

Excess deaths involving CVD in England since the onset of the Covid-19 pandemic: an analysis and explainer

Contents

Table of Figures.....	2
Table of Abbreviations	3
Glossary	4
Introduction	6
Section 1: Trends in CVD deaths	8
1.1. Excess deaths involving CVD in England	8
1.2. Excess deaths involving CVD compared to excess deaths involving other disease areas.....	11
1.3. Age-standardised mortality rates.....	13
1.4. Age and Geographic Region	14
Section 2: Statistical methodology	16
2.1 Calculating ‘excess deaths’	16
2.2. Broadening the analysis of excess deaths involving ‘ischaemic heart disease’ to ‘cardiovascular disease’	16
2.3. Alternative indicators of CVD mortality trends: age-standardised mortality rates	17
2.4. Statistical analysis.....	17
2.5. Notes on classifying ‘years of the pandemic’	17
2.6. Limitations of excess deaths.....	18
Section 3: What is driving the trends and patterns?	20
3.1. Association between excess deaths involving CVD and deaths involving CVD where Covid-19 was the underlying cause of death.....	20
3.2. Potential factors contributing to high levels of excess deaths involving CVD	21
3.2.1. Direct and indirect effects of Covid-19 infection.....	21
3.2.2. Disruption to the health service.....	22
3.2.3. Other factors	27
Conclusion.....	28
Appendix – ICD-10 cause of death reference codes	30
Appendix – Supplementary Analysis:	31
A.1. Regional impact – Analysis and Discussion.....	31
A.2. Age and excess deaths - Analysis.....	34
A.3. Excess deaths involving ischaemic heart disease.....	35

Table of Figures

Figure 1 - Excess deaths in England involving CVD (any mention on death certificate), compared to deaths in England where the underlying cause was Covid-19, where CVD was also mentioned on the death certificate	8
Figure 2 - Excess deaths in England involving CVD (any mention on death certificate), compared to deaths where the underlying cause was Covid-19 and where CVD was also mentioned on the death certificate.....	10
Figure 3 - Excess deaths in England involving major disease areas (any mention on death certificate), compared to deaths where the underlying cause was Covid-19 and where named disease area was also mentioned on the death certificate	11
Figure 4 - All-age age-standardised mortality rate per 100,000 from cardiovascular diseases (underlying cause of death) in England, 2013 to 2021.....	13
Figure 5 - Under-75 age-standardised mortality rate per 100,000 from cardiovascular diseases (underlying cause of death) in England, 2013 to 2021.....	14
Figure 6 - Excess deaths involving IHD (any mention on death certificate) versus deaths involving IHD where Covid-19 was the underlying cause, by region and pandemic year in England.....	31
Figure 7 - Ratio of registered to expected deaths involving CVD (any mention on death certificate), by region and year of pandemic	32
Figure 8 - Excess deaths involving CVD (any mention on death certificate) in England, 21st March 2020 - 30th December 2022, by age group and time period	34
Figure 9 - Excess deaths involving IHD (any mention on death certificate) in England, compared to deaths where the underlying cause was Covid-19 and where IHD was also mentioned on the death certificate	35

Table of Abbreviations

A&E	Accident and emergency
ASMR	Age-standardised mortality rates
CVD	Cardiovascular diseases
ICD-10	International Classification of Diseases, 10th Revision
IHD	Ischaemic heart diseases
NHS	National Health Service
NHSE	NHS England
OHID	Office for Health Improvement and Disparities
ONS	Office for National Statistics
PCR	Polymerase chain reaction
RCEM	Royal College of Emergency Medicine
UEC	Urgent and emergency care

Glossary

Term/phrase	Definition/description
Excess mortality/deaths	The World Health Organization defines 'excess mortality' as: <i>"the difference in the total number of deaths in a crisis compared to those expected under normal conditions"</i>
Deaths <u>involving</u> [specific disease] ...	This phrasing indicates where a disease has received <u>any mention</u> on either part 1 or part 2 of the death certificate of an individual, but does not indicate that it was the <u>underlying cause of death</u> (see next definition). Death certificates frequently mention multiple diseases, and the inclusion of one cause of death in this phrasing does not exclude other diseases from contributing to the death.
Underlying cause of death	The World Health Organization defines the 'underlying cause of death' as the following: <i>"the disease or injury which initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury".¹</i> This definition is embedded within the guidance for doctors within England and Wales completing Medical Certificates of Cause of Death, as issued by the Office for National Statistics (ONS). ² The underlying cause of death is assigned to each death by ONS as part of their process for coding causes of death. This is typically the condition recorded by the certifier on the lowest completed line of part 1 of the medical certificate of death (e.g. 1c leading to 1b leading to 1a). However, this is not always the case, such as when a death certificate has not been completed correctly (e.g. if there is more than one cause on a line with no indication of sequence) or, for correctly-completed certificates, when particular conditions, combinations, or circumstances are present. In these situations, ONS employ a set of selection and modification rules to determine the underlying cause of death. Further

¹ World Health Organization, 2023. Cause of death. Available from:

<https://www.who.int/standards/classifications/classification-of-diseases/cause-of-death>

² Office for National Statistics, 2022. Guidance for doctors completing Medical Certificates of Cause of Death in England and Wales. Available from:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1062236/Guidance_for_Doctors_completing_medical_certificates_Mar_22.pdf

	<p>details on these can be found in Section 9 of the ONS' user guide to mortality statistics.³</p>
Cardiovascular diseases	<p>This term refers to the main collection of diseases that impact the heart and circulation.</p> <p>In this report, we use it specifically to refer to the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) category of 'Diseases of the circulatory system' (ICD 100-199), which is used for the reporting of diseases on death statistics in England, and the basis for the disease coding in OHID's excess mortality tool.</p> <p>When this term is used it contains diseases including, ischaemic heart diseases, heart failure, and cerebrovascular diseases (stroke)⁴.</p> <p>This definition does, however, exclude other cardiovascular-related diseases, such as cardiovascular conditions originating in the perinatal period, congenital heart disease, vascular dementia, and neoplasms (cancers) of the circulatory system, which are not included in ICD codes 100-199.</p>
Year of the pandemic	<p>For the national-level data (for which OHID provides weekly data), these represent 12-month groupings of OHID's data from the onset of their reporting on 21st March 2020.</p> <p>For the regional-level data (for which OHID provides 4-5 week groupings of data), these are <i>roughly</i> 12-month groupings from the onset of OHID's reporting on 21st March 2020. The national and region-level 'years of the pandemic' are thus closely aligned, but not identical, and this is discussed in more detail in section 2.5.</p>
Mortality displacement	<p>According to the Office for National Statistics:</p> <p><i>"Mortality displacement is a phenomenon by which a period of high mortality can be followed by below-average mortality. Mortality displacement occurs when vulnerable people, such as older people and those who already had medical conditions, die sooner than expected. Therefore, these individuals are not dying in the following days, weeks, or months, where they would likely have died, potentially leading to a lower-than-average period of mortality."</i>⁵</p>

³ Office for National Statistics, 2022. User guide to mortality statistics. Available from: <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/methodologies/userguidetomortalitystatisticsjuly2017#cause-of-death-coding>

⁴ The 11th and most recent version of the International Statistical Classification of Diseases reclassifies cerebrovascular diseases as 'Diseases of the nervous system', but this version is not yet in use in England.

⁵ Office for National Statistics. 2022. Excess mortality and mortality displacement in England and Wales: 2020 to mid-2021. Available from: <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/articles/excessmortalityandmortalitydisplacementinenglandandwales/2020tomid2021>

Introduction

In November 2022, we released [Tipping Point](#), which included analysis of the Office for Health Improvement and Disparities' (OHID) excess mortality data⁶ and highlighted that there had—at that point in time—been around 30,000 excess deaths involving ischaemic heart disease (IHD) in England since the onset of the pandemic. In the report, we argued that, after the first year of the pandemic in England, persistently high levels of excess deaths involving IHD could not be explained entirely by acute Covid-19 infection. Instead, we suggested that persistently high levels of excess deaths involving IHD were also likely explained, in part, by extreme and continuing disruption to the national health service, alongside long-term cardiovascular complications of prior Covid-19 infection.

In light of nearly a year's more data on excess deaths from the Office for Health Improvement and Disparities (OHID), along with data now available for a broader disease category of 'cardiovascular diseases' from OHID, we re-examined excess deaths in England since the onset of the pandemic. As of June 2023, there have been nearly 100,000 excess deaths in England involving IHD or other cardiovascular diseases (CVD).

The primary purpose of this document is to explain what we mean when we say there have now been nearly 100,000 excess deaths involving CVD in England since the onset of the Covid-19 pandemic. It will also shine light on two key findings of our analysis: 1) that acute Covid-19 infection does not appear to explain even a third of excess deaths involving CVD in the most recent year of the pandemic, and 2) that excess deaths involving CVD outnumber excess deaths involving other individual disease areas (excluding Covid-19 deaths) reported by OHID since the onset of the pandemic in England.

Considered alongside other concerning indicators of CVD mortality in England (particularly premature mortality rates, which are also presented in this analysis), these findings warrant further attention, both to understand why they may be occurring, and to encourage action to help remedy this troubling picture of CVD mortality in England. To that end, supplementary analysis is provided in the appendix of this document that highlights the geographic and demographic dimensions of excess deaths involving CVD in England since the onset of the Covid-19 pandemic.

Undoubtedly, the drivers of continuingly high levels of excess deaths involving CVD in England are complex and multifactorial, and this analysis cannot offer certainty as to whether an *individual* factor plays an outsized role in driving these excess deaths. Nonetheless, the discussion section of this document includes references to several factors that are hypothesised to have contributed to continuingly high levels of excess deaths involving CVD in England. These include: epidemiological factors relating to direct and indirect consequences of Covid-19 infection; extreme disruption to the healthcare service stemming from the pandemic; changing patient behaviour; and poorer wider population

⁶ Office for Health Improvement and Disparities. 2023. Excess mortality in England and English regions. Available from: <https://www.gov.uk/government/statistics/excess-mortality-in-england-and-english-regions>

health in England in the years preceding, and since the onset of, the Covid-19 pandemic in England.

