Public Health Scotland

Scottish Burden of Disease

Future prevalence and burden of tracheal, bronchus, and lung cancer

A Management information release for Scotland

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Context

Over the next two decades, Scotland is expected to experience changing demographics, most notably an increase in the ageing population.[1] Public Health Scotland's Scottish Burden of Disease (SBoD) study has recently been adapted to forecast how these demographic and population health trends are expected to combine, to anticipate the extent of future public health challenges. Initial work focused on the impact of the changing demographic situation only and found that, despite a projected 1.2% decrease in the Scottish population, the combined annual disease burden from all causes of disease and injury is forecast to increase 21% in the next 20 years.[2] Absolute increases in annual disease burdens are forecast to be largest for cardiovascular diseases, cancers, and neurological diseases – together accounting for approximately two-thirds of the total increase in forecasted disease burden.

These findings are set alongside the context of a projected reduction in working-age population over that same time period with an old-age dependency ratio projected to increase from 57% in 2022 to 64% in 2042.[1] These changes will have important implications for public health and the health and social care system. To address these challenges, alongside financial constraints and sustainability, decision makers need to consider both more effective approaches to prevention and different models of care. In doing so, alongside demographic change, consideration of epidemiological changes is needed as these have the potential to either ease or add to the pressure within an already stretched system.

Please note, a version of this 'Scottish Burden of Disease - Future prevalence and burden of tracheal, bronchus, and lung cancer' was published temporarily in error on 27 May 2025 and some figures may have changed following final quality assurance checks.

Background

Disease prevalence is a measure of the overall occurrence of a disease at a point in time. It is a helpful metric as it outlines the scale of population-level health demands that are likely to arise from living with a disease. This in turn can inform discussions over how best to meet these health needs through health and social care service provision, and over how these needs could be reduced through public health interventions.

Cancer prevalence is influenced by two epidemiological factors:

- The rate of new cases (incidence)
- Case fatality:
    - Rate of remission/cure
    - Survival rate of prevalent cases

The prevalence of cancer is largely influenced through two main pathways: the incidence of the disease, and the case fatality of those diagnosed with cancer. Case fatality comprises two states: the rate of remission and cure, and the survival rate. Survival from cancers varies from person to person and is influenced by the stage of cancer at diagnosis, treatment and previous health status. In addition, earlier detection of cancers may also increase prevalence rates, including through improved survival. Successful prevention of many cancers can reduce incidence rates and prevalence of cancer.

In this report, we project the prevalence of trachea, bronchus and lung cancers ("lung cancer") over the next two decades by incorporating information on historic trends in the prevalence of lung cancer, alongside projected changes in the Scottish population. The SBoD 2019 study found lung cancer was the fourth leading cause of disease burden in Scotland, with an estimated 87,000 disability-adjusted life years (DALYs). Lung cancer exhibits sizeable absolute and relative inequalities, with 55% of lung cancer DALYs estimated to be attributable to inequalities in multiple deprivation.[3]

Methodology

Data

Estimates of the number of people living with lung cancer in Scotland were calculated for each year from 2000 to 2019. Individual cases of lung cancer were identified from the Scottish Cancer Registry and a 20-year lookback period applied. In records from 1997, ICD-10 coding was applied in Scotland, and prior to 1997 ICD-9 was applied.[4,5] Cases were then linked to the NRS Register of Deaths using the Community Health Index (CHI) to exclude those who were no longer alive at the end of the year of interest. [6,7] In addition, cases were excluded if they were recorded in the Scottish Cancer Registry as no longer living in Scotland in the year of interest.

A full list of ICD codes used to define lung cancer can be found in **Appendix 1**.

Analyses

Future estimates of lung cancer prevalence were calculated using age-period-cohort (APC) models. APC models allow the independent effects of age, time-period and birth cohorts to be included in the model alongside a linear period component to adjust for the collinearity between age, period and cohort. There are several advantages to this approach, the main one being that period and cohort effects serve as proxies for changing events such as risk factors, public health, and improvements in medical interventions, which are often difficult to measure directly.

