Public Health Scotland

Scottish Burden of Disease

Future prevalence and burden of cerebrovascular disease

A Management information release for Scotland

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Context

Scotland is expected to see a rapidly ageing population, within the context of a slight overall decrease in population, over the next two decades.[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.

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.

Disease prevalence is influenced by three epidemiological concepts:

- The rate of new cases (incidence)
- The rate of remission (cure)
- The survival rate of prevalent cases (death)

Cerebrovascular disease is a long-term condition. Once an individual experiences a cerebrovascular event, or is diagnosed with cerebrovascular disease, there is no treatment which can fully reverse the damage that has already occurred. The consequences from cerebrovascular disease can vary from person to person and can include an increased risk of early death. Rapid treatment is important to aid recovery, as well as prevent additional damage. The prevalence of cerebrovascular disease is therefore influenced through two main pathways: the incidence of cerebrovascular disease, and the survival rate of prevalent cases. If improvements in mortality are not met by equivalent improvements in disease prevention, the number of prevalent cases will grow.

In this report, we project the prevalence of cerebrovascular disease over the next two decades by incorporating information on historic trends of the prevalence of cerebrovascular disease, alongside projected changes in the Scottish population. The SBoD 2019 study found cerebrovascular disease was the fifth leading cause of disease burden in Scotland, with an estimated 77,000 disability-adjusted life years (DALYs). Cerebrovascular disease exhibits sizeable absolute and relative inequalities, with 31% of DALYs estimated to be attributable to inequalities in multiple deprivation.[3]

Methodology

Data

Estimates of the number of people living with cerebrovascular disease in Scotland were calculated for each year from 2000 to 2019. Cases were identified data from the following Scottish Morbidity Records (SMR) datasets: 01 Inpatient and Daycase dataset (SMR01); 04 Mental Health Inpatients dataset (SMR04); and Geriatric Long-Stay (SMR01E) dataset, using a standard lookback period of 20 years.[4] SMR01/01E records allow the recording of up to six diagnosis codes. In records from 1997, ICD-10 coding was applied in Scotland, and prior to 1997 ICD-9 was applied.[5,6] Cases were identified if an appropriate code was recorded in any of the six positions and the records linked with the National Records of Scotland (NRS) Vital Events (Deaths) Register using the Community Health Index Number.[7,8]

Prevalence was estimated annually, between 2000 and 2019, and included individuals with a recorded diagnosis of cerebrovascular disease in the previous 20 years who were still alive at the end of the year of interest. In addition, exclusion adjustments were made to account for the small proportion of prevalent individuals who we estimated would no longer be living in Scotland in the year of interest.

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

Analyses

Future estimates of prevalence were projected using age-period-cohort (APC) regression models. APC models allow the independent effects of age, period and birth cohorts to be included in the model, as well as a linear trend. There are several advantages to this approach, the main one being that period and cohort effects serve as proxies for events such as risk factors, public health and medical interventions, which are often difficult to measure directly.

APC models - were fitted to sex-specific data and the best fitting model, 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 period trend was selected based on whether a significant change was estimated between the two time periods. Following selection of the best-fit model, these resulting age and sex specific prevalence estimates were combined with Office for National Statistics (ONS) 2020-based interim national population projections, recommended for use by the NRS, to generate future estimates of prevalence. [9]

For both male and female models, a full age-period-cohort model was identified as the best fitting model. In addition, the linear trend for the two most recent time periods (2010-2019) was applied. As it's unlikely current trends will continue at the same rate throughout the projection period, 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.

As a comparator, future estimates of prevalence incorporating demographic changes only were calculated. Here, the sex-specific cerebrovascular disease 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.

Estimates of prevalence for cerebrovascular disease reported here may differ to other published estimates of prevalence in Scotland, as these estimated follow the disease models and definitions outlined by the SBoD study.

Main points

- The number of people with cerebrovascular disease in Scotland is estimated to increase by 35% from 2019 to 2044, from 106,000 prevalent cases to 143,000. This equates to an additional 37,000 people living with cerebrovascular disease 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 males and females aged 65 to 84 years. 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 cerebrovascular disease will increase between 2019 and 2044.