Finally, it is important to acknowledge that, whilst 'excess deaths' are an aggregate measure designed to help understand trends in mortality following disruptive events (like the Covid-19 pandemic), each of the deaths presented in the totals of this analysis represents an individual who has sadly died. Describing deaths above a certain volume as 'excess' does not mean that deaths at, or below, these volumes are in any way lesser for those who die or for their loved ones. However, using 'excess deaths' to highlight how mortality volumes have changed since the onset of the Covid-19 pandemic is an important step in drawing attention of researchers and policymakers to trends in mortality that are having a real impact. It is our hope that doing so will encourage both further research to better understand the drivers of this concerning trend, and policy interventions to help bring an end to higher-than-expected levels of deaths involving CVD.

Section 1: Trends in CVD deaths

1.1. Excess deaths involving CVD in England

The following figures compare deaths involving CVD, referring to those where CVD (ICD-10 I00-I99) is mentioned anywhere on the death certificate; and 'deaths where the underlying cause was Covid-19, where CVD was also mentioned on the death certificate', which shows the number of deaths involving CVD (any mention on the death certificate) where Covid-19 was listed as the underlying cause of death (see Glossary for more information).

Figure 1 - Excess deaths in England involving CVD (any mention on death certificate), compared to deaths in England where the underlying cause was Covid-19, where CVD was also mentioned on the death certificate

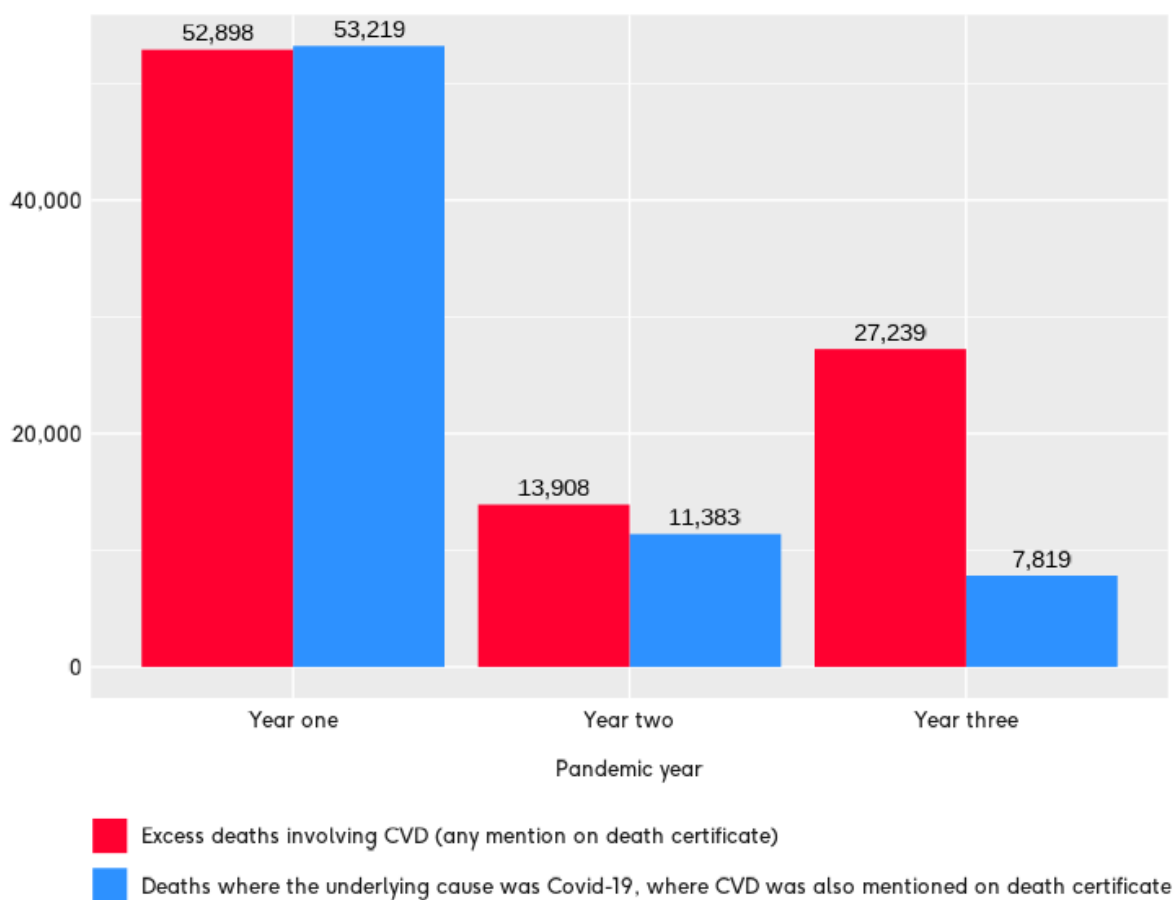


Figure 1: Key findings

Figure 1 shows the number of excess deaths involving CVD (any mention of the death certificate) compared to the number of deaths where Covid-19 was listed as the underlying cause of death and where CVD was also mentioned on the death certificate. Data are displayed for the first three years of the pandemic in England.

- Of the total 96,540 excess deaths involving CVD in England since the onset of the pandemic, more than 50% occurred in the first year of the pandemic alone.
- Excess deaths involving CVD dropped significantly in the second year of the pandemic, but then rebounded in the third year of the pandemic, where there were around 13,000 more excess deaths involving CVD than in the preceding second year.
- In the third year of the pandemic, the number of excess deaths involving CVD outnumbered the number of deaths involving CVD where Covid-19 was the underlying cause by around 19,400 deaths.

Figure 1: Further observations

Figure 1 compares excess deaths involving CVD, referring to those where CVD (ICD-10 I00-I99) is mentioned anywhere on the death certificate; and deaths where the underlying cause was Covid-19 where CVD was *also* mentioned on the death certificate. Data is displayed for the first three years of the pandemic in England, with the current fourth year excluded due to limited data available at this time.

Of the total 96,540 excess deaths involving CVD in England since the onset of the pandemic, more than 50% occurred in the first year of the pandemic alone (Figure 1). In the first year of the pandemic, the number of excess deaths involving CVD (n=52,898) was highly similar to the number of deaths where Covid-19 was the underlying cause of death where CVD was also mentioned on the death certificate (n=53,219). In the second year of the pandemic, volumes of both these measures were significantly lower than the first year of the pandemic, but the volumes of excess deaths involving CVD (n= 13,908) exceeded the number of deaths involving CVD where Covid-19 was the underlying cause of death (n=11,383) by around 2,500 deaths.

Notably, in the third year of the pandemic, the number of excess deaths involving CVD (n=27,239) increased significantly compared to the second year of the pandemic, whilst the number of deaths involving CVD where Covid-19 was the underlying cause of death (n=7,819) fell again compared to the previous year. Likewise, the gap between these two measures also grew in the third year of the pandemic, with the number of excess deaths involving CVD outnumbering the number of deaths involving CVD where Covid-19 was the underlying cause by around 19,400 deaths.

Figure 4 - Excess deaths in England involving CVD (any mention on death certificate), compared to deaths where the underlying cause was Covid-19 and where CVD was also mentioned on the death certificate

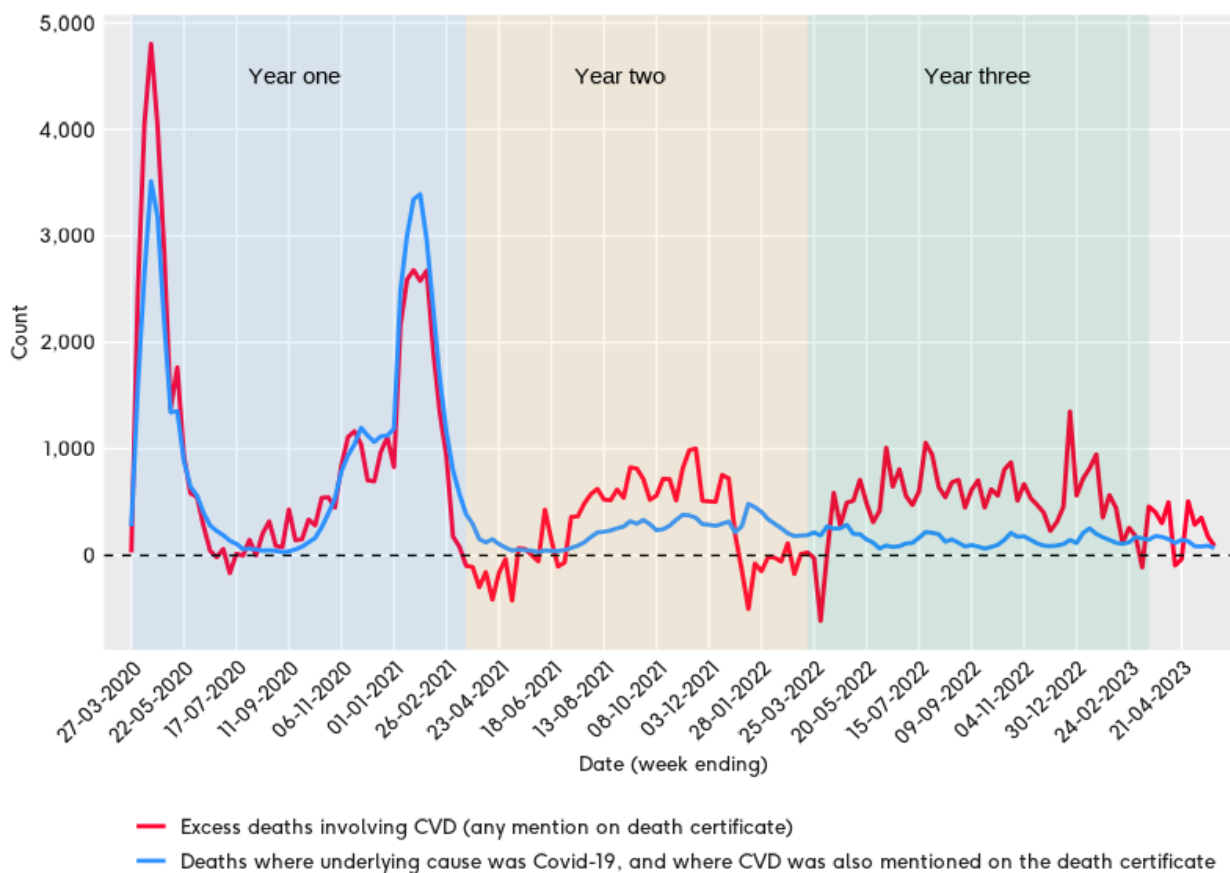


Figure 2 – Key findings:

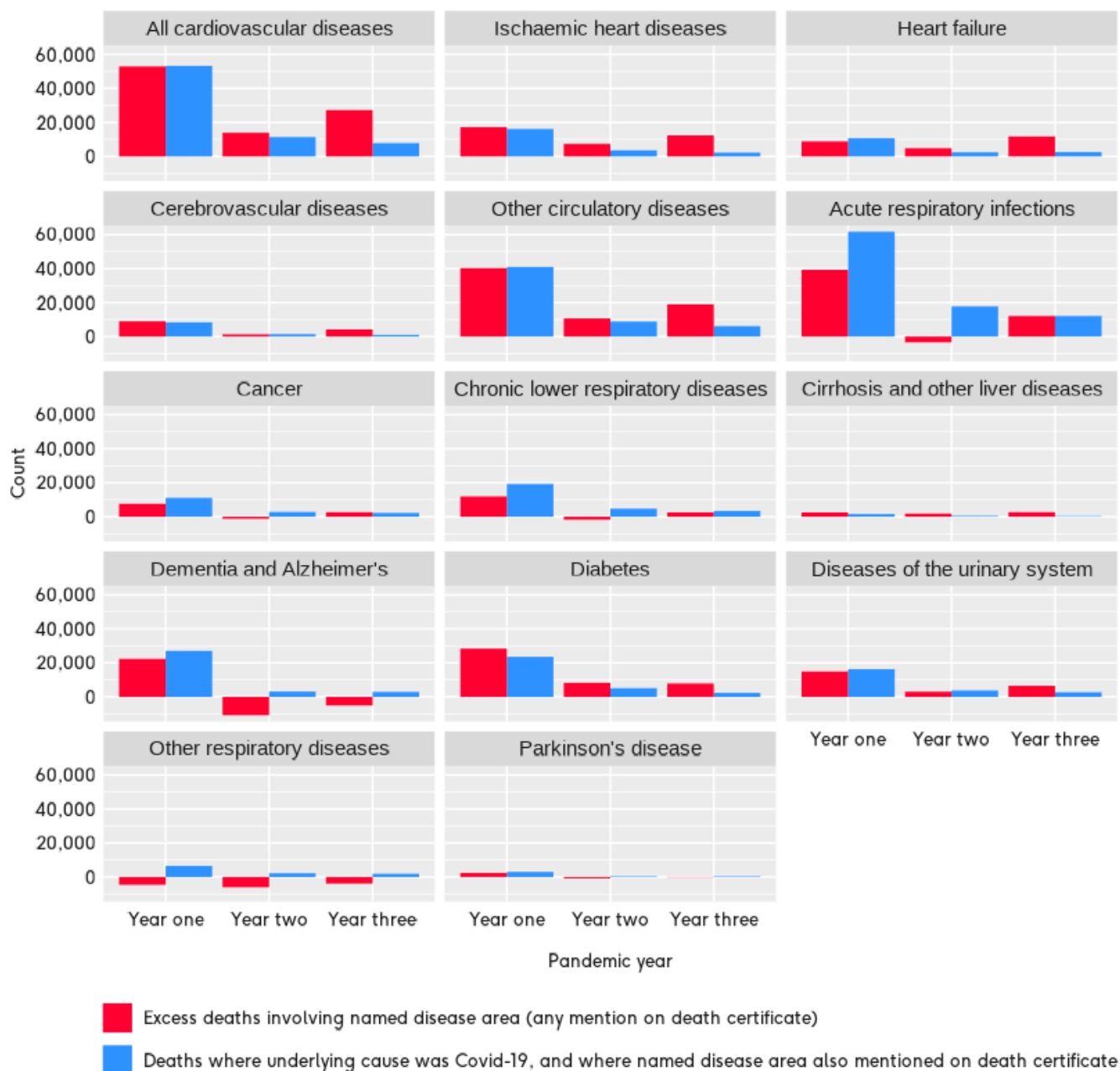
- In the first year of the pandemic, there is a clear association, on a week-by-week level, between excess deaths involving CVD, and deaths involving CVD where Covid-19 was the underlying cause of death.
- This association appears to weaken in the second year of the pandemic, and this continues into the third year of the pandemic.

Figure 2 – Further observation

If we examine the excess deaths data at a more granular time-series level, as Figure 2 displays, further observations can be made. First, in the first year of the pandemic, there is a clear association between the weekly number of excess deaths involving CVD and the reported numbers of weekly deaths involving CVD where Covid-19 was the underlying cause of death. Please note, however, the discussion section at the end of this analysis, which examines potential reasons for the gap between the two measures seen at the beginning of the first year of the pandemic. Secondly, Figure 2 also makes clear that the association between these two measures decreases from the second year of the pandemic onwards, with the lines representing the two measures no longer tracking each other closely.

1.2. Excess deaths involving CVD compared to excess deaths involving other disease areas

Figure 7 - Excess deaths in England involving major disease areas (any mention on death certificate), compared to deaths where the underlying cause was Covid-19 and where named disease area was also mentioned on the death certificate



Notes:

- Please see the Appendix for a full list of ICD-10 codes used for Figure 3, and also note that 'All cardiovascular diseases' includes the ICD-10 codes for 'Cerebrovascular diseases', 'Heart failure', 'Ischaemic heart diseases', and 'Other circulatory diseases'.
- Cardiovascular diseases are displayed first in order of ICD-10 codes, with other disease areas then displayed in alphabetical order.

Figure 3 – Key findings:

- Generally, excess deaths were highest across disease areas in the first year of the pandemic, fell in the second year, and rebounded in the third year.
- Deaths where Covid-19 was the underlying cause of death have generally fallen year-on-year across disease areas.
- In every year of the pandemic, there have been more excess deaths involving CVD than excess deaths involving other disease groups in this analysis.

Figure 3 – Further observations:

Figure 3 displays the numbers of excess deaths involving major diseases areas (any mention on death certificate) alongside the numbers of deaths involving these disease areas where Covid-19 was the underlying cause of death, according to pandemic year in England.⁷ This gives a comparative view of how volumes of excess deaths have differed by disease area (any mention of death certificate), but also an indication as to how much excess deaths have potentially been driven by deaths from acute Covid-19 infection, and how this varies by major disease area.

Generally, excess deaths were highest across most disease areas in the first year of the pandemic, fell in the second year, and then rebounded to varying degrees in the third year of the pandemic (Figure 3). Deaths where Covid-19 was the underlying cause of death have, however, generally fallen year-on-year across disease areas. Cardiovascular disease follows these patterns, but there are important differences compared to other major disease areas.

Notably, in every year of the pandemic, there have been more excess deaths involving CVD than excess deaths involving any disease group contained in the OHID data. Second, there have been excess deaths involving CVD (i.e. more deaths than expected under OHID's calculations) in every year of the pandemic. This is not the case for other disease areas, including acute respiratory infections, cancer, and dementia. Finally, in the third year of the pandemic, there is a larger gap between the number of excess deaths involving CVD and number of deaths involving CVD where Covid-19 was the underlying cause, than there is for other disease areas.

⁷ Please note that due to the limited data available for the current 'Year four' of the pandemic, and the difficulties displaying this clearly in a faceted bar chart for all diseases, 'Year four' has been excluded from this visualisation. Please use the OHID Excess Mortality tool to view these data.

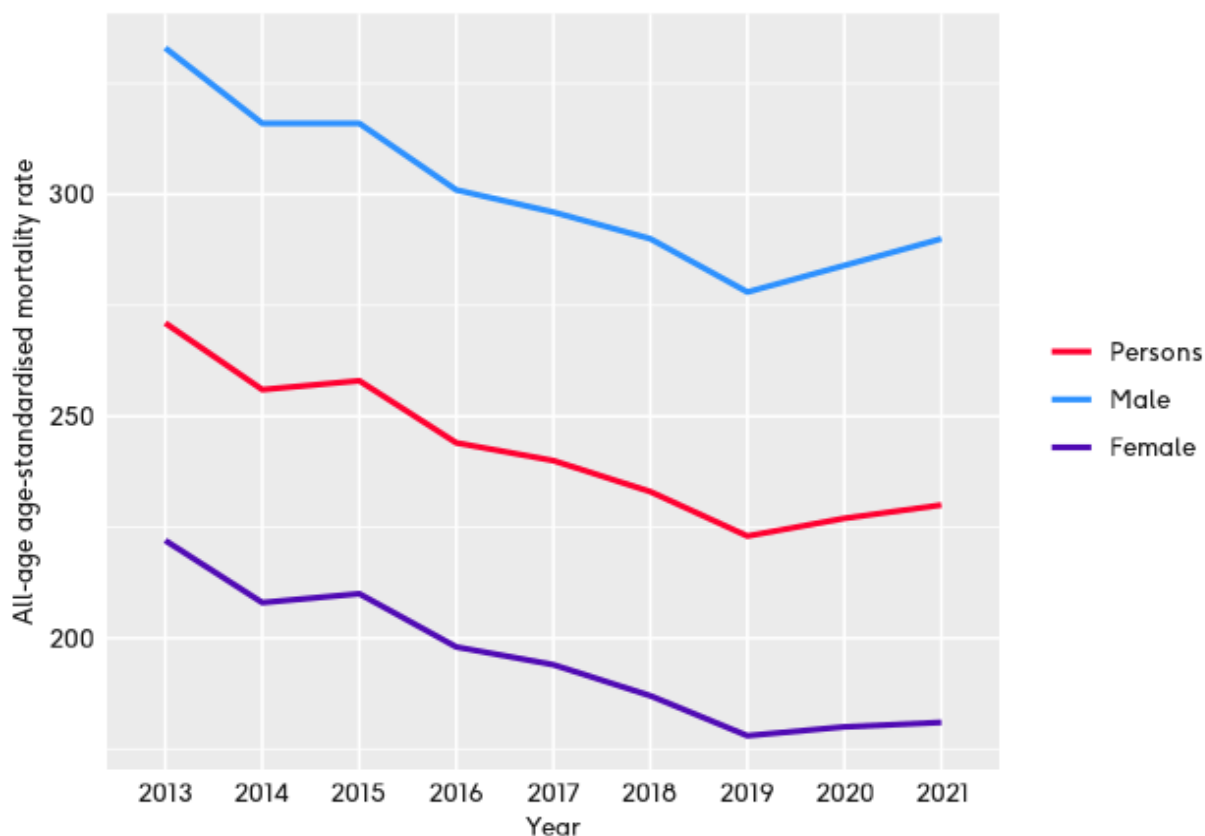
1.3. Age-standardised mortality rates

It is helpful to contextualise excess deaths alongside other measures of CVD mortality. In particular, it is useful to examine how age-standardised mortality rates (ASMR) for CVD have changed since the onset of the Covid-19 pandemic. ASMRs are useful because they control for the impact of age on mortality levels (including the frequency of deaths in different age brackets, and how these age brackets change in size over time). They are also beneficial in helping to hone in more precisely on the impact of CVD as a driver of mortality because they also represent deaths where cardiovascular disease was the underlying cause.