APC models were fitted to sex-specific data and the best fitting models, based on goodness-of-fit criteria, were selected. In addition, where the linear period trend was included in the model, either the full trend (from 2000-2019) was used or the more recent trend only (from 2010-2019). The linear period trend was selected based on whether a significant change ($p < 0.05$) was estimated between the two time periods. Following selection of the best-fit model, the resulting age and sex specific prevalence estimates were combined with Office for National Statistics (ONS) 2020-based interim national population projections for each year, recommended for use by the NRS, to generate future estimates of prevalence.[8]

For both male and female models, a full age-period-cohort model was identified as the best fitting model. For males, the linear trends for the full time period were applied; for women, the linear trend for the two most recent time periods (2010-2019) was applied. To compensate for the likelihood that these trends are unlikely to continue without changing indefinitely, the linear trend parameter was cut by 0%, 25% and 50% in the first, second and third 5-year period, respectively, to decrease the effect of current trends.[9]

As a comparator, future estimates of prevalence incorporating demographic changes only were calculated. Here, the sex-specific lung cancer prevalence for 2019 was calculated by five-year age group. These age and sex-specific estimates were then applied to NRS Population Projections to generate future estimates. These estimates assume that prevalence remains constant over the forecast period. That is, all future changes would be due to the changing demographics in Scotland ignoring the time trends identified in APC models. Estimates included in this report are those which include the impacts of projected demographic changes and historic epidemiological trends, unless stated. Analysis was carried out in RStudio using the Nordpred R package for modelling. [10, 11]

Estimates of prevalence of lung cancer reported here may differ to other published estimates of prevalence in Scotland because of differing methodologies.

Finally, these estimates of future prevalence were then used to calculate estimates of the future burden of lung cancer due to morbidity. The SBoD study follows the Global Burden of Disease (GBD) methodology which relies on severity distributions to quantify the proportion of the prevalent population in a particular health state and disability weights to take account of the consequences of both the condition and the health state.[12] Prevalence forecasts were distributed to each severity level according to the fixed proportions developed for use in the GBD 2016 study.[13] The burden due to morbidity was calculated by applying the disability weight to the number of prevalent cases in each severity level and adjusting for comorbidity. Severity distributions and disability weights for lung cancer can be found in **Appendix 1.**

Main points

- The number of people with lung cancer in Scotland is estimated to increase by 59% from 2019 to 2044, from 10,600 prevalent cases to 16,800. This equates to an additional 6,200 people living with lung cancer in 2044, compared to 2019.

- Absolute and relative changes differ between the age groups and sexes. The largest absolute change in prevalence is forecast to be in females aged 65 to 84 years and aged 85 years and over. The largest relative increases are projected to be in males and females aged 85 years and over.

- Due to projected increases in the number of prevalent cases, unless mitigated by reductions in disease severity, the non-fatal burden of lung cancer will increase between 2019 and 2044.

- These projected increases in prevalence and burden of lung cancer are not inevitable - effective prevention, particularly through reductions in smoking prevalence, can contribute to reducing the number of people being diagnosed with lung cancer.

Results and commentary

Results

From 2000 to 2019, the number of people living with a diagnosis of lung cancer increased from 5,500 to 10,500; an increase of 73% (Figure 1). Through incorporating the impact of projected population changes (age-effects) from 2019 onwards and assuming the underlying prevalence rate remains the same as it was in 2019, we estimate the number of people with lung cancer could rise from 10,600 to 12,600 from 2019 to 2044; an increase of 19% (Figure 1 and Table 1). Refining these estimates further by incorporating historical pre-pandemic age, period- and cohort-effects identified in underlying historic data, we estimate that the number of people with lung cancer would increase from 10,600 in 2019 to 16,800 in 2044; an increase of 59% (Figure 1 and Table 1).

Figure 1: Trend in the number of people with lung cancer (2000 to 2019) with projections to 2044 (mean value per five-year period)