- Any increase in the number of people diagnosed with cerebrovascular disease is likely to impact on the sustainability of services in the future.

- These projected increases in prevalence and burden of cerebrovascular disease are not inevitable - effective prevention at all levels can contribute to reducing the number of people having a stroke and assist those who have had a stroke to live at lower levels of severity.

Results and commentary

Results

From 2000 to 2019, the number of people with a diagnosis of cerebrovascular disease increased from 78,000 to 105,500; an increase of 35% (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 cerebrovascular disease could rise from 105,500 to 140,000 from 2019 to 2044; an increase of 33% (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 cerebrovascular disease would increase from 105,500 in 2019 to 143,226 in 2044; an increase of 36% (Figure 1 and Table 1)

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

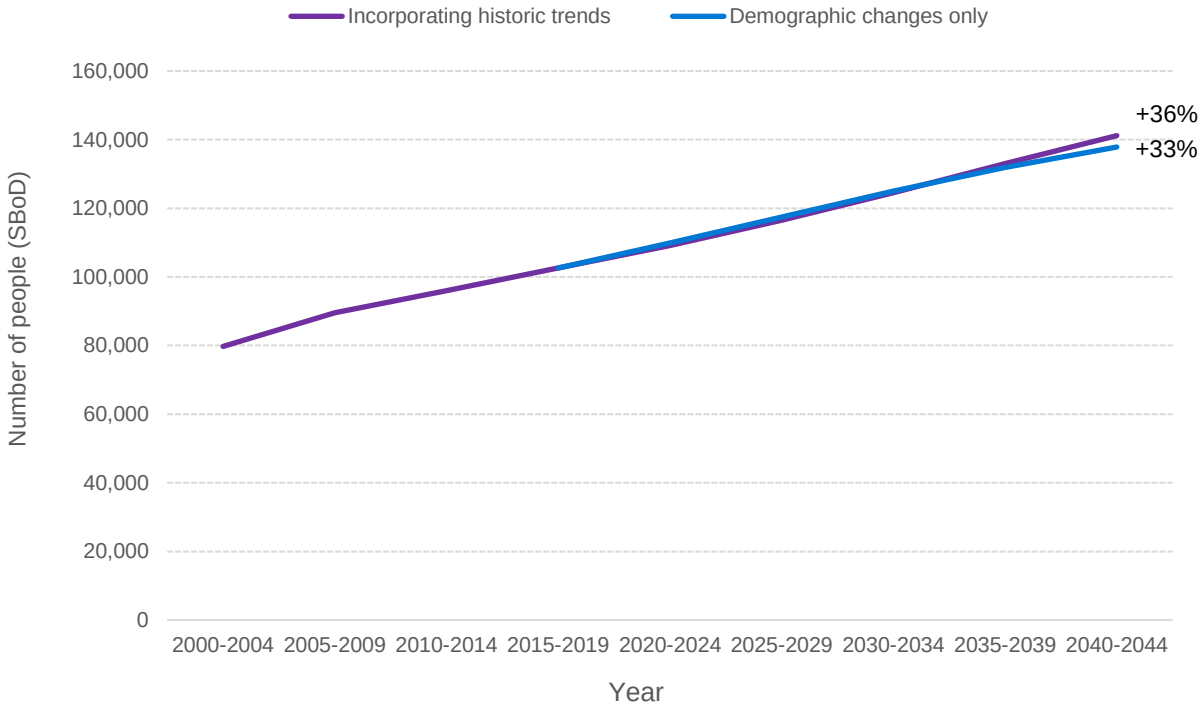


Table 1: Estimated number of people with cerebrovascular disease in Scotland using two different methods (selected years) with projections to 2044

Method	2019	2024	2029	2034	2039	2044	Change (n) (2019 to 2044)	Change (%) (2019 to 2044)
Demographic changes only	105,450	112,945	120,581	128,107	134,387	140,110	+34,659	+32.9%
Incorporating historic trends and demographic changes	105,450	112,130	119,626	127,456	135,239	143,226	+37,776	+35.8%

In the full model, incorporating historic trends and demographic changes, the largest absolute and relative increases in prevalence are expected to be seen for males. For males, an increase of 38% is projected, representing an absolute increase of 20,651 prevalent cases (Table 2). For females, there is projected to be a 34% increase in prevalence, representing an absolute increase of 17,124 prevalent cases.