The following graphs show all-age and premature (under 75) age-standardised mortality rates from CVD (ICD-10, I00-I99) in England over the last twenty years (Figures 4 and 5).

Figure 10 - All-age age-standardised mortality rate per 100,000 from cardiovascular diseases (underlying cause of death) in England, 2013 to 2021

Source: Office for National Statistics



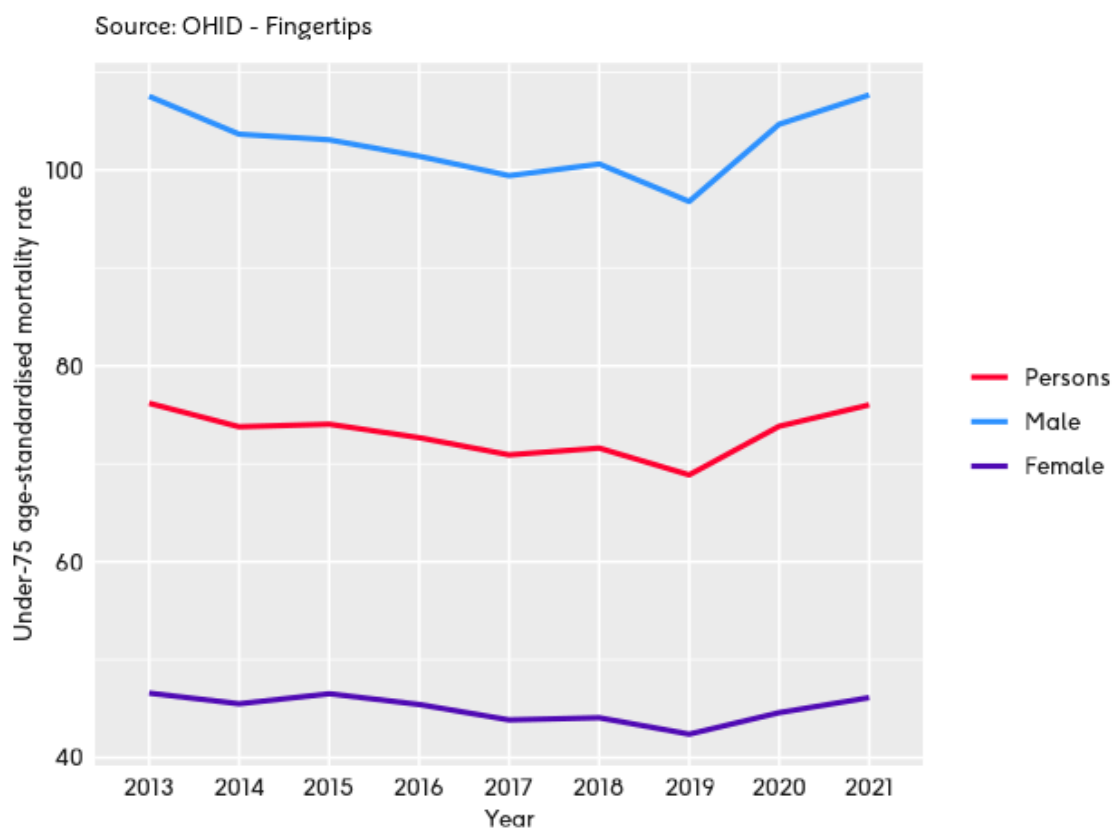
Notes:

- Pre-2021 data may be revised following the latest census.

Figure 4 – Key findings:

- All-age ASMRs from cardiovascular disease have increased since 2019.
- The increases in all-age ASMRs from cardiovascular disease have occurred across both sexes but have been larger for males than females.

Figure 13 - Under-75 age-standardised mortality rate per 100,000 from cardiovascular diseases (underlying cause of death) in England, 2013 to 2021



Notes:

- Pre-2021 data may be revised following the latest census.

Figure 5 – Key findings:

- Under-75 ASMRs for cardiovascular disease have increased since 2019, and are now at their highest levels since 2013 for both sexes.
- The increase in under-75 ASMRs for cardiovascular disease has been larger for males than females.

Figures 4 and 5 – Further observations:

Figures 4 and 5 show that ASMRs from CVD have increased since 2020, both for all-age mortality, and—particularly—premature mortality. This is the case for both sexes, but with larger observed increases for males than females. This points to a general worsening in CVD outcomes during 2020 and 2021, particularly amongst the under-75s, where the ASMR for CVD increased from 68.9 in 2019 to 73.8 in 2020, and to 76.0 in 2021. These represent a return to levels of premature ASMRs from CVD not seen since 2013 and suggest a need to better understand and address the factors driving these trends.

1.4. Age and Geographic Region

OHID also make data on excess mortality by cause available at a regional level, and have also produced a bespoke cut of the data that makes it possible to examine excess deaths by

age and cause (albeit for a shorter time period, up to 30th December 2022).⁸ Whilst a full analysis of these data is outside the scope of this document, a brief analysis of these datasets is provided in the Appendix, and at this point it is worth highlighting some of the top-line trends from these.

The national trends seen in excess deaths involving CVD are generally borne out at a regional level, with excess deaths involving CVD highest in the first year of the pandemic, lowest in the second year, and rebounding in the third year, in eight of the nine regions of England. In every region, the number of deaths involving CVD where the underlying cause was Covid-19 has also declined with each subsequent year of the pandemic. However, there is some variation in how badly different regions have been impacted by excess deaths involving CVD, including when controlling for population size.

In the period for which data are available (21st March 2020 to 30th December 2022), excess deaths involving CVD were concentrated amongst the over-45s (86,696 deaths) compared to 2,452 amongst those under 45 (Appendix – A.2). However, in this period there were almost as many excess deaths involving CVD amongst people aged 45-74 (n=43,023) as there were amongst people aged 75 and over (n=43,673).

⁸ Please note that whilst OHID also produce data on excess mortality by ethnicity and area deprivation. However, they do not make this available by cause, and subsequently we cannot comment on these areas in relation to excess deaths involving CVD.

Section 2: Statistical methodology

2.1. Calculating 'excess deaths'

There are a number of different approaches to calculating 'excess deaths', but in essence all approaches have to establish an 'expected' number of deaths (usually based on historic mortality levels), to which 'actual' deaths can be compared. Any registered deaths above the number of expected deaths represent 'excess deaths'. In England, the two main sources of excess death statistics are the Office for National Statistics (ONS) and the Office for Health Improvement and Disparities (OHID).

ONS calculate excess mortality by comparing the number of registered deaths in a given week with average number of deaths registered in the equivalent week in five preceding years but excluding 2020 (i.e. for expected deaths in 2022, the five-year average used is 2016-2019 plus 2021).^{9,10} In contrast, OHID's approach—which is outlined in detail in the methodology paper¹¹ that accompanies their public-facing tool—compares the number of registered deaths in a week with the number of expected deaths based on trends in mortality rates from 2015 to 2019. This has the advantage of taking into account changes in population size and structure (particularly, changing age profiles). Because of these controls for changing population structure over time, as in *Tipping Point*, we have opted to use OHID data for the analysis in this document. These data are sourced from OHID's public-facing excess mortality tools, with the national tool used to source England-wide data, and the regional tool used to source the regional data analysed in this document.

2.2. Broadening the analysis of excess deaths involving 'ischaemic heart disease' to 'cardiovascular disease'

In *Tipping Point*, we focussed our analysis on excess deaths involving IHD (ICD-10 I20-I25). At the time of publication, the total number of estimated excess deaths for cardiovascular disease (ICD-10 I00-I99) was not publicly available. OHID's Excess Mortality tool did, at the time, provide estimates of excess mortality for other cardiovascular conditions, such as cerebrovascular diseases (ICD-10 I60-I69), alongside IHD. However, combining these data to arrive at a total number of excess deaths involving CVD would have been inaccurate, as it would have resulted in 'double counting' deaths where multiple cardiovascular conditions appeared on one person's death certificate. As an alternative, we used IHD—the single largest cause of mortality in England within the broader disease grouping of cardiovascular

⁹ Office for National Statistics, 2023. Monthly mortality analysis, England and Wales: December 2022. Available from:

<https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/monthlymortalityanalysisenglandandwales/december2022#excess-mortality-in-england-and-wales>

¹⁰ Office for National Statistics, 2023. Deaths registered weekly in England and Wales – Provisional. Available from:

<https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsregisteredweeklyinenglandandwalesprovisional/weekending31march2023>

¹¹ Office for Health Improvement and Disparities, 2022. Excess Mortality in England: Methodology. Available from: <https://fingertips.phe.org.uk/documents/EMMethodology.pdf>

diseases¹²—as a demonstrative example of the continuingly high levels of excess deaths involving heart and circulatory diseases in England since the onset of the Covid-19 pandemic.