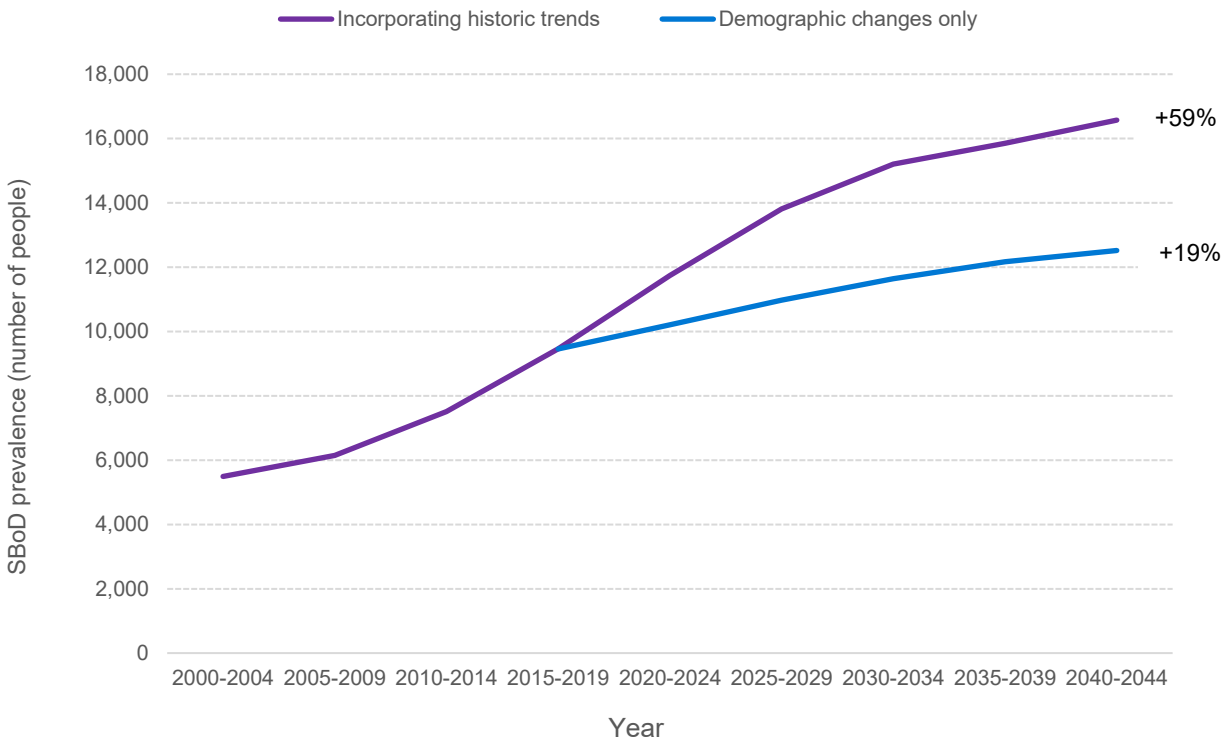

Table 1: Estimated number of people with lung cancer in Scotland using two different methods (selected years) with projections to 2044

Method	2019	2024	2029	2034	2039	2044	Change (n) (2019 to 2044)	Change (%) (2019 to 2044)
Demographic changes only	10,580	10,522	11,261	11,872	12,336	12,609	+2,029	+19.2%
Incorporating historic trends and demographic changes	10,580	12,103	14,204	15,550	16,128	16,765	+6,185	+58.5%

In the full model, which incorporates both historic trends and demographic changes, the largest absolute increase in prevalence is expected to be seen for females. For females, an increase of 68% is projected, representing an absolute increase of 4,000 prevalent cases (Table 2). For males, there is projected to be a 46% increase in prevalence, representing an absolute increase of 2,100 prevalent cases.

Table 2: Estimated number of people with lung cancer incorporating historic trends with projections to 2044, by sex (selected years)

Sex	2019	2024	2029	2034	2039	2044	Change (n) (2019 to 2044)	Change (%) (2019 to 2044)
Male	4,612	5,022	5,563	5,941	6,244	6,747	+2,135	+46.3%
Female	5,968	7,081	8,641	9,609	9,884	10,018	+4,050	+67.9%

In addition to sex-specific differences, estimates of future prevalence are projected to vary across age groups (Figure 2, Table 3). Prevalence is projected to increase in all age groups over 25 years of age, but with no clear pattern to the increases

Figure 2: Percentage change (2019-2044) in the estimated number of people with lung cancer by sex and age group

