CAUSED BY SMOKING IN
CURRENT PARLIAMENTARY TERM**

NORTH EAST	Around 13,200
NORTH WEST	Around 34,300
YORKSHIRE AND THE HUMBER	Around 27,000
EAST MIDLANDS	Around 22,000
WEST MIDLANDS	Around 24,700
EAST OF ENGLAND	Around 26,000
LONDON	Around 36,700
SOUTH EAST	Around 36,300
SOUTH WEST	Around 23,200

Table S2. The total number of cancer cases (ICD-10: C 00–C06, C09–C10, C11, C12–C14, C15 subtypes, C16, C18, C20, C22, C25, C32, C33–C34, C50, C53, C56–C57.4, C64–C66, C68, C67, C91–C95) estimated to be caused by smoking over the assumed current Westminster parliamentary term (09/07/2024 to 09/07/2029)

Projected cancer cases caused by tobacco in the current parliamentary term – broken down by parliamentary constituency in the UK

Smoking prevalence is not measured by national health surveys at the constituency level, so the method described above for regional estimates could not be used for constituency estimates. Therefore, estimates were produced for the area surrounding each parliamentary constituency based on smoking prevalence by local authority (LA) or Health and Social Care Trust (HSCT).

The projected number of cancer cases caused by tobacco in the current parliamentary term in England, Scotland and Wales was used to estimate the number caused in each LA within those nations. For Northern Ireland, the projected number of cancer cases caused by tobacco was used to estimate the number of cases caused in each HSCT. The estimated number of cases caused in each LA (or HSCT in Northern Ireland) was then mapped onto parliamentary constituency boundaries to give an estimate of the number of cancer cases caused by smoking in the area surrounding each parliamentary constituency. As the most recent at the time of publication, LA 2022 boundaries were mapped on to parliamentary constituency 2025 boundaries. Where a constituency boundary included part of multiple LAs or HSCTs, the estimated number of cases in each included LA or HSCT was summed together.

For each incidence year included in the calculations, the distribution of smoking prevalence by LA or HSCT in each constituent nation ten years prior was applied to the estimated number of cancer cases caused by tobacco in the relevant constituent nation.^{4,21} For example, 1.3% of people who smoked in England in 2015 lived in Manchester, so it was assumed that 1.3% of cancer cases caused by smoking in England in 2025 would be in Manchester. For incomplete years (2024 and 2029), cases for the relevant portion of the year were distributed in the same way, based on whole-year average smoking prevalence ten years prior. Estimates for each year (2024–2029) were then summed to give a total estimate across the period.

For England, Scotland and Wales, the distribution percentages were calculated as the proportion of people who smoke in each LA multiplied by the weighted count in the LA, over the total number of people who smoke in the relevant constituent nation, for each exposure year (2014–2019). For Northern Ireland, the distribution percentages were calculated as the proportion of people who smoke in each HSCT multiplied by population estimates for the HSCT, over the total number of people who smoke in Northern Ireland, for each exposure year (2014–2019). The population counts used to inform these calculations were based on 2011 census data.

Due to a lack of available input data, the estimates presented here assume that the age- and sex-profile of smoking prevalence and cancer incidence is constant across LAs (or across HSCTs in Northern Ireland) within each nation. It should also be noted that smoking prevalence data used in distribution calculations for England, Scotland and Wales were taken from the Annual Population Survey.⁴ For Scotland and Wales, this is a different source to the exposure prevalence input data used in the overarching PAF calculation due to a lack of reliable estimates by LA in the nation-specific health surveys for the necessary exposure years. For Northern Ireland, smoking prevalence data used in the distribution calculations was taken from the Health Survey for Northern Ireland²¹, in line with the overarching PAF calculation.

Where data were unavailable due to boundary changes or local authority restructuring, prevalence data from the closest available data year was used as a proxy in the distribution calculations. This affected Buckinghamshire, North Northamptonshire, West Northamptonshire, and City of London. There were no smoking prevalence estimates available at all for Isles of Scilly, so we were unable to produce an estimate for this LA. Therefore, the estimate for the area surrounding the St. Ives constituency is based on estimated cases in Cornwall only.

The estimated number of cancer cases caused by smoking in the area surrounding each parliamentary constituency is available upon request, or by visiting <https://crukcanerintelligence.shinyapps.io/LocalStats/>. Note that these figures should not be summed, for example across groups of nearby constituencies, because there is substantial overlap between the areas surrounding constituencies.