As of the release of an updated tool from OHID in December 2022, it is possible to analyse excess deaths involving all cardiovascular diseases (ICD-10 I00-I99), enabling us to take a broader perspective on excess deaths as they relate to cardiovascular disease. Using this updated analysis explains why the figure for excess deaths we are using now is significantly larger than what we presented following the release of *Tipping Point* in November 2022. Though, it should be noted that excess deaths from ischaemic heart disease have also increased, from around 30,000 at the time of *Tipping Point*'s publication, to over 38,000 at the time of this document's publication (see Appendix for additional analysis).

2.3. Alternative indicators of CVD mortality trends: age-standardised mortality rates

In addition to the data presented relating to excess mortality, in Section 1.3. we present analysis of age-standardised mortality rates (all-age and under-75s) using data sourced from ONS and OHID. This is provided to contextualise the excess mortality data alongside other indicators of CVD mortality, and to help account for some of the limitations of excess mortality as a measure of mortality.

2.4. Statistical analysis

Analysis of the data was conducted using R,¹³ and figures were produced using ggplot2.¹⁴

2.5. Notes on classifying 'years of the pandemic'

Throughout this analysis, we break down the pandemic into four time periods, to aid in examining how the trends around excess deaths involving cardiovascular disease in England have changed over the course of the pandemic. To do so, we have opted to use a custom time-period grouping called 'year of the pandemic'. These are 12-month groupings of the OHID data,¹⁵ as outlined in Table 1. It should be noted that, because OHID reports national and regional excess mortality using different time periods (weekly data for national excess mortality, and approximately monthly groupings of data for regional excess mortality), the time periods covered by the national and regional years of the pandemic differ slightly. Thus, regional totals may not exactly match totals for the national figures, for equivalent years of the pandemic. It should also be stressed that the data for the most recent year, 'Year four', is incomplete and—at the time of publication—only covers a period of around nine weeks for the national data.

¹² British Heart Foundation, 2023. Heart & Circulatory Disease Statistics 2023. Available from: <https://www.bhf.org.uk/what-we-do/our-research/heart-statistics/heart-statistics-publications/cardiovascular-disease-statistics-2023>

¹³ R Core Team. 2022. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>

¹⁴ H. Wickham, 2016. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

¹⁵ OHID groups data in the Excess Mortality tool into weekly reporting periods for the national data, and roughly month-long reporting periods for the regional data, and these do not exactly align with the 365-day calendar year. Thus 'pandemic year' groupings in this analysis are each slightly larger than one full calendar year.

This means that ‘Year one’ captures the first 12-months of the pandemic in England, which contains the entire period before the vaccine programme was rolled out to the people most at risk from acute Covid-19 infection (through December 2020). Additionally, year one includes the 12-month period in which there was the highest mortality from (or involving) Covid-19 infection, with mortality from (or involving) Covid-19 infection never again reaching—at the time of publication—the levels seen in this initial 12-month period.¹⁶ It should be noted, however, that many people have continued to tragically die from or with Covid-19 infection in subsequent years of the pandemic, and that the pandemic continues to place significant strain on the health service, both in terms of the numbers of patients in hospital with Covid-19,¹⁷ and higher than levels of staff sickness compared to the era before the pandemic,¹⁸ to which Covid-19 infection is still a significant contributing factor.¹⁹

Table 1 – ‘Pandemic year’ definitions

Pandemic Year	National data	Regional data
Year one	21 st March 2020 to 19 th March 2021 (363 days)	21 st March 2020 to 2 nd April 2021 (377 days)
Year two	20 th March 2021 to 18 th March 2022 (363 days)	3 rd April 2021 to 22 nd April 2021 (384 days)
Year three	19 th March 2022 to 17 th March 2023 (363 days)	23 rd April 2022 to 28 th April 2023 (270 days)
Year four	18 th March 2023 to 26 th May 2023	29 th April 2023 to 26 th May 2023

2.6. Limitations of excess deaths

Finally, it is important to recognise that whilst ‘excess deaths’ are a useful measure of trends in mortality following disruptive events like the Covid-19 pandemic, they are not without limitations and several factors should be considered when interpreting the data in this analysis. Firstly, excess deaths are a modelled population-level measure. There is no way, for instance, to establish whether an individual would have died or not under usual circumstances (i.e., had the pandemic never occurred). Likewise, calculating ‘excess deaths’

¹⁶ UK Government, 2023. Coronavirus Dashboard. Available from:

<https://coronavirus.data.gov.uk/details/deaths?areaType=nation&areaName=England>

¹⁷ NHS England, 2023. Covid-19 Hospital Activity. Available from:

<https://www.england.nhs.uk/statistics/statistical-work-areas/covid-19-hospital-activity/>

¹⁸ NHS England, 2023. NHS Sickness Absence Rates. Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/nhs-sickness-absence-rates>

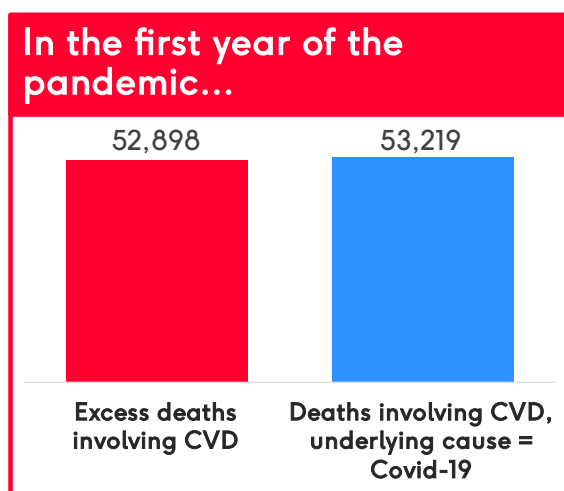
¹⁹ NHS England, 2023. Urgent and Emergency Care Daily Situation Reports 2022-23 - COVID daily sitrep time series. Available from: <https://www.england.nhs.uk/statistics/statistical-work-areas/uec-sitrep/urgent-and-emergency-care-daily-situation-reports-2022-23/>

requires a baseline number of deaths to use as a comparison to the actual number of registered deaths, and there is no perfect method for calculating how many people would have died under normal circumstances.

Section 3: What is driving the trends and patterns?

3.1. Association between excess deaths involving CVD and deaths involving CVD where Covid-19 was the underlying cause of death

In the first year of the pandemic in England, data suggests that excess deaths involving CVD were largely driven by deaths involving CVD where the underlying cause was acute Covid-19 infection. This is indicated by the highly similar total volumes for each measure in this period (Figure 1). It is also suggested by the close agreement between the two measures visible when looking at the data in a weekly time series format (Figure 2), which shows how, in the first year of the pandemic, excess deaths involving CVD largely follow the pattern of deaths involving CVD where the underlying cause of death was Covid-19 infection.



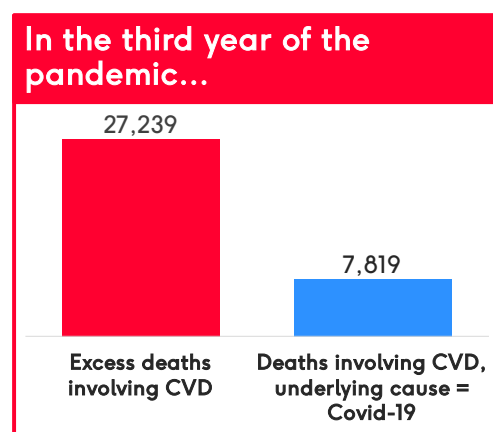
In the first months of the pandemic, excess deaths involving CVD appear to have outnumbered those where Covid-19 was the underlying cause (Figure 2). This can potentially be explained by the difficulty of diagnosing Covid-19 infection in this initial period of the pandemic, before widespread testing apparatus (such as PCR testing) was established and accessible for hospitals and the social care sector.²⁰ As some clinicians have posited, doctors may have been reluctant to include Covid-19 on death certificates in the absence of a test, even if the deceased had displayed Covid-19 symptoms.²¹ Hence, the number of Covid-19 related excess deaths involving CVD may be underreported in the first year of the pandemic (particularly in the initial months of the first year).

In the second year of the pandemic, there is a weaker agreement between excess deaths involving CVD and deaths involving CVD where Covid-19 was the underlying cause of death. Figure 1 highlights that excess deaths involving CVD outnumber deaths involving CVD where Covid-19 was the underlying cause of death by a figure of around 2,500, and the time series analysis in Figure 2 shows a weaker agreement between the two measures on a weekly-basis. Therefore, even if every death involving CVD where Covid-19 was the underlying cause of death represented an excess death (i.e. one that would not have happened without the disruptive event of the pandemic), then there would still be around 2,500 excess deaths involving CVD that could not be attributed to acute Covid-19 infection.

²⁰ Briggs, A., Jenkins, D., & Fraser, C. 2020. NHS Test and Trace: the journey so far. Health Foundation. Available from: <https://www.health.org.uk/publications/long-reads/nhs-test-and-trace-the-journey-so-far>

²¹ Oliver, D. 2021. David Oliver: Mistruths and misunderstandings about covid-19 death numbers. BMJ, 372. <https://doi.org/10.1136/bmj.n352>

In the third, year of the pandemic, there is an even larger gap between the total number of excess deaths involving CVD and the number of deaths involving CVD where Covid-19 was the underlying cause of death (Figure 1), and on a week-by-week basis the close agreement between the two measures identified in the first year of the pandemic is no longer apparent (Figure 2). Indeed, from the data displayed in Figure 1, less than a third of excess deaths involving CVD can potentially be attributed to acute Covid-19 infection.



Together, these observations suggest that excess deaths involving CVD may have primarily been driven by deaths from acute Covid-19 infection in the first and—to a less extent—the second year of the pandemic. However, in the third year of the pandemic, less than a third of excess deaths involving CVD can potentially be attributed to acute Covid-19 infection, and there is consequently a need for further research to understand what is driving higher-than-expected numbers of deaths involving cardiovascular disease.