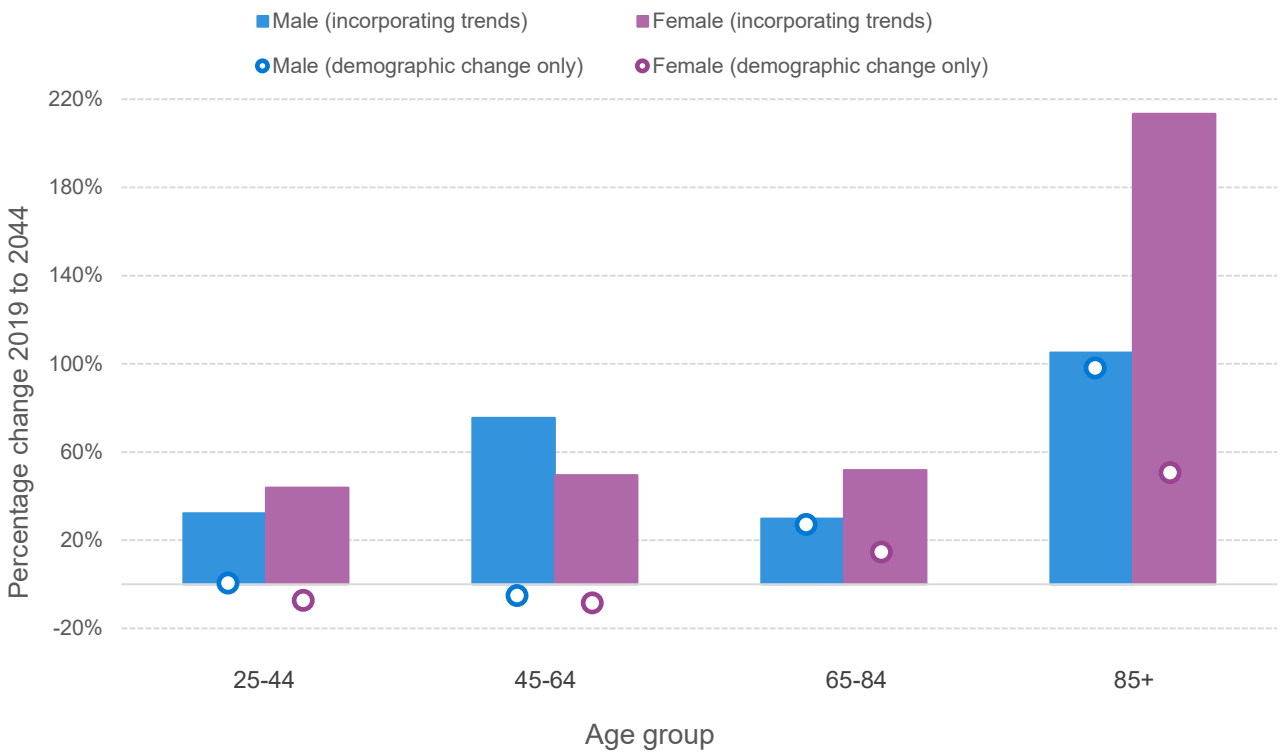

Table 3: Percentage change (2019-2044) in the estimated number of people with lung cancer by sex and age group

Sex	Agegroup	Demographic changes only % (n)*	Incorporating historic changes % (n)*
Male	25 to 44 years	0.5% (1)	32.2% (20)
	45 to 64 years	-5.1% (-48)	75.5% (704)
	65 to 84 years	27.1% (856)	29.8% (943)
	85 years and over	98.0% (437)	105.1% (469)
Female	25 to 44 years	-7.4% (-5)	43.9% (21)
	45 to 64 years	-8.6% (-107)	49.5% (618)
	65 to 84 years	14.5% (585)	51.8% (2,087)
	85 years and over	50.6% (313)	213.4% (1,319)

* Change in numbers denoted in brackets

** Small differences in total values due to rounding and exclusion of younger age groups

In the model incorporating historic changes, the largest absolute increases are projected in the 65 to 84 years age group. For males aged 65 to 84 years an absolute increase of 943 prevalent cases is projected from 2019 to 2044, representing a relative increase of 30%. For females aged 65 to 84 years an absolute increase of 2,087 prevalent cases is projected from 2019 to 2044, representing a relative increase of 52%. The largest relative increases are projected in the 85 years and over age group. For males aged 85 years and over, an absolute increase of 469 prevalent cases is projected from 2019 to 2044, representing a relative increase of 105%. For females aged 85 years and over an absolute increase of 1,319 prevalent cases is projected from 2019 to 2044, representing a relative increase of 213%.

Considering the demographic change only model, projected estimates in males aged 65 to 84 years and 85 years and over are similar to those resulting from the fully model, however differ in other age-sex strata. The most noticeable differences are in

younger age groups, 25 to 44 years and 45 to 84 years, where small relative decreases are projected when applying the demographic change only model, compared to increases in the full model. Similar to the full model, the largest absolute increases are projected in the 65 to 84 years age group and the largest relative increases in the 85 and over age groups, however these relative increases are projected to be considerably smaller than those estimated by the model incorporating historic trends.