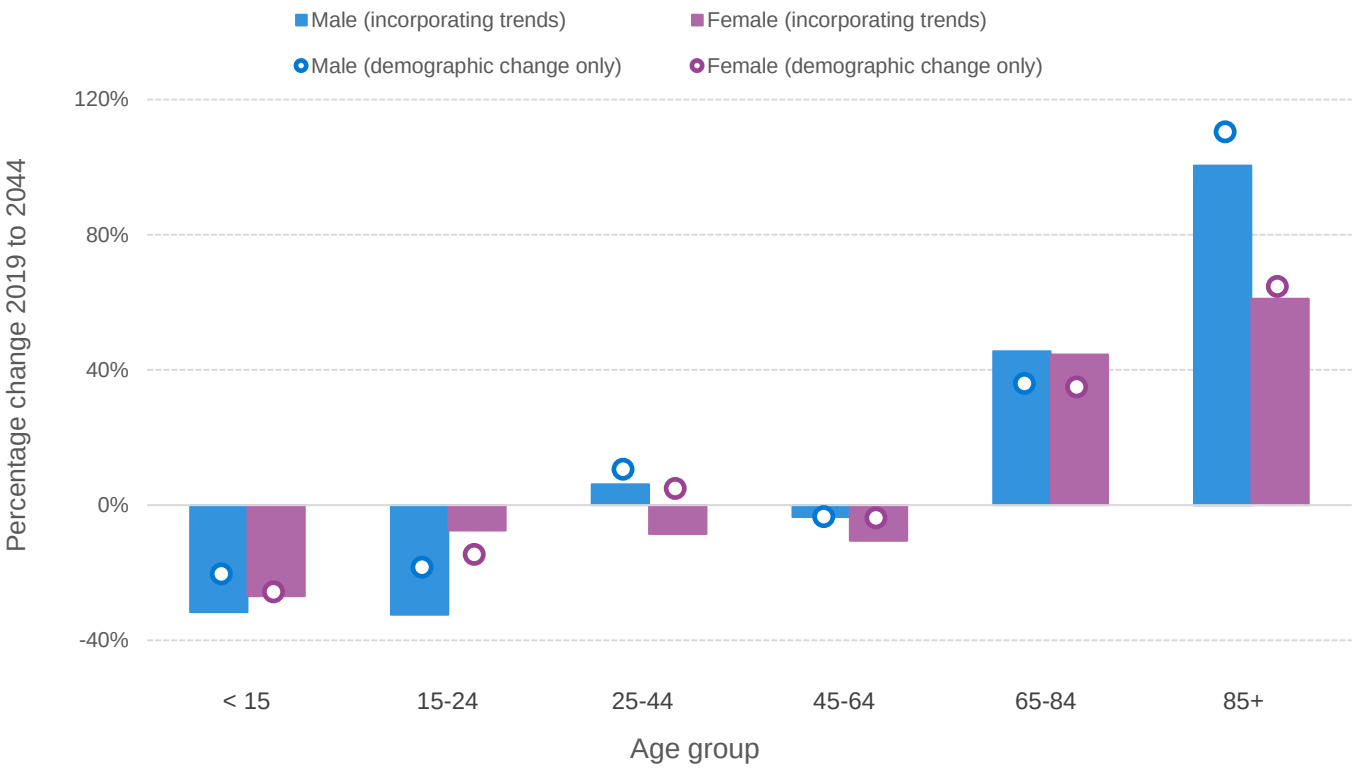
Table 2: Estimated number of people with cerebrovascular disease incorporating historic trends with projections to 2044, by sex (selected years)

Sex	2019	2024	2029	2034	2039	2044	Change (n) (2019 to 2044)	Change (%) (2019 to 2044)
Male	54,499	58,164	62,442	66,635	70,851	75,150	+20,651	+37.9%
Female	50,951	53,967	57,184	60,820	64,388	68,076	+17,124	+33.6%

In addition to sex-specific differences, estimated future prevalence is different across age groups (Figure 2). Prevalence is projected to decrease in all groups under 65 years, with the exception of males aged 25 to 44 years. However, a relative increase in prevalence of 100% is forecast in males aged 85 and over and 61% in females aged 85+ years. These results are influenced by the 61% increase in the population aged 75 years and over projected by the NRS.