3.2. Potential factors contributing to high levels of excess deaths involving CVD

Inevitably, numerous factors have contributed to higher-than-expected numbers of deaths involving CVD since the start of the pandemic. While we cannot definitively outline whether one factor has more impact than another, we can note trends and draw out areas for further investigation. Some of the contributing factors include: the broader direct and indirect effects of Covid-19 infection on cardiovascular health; and pandemic-related disruptions to the national health service, including significant disruptions across primary, secondary, and urgent and emergency care; and changing health-seeking behaviours from the public.

3.2.1. Direct and indirect effects of Covid-19 infection

Acute Covid-19 infection was likely the primary driver of excess mortality involving CVD in the first year of the pandemic. This is unsurprising as an umbrella review of international research conducted during 2020 suggested that people living with heart and circulatory diseases were at significantly increased risk of severe outcomes (3.9 times higher) and death (2.7 times higher) directly from Covid-19. The review concluded that the presence of any cardiovascular risk factor or cardiovascular co-morbidity was a significant predictor of Covid-19 case fatality rate.²²

²² Report commissioned by Public Health England, Cardiovascular Risk Factors, Cardiovascular Disease and COVID-19: An Umbrella Review. 2021. Liverpool Centre for Cardiovascular Science, University of Liverpool. Available from: <https://www.healthcheck.nhs.uk/commissioners-and-providers/evidence/>

Furthermore, research shows there is a strong link between previous Covid-19 infection and a higher risk of adverse CVD outcomes, such as heart attacks or strokes, for around 12-18 months following infection.^{23,24 25} Though, it is important to note that most international studies report the risk of cardiovascular outcomes amongst people who were infected with early variants of Covid-19 before the roll-out of their respective vaccine programmes and before evidence-based treatments became available.²⁶ Early evidence suggests, however, that Covid-19 vaccination reduces the risk of major adverse cardiac events (including myocardial infarction and stroke) at least up to 6 months after subsequent Covid-19 infection.^{27, 28,29}

Given the high population exposure to Covid-19 infection,³⁰ the longer-term cardiovascular complications of Covid-19 infection may explain in part greater cardiovascular care needs and in turn be a contributing factor to the high numbers of excess deaths involving CVD since the onset of the pandemic. Further research is needed to better understand whether newer variants of SARS-CoV-2 have similar cardiovascular consequences, including in vaccinated populations.

3.2.2. Disruption to the health service

As outlined in our *Tipping Point* report, the impact of the pandemic on the health service across the whole patient pathway is likely a significant contributing factor in excess mortality involving CVD following the first year of the pandemic. The reasons subsequently listed are not exhaustive, but represent several factors relating to disruptions to the health service that have potentially contributed to the high levels of excess deaths involving CVD in England since the start of the Covid-19 pandemic.

²³ Wan EYF, Mathur S, Zhang R, et al. 2023. Association of COVID-19 with short- and long-term risk of cardiovascular disease and mortality: A prospective cohort in UK Biobank. *Cardiovasc Res*. <https://doi.org/10.1093/cvr/cvac195>

²⁴ Xie, Y., Xu, E., Bowe, B. et al. Long-term cardiovascular outcomes of COVID-19. 2022. *Nat Med* **28**, 583–590. <https://doi.org/10.1038/s41591-022-01689-3>

²⁵ Knight, R., Walker, V., Ip, S., Cooper, J. A., Bolton, T., Keene, S., Denholm, R., Akbari, A., Abbasizanjani, H., Torabi, F., Omigie, E., Hollings, S., North, T. L., Toms, R., Jiang, X., Angelantonio, E. D., Denaxas, S., Thygesen, J. H., Tomlinson, C., Bray, B., ... CVD-COVID-UK/COVID-IMPACT Consortium and the Longitudinal Health and Wellbeing COVID-19 National Core Study, 2022. Association of COVID-19 With Major Arterial and Venous Thrombotic Diseases: A Population-Wide Cohort Study of 48 Million Adults in England and Wales. *Circulation*, *146*(12), 892–906. <https://doi.org/10.1161/CIRCULATIONAHA.122.060785>

²⁶ Wan EYF, Mathur S, Zhang R, et al. 2023. Association of COVID-19 with short- and long-term risk of cardiovascular disease and mortality: A prospective cohort in UK Biobank. *Cardiovasc Res*. <https://doi.org/10.1093/cvr/cvac195>

²⁷ Jiang J, Chan L, Kauffman J, et al. 2023. Impact of Vaccination on Major Adverse Cardiovascular Events in Patients With COVID-19 Infection. *J Am Coll Cardiol*. *81* (9) 928–930. <https://doi.org/10.1016/j.jacc.2022.12.006>

²⁸ Kim Y, Huh K, Park Y, Peck KR, Jung J. 2022. Association Between Vaccination and Acute Myocardial Infarction and Ischemic Stroke After COVID-19 Infection. *JAMA*. *328*(9):887–889. <https://doi.org/10.1001/jama.2022.12992>

²⁹ Whittaker, H., Kallis, C., Wood, A., Bolton, T., Walker, S., Sheikh, A., ... & Quint, J. K. 2023. Risk of cardiovascular events following COVID-19 in people with and without pre-existing chronic respiratory disease. medRxiv, 2023-03. <https://doi.org/10.1101/2023.03.01.23286624>

³⁰ UK Government – Covid-19 England Summary. Available from: <https://coronavirus.data.gov.uk/>

Disruption to primary care services and secondary prevention activity

In the first year of the pandemic, there was seismic disruption to the primary care services involved in the prevention, diagnosis, and management of risk factors for cardiovascular disease, such as high blood pressure or raised cholesterol, which could be leading to additional cardiovascular events. While primary care has stayed open throughout every stage of the pandemic, consultations plummeted in the initial months,³¹ and the proportion of face-to-face appointments, which were largely replaced with remote care early in the pandemic, have still not returned to pre-pandemic levels.³² While remote care can have some benefits for some patients, and allowed for episodes of care to go ahead that would have been cancelled in the early stages of the pandemic, it reduces opportunities for case finding (detection of treatable cardiovascular disease risk factors) and making every contact count.

Notably, the NHS England Health Check Programme (offered to people aged 40-74, every five years, predominantly to detect the early signs of CVD) was also suspended during the initial months of the pandemic and only recovered to pre-pandemic levels of reach in Q2 (July-September) of 2022/23.³³ This is significant because reviews of the effectiveness of the NHS Health Check Programme show that NHS Health Check attendees have a significantly lower likelihood of hospital admissions for CVD and type 2 diabetes, death from CVD, and all causes of death over 1, 3, and 5 years after attendance, compared to people who have not attended.³⁴

In addition to detection and diagnosis, there has also been significant disruption to the routine management of CVD and its risk factors, particularly in the first year of the pandemic. All cardiovascular conditions which require an assessment by a healthcare professional suffered significant disruption, including hypertension, which is the leading modifiable risk factor for cardiovascular disease in the UK.³⁵

The NHS has made CVD prevention a key component of its recovery efforts and highlighted it as a system priority in all NHS Operational Planning Guidance issued since the pandemic began. Despite this prioritisation and focus, however, CVD prevention activity has still not recovered to pre-pandemic levels. For example, in March 2020, 67.5% of 18- to 79-year-olds with hypertension had their blood pressure treated to target. In March 2021, this fell to 46.1%,

³¹ Nuffield Trust, Primary Care Update, September 2021: <https://www.nuffieldtrust.org.uk/news-item/primary-care-1>

³² BHF analysis of NHS England – Appointments in General Practice data. Data available:

<https://digital.nhs.uk/data-and-information/publications/statistical/appointments-in-general-practice>

³³ Office for Health Improvement and Disparities, 2023. Fingers – Public Health Data, NHS Health Check.

Available from: <https://fingertips.phe.org.uk/>

³⁴ Compared to patients who have not received an NHS Health Check (OR=1), the odds ratio of the following, 5 years after a Health Check are: CVD hospital admission (OR=0.8); Type 2 diabetes admission (OR=0.53), CVD death (OR=0.54), and all-cause death (OR=0.53)

³⁵ Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019. (2021). Reference Life Table. Seattle, United States of America: Institute for Health Metrics and Evaluation (IHME).

showing the dramatic disruption from the pandemic to routine care. By December 2022, the data shows a partial recovery to 60% treated to target.³⁶

More patients waiting longer for heart tests and procedures

By the end of April 2023, there were a record 389,266 people waiting for vital heart care such as having a stent or balloon inserted to reopen a blocked artery, open heart surgery, or valve replacement operations or waiting for diagnostics or outpatient care.³⁷ This is a 67% increase in the number of people waiting compared to the end of February 2020. A record 11,557 cardiac patients have been waiting for at least a year – 413 times higher than before the pandemic. Waiting times for a heart ultrasound, known as an echocardiogram (echo), remain at a stubbornly high level. As of April 2023, there were over 157,000 people waiting for an echo test. Furthermore, of those waiting for a diagnostic echocardiogram at the end of April 2023, well over a third (39%) had been waiting over six weeks, compared to just 4% at the end of Feb 2020.³⁸ Despite the NHS delivering a record number (1.61 million) of echocardiogram tests in 2022, diagnostic care for heart patients is still struggling to make up ground lost during the pandemic.

Studies show that long delays to vital tests, procedures, and operations can increase heart patients' risk of avoidable hospital admissions, disability from heart failure, and premature death.³⁹ Additionally, there are likely to be unmeasured adverse outcomes associated with prolonged waits for cardiac care, such as reduced quality of life or increased perioperative risk.⁴⁰

Delays to ambulance and other emergency services

Urgent and emergency care (UEC) services have been facing sustained pressure and a significant deterioration in performance standards since April 2021, which may also be contributing to levels of excess mortality involving CVD.

The performance target for ambulances to respond to a Category 2 call (those that are classed an emergency that may require rapid assessment or urgent, on-scene intervention like suspected heart attacks or strokes) is 18 minutes. In cardiac emergencies, like a heart

³⁶ NHS Benchmarking Network (2023) Data & Improvement Tool. Data available: <https://www.cvdprevent.nhs.uk/data-explorer>

³⁷ BHF analysis of NHS England Consultant-led Referral to Treatment Waiting times. Data available: <https://www.england.nhs.uk/statistics/statistical-work-areas/rtt-waiting-times/>

³⁸ The 6-week diagnostic waiting time standard was introduced in 2008 as a milestone target towards achieving the standard Referral to Treatment wait of 18 weeks in total. However, it now forms part of the NHS Constitution pledges about the care patients should receive.