In burden of disease studies, prevalence is used to calculate the non-fatal burden [years lived with disability (YLD)] of a condition, along with estimates of the severity and disability associated with the disease. Applying burden of disease methodology to the projected values of prevalence, we estimate that the non-fatal burden due to lung cancer is also projected to increase. YLD is projected to be approximately 1,200 YLD in 2044, up from 750 in 2019, representing an absolute increase of 800 YLD and a relative increase of 60%. Considering males and females stratification, the projected increases in YLD follow the same trends as seen in prevalence.

Overall burden (DALYs) is a composite measure incorporating both non-fatal and fatal burden. This projected increase in non-fatal burden will not necessarily lead to a similar change in the overall burden, as the latter will also be influenced by projected changes in mortality and fatal burden for a disease. Further work by the SBoD team is focussed on future projections of mortality and fatal burden, in order to develop forecasts of the overall burden of lung cancer in Scotland.

Summary

Both the number of people living with lung cancer and non-fatal burden of lung cancer are projected to increase over the next 20 years for males and females.

The number of people living with lung cancer in Scotland is estimated to increase by 59% from 2019 to 2044, representing an additional 6,200 people living with lung cancer.

The largest absolute increases in prevalence count are projected to be in those aged 65 to 84 years old, whereas the largest relative increases in prevalence count are projected in those aged 85 years and over. In these age groups, the largest absolute and relative increases are estimated to be seen in females.

Previous projections of lung cancer incidence by Cancer Research UK and Public Health Scotland forecast an increase in the number of cancer registrations for lung cancer from 2020 to 2040, which are likely to drive these projected increases in prevalence. [14]

Any projected increases in prevalence and burden are likely to impact the sustainability of services in the future. However, these projected increases are not inevitable. We need to continue to invest in prevention at all levels, through smoking cessation policies and services which play a major part in the primary prevention of lung cancer.

Limitations

Projections, by definition, are unstable and become less robust the longer the forecast period. External events, changes to population projections and limitations in the original models can all impact the robustness of projections. For example, the use of pre-pandemic period time trends in lung cancer prevalence do not take into account any changes in incidence and mortality from 2020 to 2023. Future SBoD iterations will incorporate sensitivity analyses to examine the robustness of the projections presented here.

Projections, by definition, are unstable and become less robust the longer the forecast period. The projections presented here are dependent on population projections, so any revision of these population projections is likely to have a considerable impact on the robustness of the projections of lung cancer prevalence. For consistency with previous publications in this series, the ONS 2020-based interim national population projections for each year were used to calculate future prevalence. Application of the recently published NRS Projected Population of Scotland: 2022-based is likely to have an impact on results described here. [15]

In these projections, as well as technical uncertainties, there may also be uncertainties in the calculation of future burden. When estimating the future non-fatal burden of lung cancer using YLD, these projections assume the distribution across severity levels will remain constant over time. This may not be the case, particularly when decreased mortality rates may cause people to live longer and develop further complications or progression of lung cancer. Any changes to the distribution of prevalence across the severity levels throughout the projection period will affect YLD estimates.

For the most recently published SBoD estimates of burden - SBoD2019 - we estimated YLD at national level by applying the SBoD 2016 age-sex-deprivation rates of YLD to the relevant NRS mid-year population estimates. For this report, YLD has been calculated by applying the severity distribution seen in SBoD2016 to 2019 observed prevalence and modelled prevalence from 2020 onwards. Therefore observed YLD for 2019 published here differs from previously published YLD.

Conclusion and next steps

This analysis forecasts an increase in the prevalence of lung cancer over the next two decades and any projected increases in prevalence and burden are likely to impact the sustainability of services in the future. However, these projected increases are not inevitable. Change is possible through investing in prevention, especially to reduce smoking levels, and exposure to other modifiable risk factors.

In 2013, the Scottish Government introduced a target, aiming for a smoking prevalence of 5% or lower amongst the adult population in Scotland.[16] Data from the Scottish Health Survey 2022 illustrates that whilst overall smoking prevalence has been reducing in Scotland since 2003, inequalities persist.[17] In 2022, the age-standardised prevalence of smoking in adults was 25% in those living in the most deprived areas, compared to 7% amongst adults living in the least deprived areas. An updated *Tobacco and Vaping Framework: Roadmap to 2034*, published by the Scottish Government 2023, acknowledges that whilst progress has been made on this target, continued effort if required, particularly with respect to inequalities in smoking prevalence.[18]

Continuing to tackle the underlying risk factors which increase the risk of lung cancer can reduce the number of new cases which occur, whilst early detection of malignant cancers can help to ensure those living with lung cancer live longer lives in better health.