Projections resulting from the demographic change only model generally follow the same pattern, with some deviation (Figure 2), with small differences in specific values.

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



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

cerebrovascular disease is also projected to increase. YLD is projected to be approximately 25,000 YLD in 2044, up from 19,000 in 2019, representing an absolute increase of 6,000 YLD and a relative increase of 34%. 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 cerebrovascular disease in Scotland.

Summary

Both the prevalence and non-fatal burden of cerebrovascular disease are projected to increase over the next 20 years for males and females.

Recent trends have illustrated that the incidence rate for cerebrovascular disease decreased by 6% from 2013/14 to 2022/23.[10] In this same period, the rate of mortality from cerebrovascular disease decreased by 25%.

Therefore, increasing prevalence estimates are being driven by modest reductions in incidence and more marked decreases in the mortality of cerebrovascular disease, that are reflected in our projections over the next two decades.

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 primary prevention we can reduce the rate of new cases of cerebrovascular disease occurring and through deploying effective secondary and tertiary prevention we can reduce the health-related quality of life impacts, and risk of early death, in people already living with, or at-risk of, cerebrovascular disease.

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 cerebrovascular disease prevalence do not take into account any changes in incidence and mortality from 2020 to 2023.

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 cerebrovascular disease 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 of cerebrovascular disease. Any changes to the distribution of prevalence across the severity levels throughout the projection period will affect YLD estimates.

Conclusion and next steps

The estimated increase in the prevalence of cerebrovascular disease over the next two decades is not inevitable. Change is possible through investing in prevention. Tackling the underlying mechanisms which increase the risk of cerebrovascular disease can reduce the number of new cases which occur whilst ensuring timely, and accessible, services are available for those who suffer acute cerebrovascular events, and from the ongoing impacts of living with the consequences of cerebrovascular disease, will ensure that people live longer lives in better health.

The SBoD team are doing further work on the future projections of mortality and fatal burden, in order to develop forecasts of the overall burden of cerebrovascular disease in Scotland. They are also working to build upon these projections to explore how forecasts may be influenced by various scenarios. Examples include changes to the prevalence of underlying risk factors for cerebrovascular disease and the introduction of any novel treatments or public health interventions. 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

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Appendices

Appendix 1 – Background information

Table A1: ICD-10 codes

IC10 code	Description
G45-	Transient cerebral ischaemic attacks and related syndromes
G46-	Vascular syndromes of brain in cerebrovascular diseases
I60-	Subarachnoid haemorrhage
I61-	Intracerebral haemorrhage
I62-	Other nontraumatic intracranial haemorrhage
I63-	Cerebral infarction
I64-	Stroke, not specified as haemorrhage or infarction
I65-	Occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction
I66-	Occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction
I67-	Other cerebrovascular diseases
I68-	Cerebrovascular disorders in diseases classified elsewhere
I69-	Sequelae of cerebrovascular disease

Table A2: ICD-9 codes

IC10 code	Description
430	Subarachnoid haemorrhage
431	Intracerebral haemorrhage
432	Other and unspecified intracranial haemorrhage
433	Occlusion and stenosis of precerebral arteries
434	Occlusion of cerebral arteries
435	Transient cerebral ischemia
436	Acute, but ill-defined, cerebrovascular disease
437	Other and ill-defined cerebrovascular disease
438	Late effects of cerebrovascular disease

Appendix 2 – Publication metadata

Publication title

Scottish Burden of Disease: Future prevalence and burden of cerebrovascular disease

Description

Release of Scottish Burden of disease prevalence estimates for cerebrovascular disease 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

04/06/2024

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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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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