³⁹ See for example: Roule, V., Rebouh, I., Lemaitre, A. *et al.* Impact of wait times on late postprocedural mortality after successful transcatheter aortic valve replacement. *Sci Rep* **12**, 5967 (2022). <https://doi.org/10.1038/s41598-022-09995-z>;

⁴⁰ Yates MT, Balmforth D, Kirmani BH, *et al.* A multi-centre prospective cohort study of patients on the elective waiting list for cardiac surgery during the COVID-19 pandemic. *Journal of the Royal Society of Medicine*. 2022;115(9):348-353. <https://doi.org/10.1177/01410768221089016>

attack, emergency service response time is critical – every minute the patient is not treated equates to potentially irreversible heart muscle damage which can lead to disability or premature death. The same holds true for stroke victims – for every minute that a stroke goes untreated, there are 1.9 million neurons in the brain that die.⁴¹

In the years leading up to the pandemic, although the 18-minute target was never met, performance was considerably stronger than what we have seen since summer 2021.⁴² Between April 2018 (when this target was introduced) and February 2020, the worst monthly average response time for Category 2 calls was 28 minutes.

Since the beginning of 2022, average ambulance response times for Category 2 calls in England have consistently been above 30 minutes. They even breached the 90-minute mark in December 2022. Ambulance waiting times show that it took over three and half hours to respond to 10% of Category 2 calls in December 2022. The national picture also masks incredible regional variation in Category 2 response times. For example, in December 2022 the average response time in the South East Coast was 46 minutes, which stands in stark contrast to the average response time in the East Midlands of 2 hours and 16 minutes.

Delays to ambulances are mirrored throughout the rest of the emergency pathway. National standards stipulate that patients arriving at an emergency department by ambulance should be handed over to A&E staff within 15 minutes, with none waiting more than 30 minutes. Almost 1 in 5 ambulance handovers experienced a delay of at least 30 minutes in 2021-22. Data from March 2023 shows a worsening situation, with 23.3% of ambulance handovers delayed by 30 minutes or more (with 9.3% delayed by 60 minutes or more).

These delays are a sign that the whole system is in crisis, and they have led to devastating consequences for patients. In January 2023, the Royal College of Emergency Medicine (RCEM) estimated that there were at least 300-500 excess deaths occurring across the UK each week due to long waits in A&E.⁴³ Furthermore, a clinical review carried out by the Association of Ambulance Chief Executives found that, in 2021, 80% of patients whose ambulance handover was delayed beyond 60 minutes experienced some level of harm (53% low harm, 23% moderate harm, and 9% severe harm).⁴⁴

⁴¹ Jeffrey L. Saver, 2005. Time is Brain – quantified, *Stroke* 37 (1), 263-266.

<https://doi.org/10.1161/01.STR.0000196957.55928.ab>

⁴² BHF analysis of NHS England, Ambulance Quality Indicators data. Data available from:

<https://www.england.nhs.uk/statistics/statistical-work-areas/ambulance-quality-indicators/>

⁴³ The RCEM figures are based on a scientific study published in the *Emergency Medicine Journal* which shows that for every 72 patients waiting between 8-12 hours from their time of arrival in the Emergency Department there is one death. Using this metric, RCEM estimates that there were 23,000 excess deaths in England in 2022 that can be linked with long waits in Emergency Departments. RCEM published their analysis in this long read: https://rcem.ac.uk/wp-content/uploads/2023/02/RCEM_Explains_long_waits_and_excess_mortality.pdf

⁴⁴ AACE, 2021. Delayed Hospital Handovers: impact assessment of patient harm, 2021. Available from: <https://aace.org.uk/wp-content/uploads/2021/11/AACE-Delayed-hospital-handovers-Impact-assessment-of-patient-harm-FINAL-Nov-2021.pdf>

According to NHSE, CVD is one of two primary drivers of this surge in UEC demand (the other being respiratory illnesses).⁴⁵ It is, therefore, reasonable to conclude that delays in this part of the pathway have led to avoidable harm coming to heart patients and premature death.

Changing patient behaviour and attitudes

The Covid-19 pandemic changed how patients interact with and view NHS services, and this is another factor that could be contributing to higher-than-expected levels of mortality involving CVD since the onset of the pandemic in England. During the first year of the pandemic, many patients faced a rapidly changing healthcare environment and had to make difficult choices about whether or how to continue their care. Surveys of patient experiences accessing care during this time typically show that a significant percentage of patients across disease areas deferred seeking treatment or avoided care settings altogether.⁴⁶

A BHF-commissioned poll of around 3,000 patients living with a heart or circulatory condition or risk factor about their experiences accessing care during the first year of the pandemic confirms this trend, showing that more than 66 per cent of those surveyed with a heart condition had put off accessing care despite their condition worsening, mostly due to fear of infection or not wanting to burden the NHS during a national emergency. A follow-up survey we commissioned with the same size patient pool shows this attitude persisted into the second year of the pandemic, with 43% of heart patients who needed medical care during this time continuing to defer treatment.⁴⁷

Delays to seeking and/or receiving medical care can result in poorer outcomes, including mortality, for a range of cardiovascular conditions,^{48,49,50} and hence some proportion of the higher-than-expected levels of deaths involving CVD seen since the start of the pandemic could potentially be attributed to patients avoiding seeking care as promptly as their symptoms warranted. Care deferment or avoidance was particularly visible early in the pandemic with regards to patients seeking care for heart attacks, with one study highlighting that, from February 2020 to the end of March 2020 only two-thirds of the expected number

⁴⁵ NHSE Board Meeting 1 December 2022: Item 7 (NHS Prevention). Available from:

<https://www.england.nhs.uk/wp-content/uploads/2022/11/221201-item-7-board-paper-prevention.pdf>

⁴⁶ Cancer Research UK, 2021. How has the pandemic affected people's help-seeking behaviour and attitudes?

Available from: <https://www.cancerresearchuk.org/health-professional/health-professional-news/how-has-the-pandemic-affected-peoples-help-seeking-behaviour-and-attitudes>

⁴⁷ The BHF commissioned YouGov to carry out two surveys on our behalf. The first was conducted online between 24 June and 3 July 2021, with a total sample size of 3,048 adults living with a heart or circulatory condition or risk factor. The second was conducted online between 21 July and 19 August, with a total sample size of 3,109 adults living with a heart or circulatory condition or risk factor.

⁴⁸ Raisi-Estabragh, Z., & Mamas, M. A. 2022. Cardiovascular health care implications of the COVID-19 pandemic. *Cardiology Clinics*, 40(3), 389-396. doi: <https://doi.org/10.1016%2Fj.ccl.2022.03.010>

⁴⁹ Bugiardini, R., Ricci, B., Cenko, E., Vasiljevic, Z., Kedev, S., Davidovic, G., ... & Badimon, L. 2017. Delayed care and mortality among women and men with myocardial infarction. *Journal of the American Heart Association*, 6(8), e005968. <https://doi.org/10.1161%2FJAHA.117.005968>

⁵⁰ Yafasova, A., Fosbøl, E. L., Johnsen, S. P., Kruuse, C., Petersen, J. K., Alhakak, A., ... & Butt, J. H. 2021. Time to thrombolysis and long-term outcomes in patients with acute ischemic stroke: a nationwide study. *Stroke*, 52(5), 1724-1732. <https://doi.org/10.1161/strokeaha.120.032837>

of patients with heart attacks were admitted to hospital, with researchers concluding that public concern about the virus may have put people off seeking urgent medical help even when experiencing symptoms of a heart attack.⁵¹

As we enter the fourth year of the pandemic, anecdotal evidence from the BHF Heart Helpline and patient focus group engagement continues to show that some heart patients are still deferring care or avoiding the NHS even when their condition appears to be deteriorating. Messaging from some NHS organisations in response to recent industrial action urging patients to use services wisely or stay away unless in case of emergency may have compounded patient fears.

3.2.3. Other factors

Aside from the direct and indirect effects of Covid-19 infection, and disruption to the health service, other factors may also have played a role in the high level of excess deaths involving CVD in England since the start of the pandemic. Notably, whilst some risk factors for cardiovascular disease have improved at a population level in recent years (particularly, declining smoking rates⁵²), other indicators are less positive. In particular, the prevalence of diabetes and obesity, which are both associated with increased risk of cardiovascular mortality,^{53, 54} have increased to historic levels over the course of the pandemic in England.^{55,56}

Additionally, reports of myocarditis and pericarditis have caused concern post Covid-19 vaccination. Covid-19 vaccine associated myocarditis has been rare, more common in young men after a second vaccine dose, and fortunately shows a favourable clinical course in the vast majority of those affected.⁵⁷ Myocarditis can cause heart scarring that can be detected with cardiac MRI – to mitigate the small chance of scarring causing a life-threatening arrhythmia in the future, it is likely that affected individuals will be offered long-term follow-up and monitoring.