Cancer prevalence is complex and increasing prevalence may be both positive and negative, depending on the underlying causes of the increase. In the short term, interventions aimed at improving detection of lung cancer may lead to an increase in prevalence through higher rates of incidence. In the longer term, these interventions may also lead to an increase in prevalence, through earlier detection of lung cancer and therefore improved survival rates. The implementation of lung cancer screening in Scotland is expected to have such an effect on the prevalence.

This publication is part of a growing body of work from Public Health Scotland's Population Health Monitoring programme, which aims to deliver high-quality population health insight and evidence to guide equitable action, inform decision-

making, and protect population wellbeing. As part of this programme, the SBoD study are doing further work on the future projections of mortality and fatal burden, in order to develop forecasts of the overall burden of lung cancer in Scotland. They are also working to build upon these projections to explore how forecasts may be influenced by various scenarios. In addition, the SBoD team are working with the Whole Systems Modelling team at PHS to determine how these various projections and scenarios are likely to impact service provision in the health and social care systems over the next 20 years.

Glossary

Burden of disease (and injury)

The quantified impact of a disease or injury on a population using the disability-adjusted life years (DALY) measure.

DALY (disability-adjusted life year)

A standardised metric that can be used to quantify the health loss due to dying prematurely or to living with the health consequences of diseases, injuries or risk factors. DALYs are a summary metric of population health. DALYs are an absolute measure of health loss; they count how many years of healthy life are lost due to death and non-fatal illness or impairment. They reflect the number of individuals who are ill or die in each age-sex group and location.

Disability

In burden of disease studies, this is synonymous for “loss of health”, or any, short or long term, departure from full health.

Disability weight

Numerical representations of the severity of health loss associated with a health state. Disability weights are numbers between 0 and 1 that are multiplied by the time spent living with a health loss to determine the years lived with disability associated with the cause of that loss. In the GBD, disability weights are derived from a worldwide, cross-cultural study to compare the relative severity of health problem.

Early death

The burden from dying prematurely. Often used synonymously with **years of life lost**.

Fatal burden

The burden from dying prematurely as measured by years of life lost. Often used synonymously with **years of life lost**.

Health loss

The total burden from early death and ill-health. Often used synonymously with **disability adjusted life year (DALY).**

Health states

The consequences of diseases and injuries or their risk factors. Health state refers to an individual's levels of functioning within a set of health domains such as mobility, cognition, pain, emotional functioning, self-care, etc. Health states do not refer to general well-being (which is a broader construct) or to aspects of participating in society, although they clearly affect these other aspects of life and may be affected by them.

Ill-health

Often used synonymously with **years lived with disability**.

Life expectancy

The average number of years of life expected to be lived by individuals who survive to a specific age.

Non-fatal burden

The burden from living with ill-health as measured by years lived with disability. Often used synonymously with **years lived with disability**.

Sequelae

Consequences of diseases and injuries for which epidemiological estimates and YLD calculations are made. It encompasses not only the traditional clinical meaning, but also a broader categorization of health outcomes such as severity levels for a particular disease, injury or impairment.

Severity distribution

Severity distributions are a means of summarising the range of health loss suffered to disease which enables estimates of disease occurrence to be paired with disability weights to estimate Years Lost to Disability in burden of disease studies.

YLD (Years of Life lived with a Disability)

In burden of disease studies this is also referred to as ‘ill-health’. YLDs are computed as the prevalence of different disease-sequelae and injury-sequelae multiplied by the disability weight for that sequela. Disability weights are selected on the basis of surveys of the general population about the loss of health associated with the health state related to a disease sequela.

YLL (Years of Life Lost due to premature mortality)

YLLs are computed by multiplying the number of deaths at each age x by a standard life expectancy at age x. In SBoD we use an aspirational world life expectancy table developed for the Global Burden of Disease study.

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Further information

Further information and data for this publication are available from the **publication page** on our website.

Rate this publication

Let us know what you think about this publication via. the link at the bottom of this **publication page** on the PHS website.

Appendices

Appendix 1 – Background information

Table A1: ICD-10 codes

IC10 code	Description
C33-	Malignant neoplasm of trachea
C34-	Malignant neoplasm of bronchus and lung

Table A2: ICD-9 codes

IC10 code	Description
162-	Malignant neoplasm of trachea bronchus and lung

Table A3: Severity levels and corresponding disability weights

Severity level / health state	Description	Disability weight
Diagnosis and primary therapy	Has pain, nausea, fatigue, weight loss and high anxiety.	0.288
Controlled phase	Has a chronic disease that requires medication every day and causes some worry but minimal interference with daily activities	0.049
Metastatic phase	Has severe pain, extreme fatigue, weight loss and high anxiety.	0.451
Terminal phase	Has lost a lot of weight and regularly uses strong medication to avoid constant pain. The person has no appetite, feels nauseous, and needs to spend most of the day in bed.	0.540

Appendix 2 – Publication metadata

Publication title

Scottish Burden of Disease: Future prevalence and burden of tracheal, bronchus, and lung cancer

Description

Release of Scottish Burden of disease prevalence estimates for tracheal, bronchus, and lung cancer for 2020-2044.

Theme

Population health and forecasts

Topic

Burden of disease

Format

PDF

Data source(s)

Please see methodology section for full data sources and time periods.

Date that data are acquired

Please see methodology section for full data sources and time periods.

Release date

24/06/2025

Frequency

Ad hoc

Timeframe of data and timeliness

The basis for the publication is SMR data from 2000 to 2019.

Continuity of data

Please see methodology section for information on continuity of data and coding.

Revisions statement

Revisions relevant to this publication

Concepts and definitions

Please see **Glossary**

Relevance and key uses of the statistics

Population health surveillance; service planning and sustainability; quality improvement and assurance.

Accuracy

The report contains projections of the prevalence of disease in Scotland to 2044. Projections and forecasts, by definition, are unstable and become less robust the longer the forecast period. Please see **Limitations** section for full details.

Completeness

Please see methodology section for information on completeness of data.

Comparability

The prevalence described in this report is estimated following the disease models and definitions outlined by the SBoD study and therefore may not be directly comparable to other estimates of prevalence.

Accessibility

It is the policy of Public Health Scotland to make its websites and products accessible according to published guidelines. More information on accessibility can be found on the **PHS website**.

Coherence and clarity

Measures to enhance coherence and clarity within this report include: explanatory chart/table notes, minimal use of abbreviations/abbreviations explained in the text, comprehensive notes on background and methodology.

Value type and unit of measurement

Figures are shown as absolute number, percentages and relative change. Units of measurement are disability-adjusted life years (DALYs); years lived with disability (YLDs) and years of life lost (YLL) and prevalence of disease. Please see **Glossary** for further details.

Disclosure

The PHS protocol on Statistical Disclosure Protocol is followed.

Official statistics accreditation

Management information.

UK Statistics Authority assessment

Not put forward for assessment.

Last published

First publication.

Next published

To be confirmed.

Date of first publication

Not applicable.

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Date form completed

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Appendix 3 – Early access details

Pre-release access

Under terms of the 'Pre-release Access to Official Statistics (Scotland) Order 2008', PHS is obliged to publish information on those receiving pre-release access ('pre-release access' refers to statistics in their final form prior to publication). The standard maximum pre-release access is five working days. Shown below are details of those receiving standard pre-release access.

Standard pre-release access:

Scottish Government Department of Health and Social Care (DHSC)

NHS board chief executives

NHS board communication leads

Early access for management information

These statistics will also have been made available to those who needed access to ‘management information’, i.e. as part of the delivery of health and care:

Early access for quality assurance

These statistics will also have been made available to those who needed access to help quality assure the publication:

Appendix 4 – PHS and official statistics

About Public Health Scotland (PHS)

PHS is a knowledge-based and intelligence driven organisation with a critical reliance on data and information to enable it to be an independent voice for the public's health, leading collaboratively and effectively across the Scottish public health system, accountable at local and national levels, and providing leadership and focus for achieving better health and wellbeing outcomes for the population. Our statistics comply with the **Code of Practice for Statistics** in terms of trustworthiness, high quality and public value. This also means that we keep data secure at all stages, through collection, processing, analysis and output production, and adhere to the Office for National Statistics '**Five Safes**' of data privacy.

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