Covid-19 illness can cause cardiac complications such as heart attacks, strokes, and cerebral thromboses but there is no evidence that vaccines lead to these cardiovascular

⁵¹ Mafham, M. M., Spata, E., Goldacre, R., Gair, D., Curnow, P., Bray, M., ... & Baigent, C. 2020. COVID-19 pandemic and admission rates for and management of acute coronary syndromes in England. *The Lancet*, 396(10248), 381-389. [https://doi.org/10.1016/S0140-6736\(20\)31356-8](https://doi.org/10.1016/S0140-6736(20)31356-8)

⁵² OHID – Fingertips, 2023. % active smokers (GP Patient Survey). Available from: <https://fingertips.phe.org.uk/>

⁵³ Laakso, M. 2010. Cardiovascular disease in type 2 diabetes from population to man to mechanisms: the Kelly West Award Lecture 2008. *Diabetes care*, 33(2), 442-449. <https://doi.org/10.2337%2Fdc09-0749>

⁵⁴ Lahey, R., & Khan, S. S. 2018. Trends in obesity and risk of cardiovascular disease. *Current epidemiology reports*, 5, 243-251. <https://doi.org/10.1007%2Fs40471-018-0160-1>

⁵⁵ OHID – Fingertips, 2023. Diabetes: QOF Prevalence (17+). Available from: <https://fingertips.phe.org.uk/>

⁵⁶ OHID – Fingertips, 2023. Percentage of adults (aged 18+) with body-mass index classified as obese. Available from: <https://fingertips.phe.org.uk/>

⁵⁷ Pillay J, Gaudet L, Wingert A, Bialy L, Mackie A S, Paterson D I et al. Incidence, risk factors, natural history, and hypothesised mechanisms of myocarditis and pericarditis following covid-19 vaccination: living evidence syntheses and review *BMJ* 2022; 378 :e069445 doi:10.1136/bmj-2021-069445

complications in either men or women.^{58,59} Between December 2020 and February 2023, the Medicines and Healthcare products Regulatory Agency have been notified of 72 UK deaths (all cause) suspected to be related to the Covid-19 vaccine (30 associated with the bivalent covid-19 Pfizer/BioNTech vaccine and 42 associated with the bivalent covid-19 vaccine Moderna).⁶⁰

Conclusion

In summary, since the onset of the pandemic, there have been nearly 100,000 excess deaths involving CVD in England. Whilst in the first year of the pandemic, the vast majority of these can likely be explained by acute Covid-19 infection, as the pandemic has continued the number of excess deaths involving CVD that can likely be attributed to acute Covid-19 infection has shrunk in each successive year. Indeed, in the third and most recent year of the pandemic (for which there is a full, 12-months of data), acute Covid-19 infection appears to account for less than a third of excess deaths involving CVD.

This analysis of data from OHID's Excess Mortality Tools has also highlighted that, unlike for any other major disease (any mention on the death certificate), deaths from cardiovascular disease remain in excess of what is expected 3 years on from the onset of the pandemic. Indeed, in every single year of the pandemic in England, there have been significantly more excess deaths involving CVD than there have excess deaths involving other disease groups presented in the OHID tool.

As this report highlights, multiple factors may underlie the persistent increase in cardiovascular excess deaths that we continue to see. More research will help establish the degree to which different factors are driving this concerning phenomenon. If we are to stop seeing excess deaths involving cardiovascular disease, we need concerted action.

⁵⁸ Jiang J, Chan L, Kauffman J, Narula J, Charney AW, Oh W, Nadkarni G; N3C Consortium. Impact of Vaccination on Major Adverse Cardiovascular Events in Patients With COVID-19 Infection. *J Am Coll Cardiol*. 2023 Jan 27;81(9):928–30. doi: [10.1016/j.jacc.2022.12.006](https://doi.org/10.1016/j.jacc.2022.12.006).

⁵⁹ Patone, M., Mei, X.W., Handunnethi, L. et al. Risks of myocarditis, pericarditis, and cardiac arrhythmias associated with COVID-19 vaccination or SARS-CoV-2 infection. *Nat Med* 28, 410–422 (2022). <https://doi.org/10.1038/s41591-021-01630-0>

⁶⁰ Medicines and Healthcare products Regulatory Agency, 2023. Coronavirus vaccine - summary of Yellow Card reporting. Available from: <https://www.gov.uk/government/publications/coronavirus-covid-19-vaccine-adverse-reactions/coronavirus-vaccine-summary-of-yellow-card-reporting>

Acknowledgements

The authors would like to extend their thanks to Charles Tallack (Director of Data Analytics at the Health Foundation) and Professor Obioha Chukwunyere Ukoumunne (Professor in Medical Statistics at the University of Exeter) for their review and comments on a draft version of this analysis. The authors would also like to acknowledge and thank Allan Baker, Justine Fitzpatrick, and Martin White from Office for Health Improvement & Disparities for their review and comments on a previous draft.

Appendix – ICD-10 cause of death reference codes

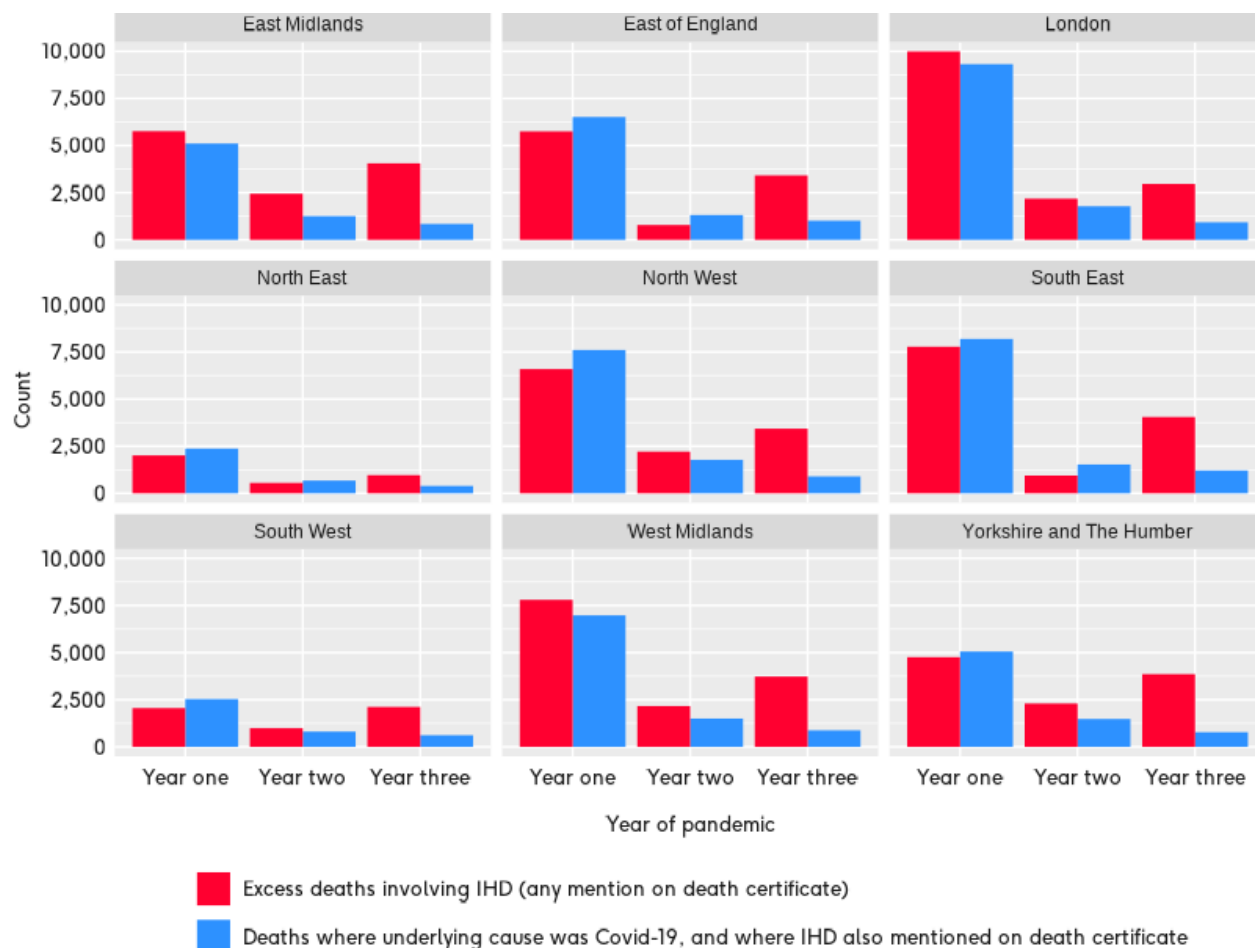
The following table is adapted from OHID's own methodology paper on excess mortality in England,⁶¹ and covers all the disease areas included in OHID's excess mortality dataset, and Figure 3 of this analysis.

Cause	ICD10 code
All cardiovascular diseases	All mentions of I00-I99
Ischaemic heart diseases	All mentions of I20-I25
Cerebrovascular diseases	All mentions of I60-I69
Other circulatory diseases	All mentions beginning with I (excluding I20-I25 and I60-I69)
Heart failure	All mentions of I11.0, I25.5, I42.0, I42.9, I50.0, I50.1, I50.9
Cardiovascular diseases	All mentions beginning with I
Cancer	All mentions of C00-C97
Acute respiratory infections	All mentions of J00-J22
Chronic lower respiratory diseases	All mentions of J40-J47
Other respiratory diseases	All mentions beginning with J (excluding J00-J22 and J40-J47)
Dementia and Alzheimer's	All mentions of F01, F03, or G30
Diseases of the urinary system	All mentions of N00-N39
Cirrhosis and other liver diseases	All mentions of K70-K76
Diabetes	All mentions of E10-E14
Parkinson's disease	All mentions of G20

⁶¹ Office for Health Improvement and Disparities, 2022. Excess Mortality in England: Methodology. Available from: <https://fingertips.phe.org.uk/documents/EMMethodology.pdf>

Appendix – Supplementary Analysis:

Figure 16 - Excess deaths involving IHD (any mention on death certificate) versus deaths involving IHD where Covid-19 was the underlying cause, by region and pandemic year in England



A.1. Regional impact – Analysis and Discussion

Similar trends as those identified at a national level are broadly observable at a regional level, if we analyse data from OHID’s regional excess mortality tool.

Figure 6 displays volumes of excess deaths involving CVD in the English geographic regions, compared to deaths involving CVD where Covid-19 was the underlying cause of death, broken down by years of the pandemic.⁶² In 8 out of the 9 regions, volumes of excess deaths involving CVD follow the national pattern of being highest in the first year of the pandemic, lowest in the second year, and with the third year seeing excess death volumes somewhere between the two. This is also true if we control for the differing population sizes of the various regions, and measure excess deaths as a ratio of registered-to-expected deaths involving

⁶² Please note that, as outlined in the glossary and section 1.4, due to differences in how OHID reports excess mortality data at national and regional levels, the time periods represented by the pandemic years differ slightly for the national and regional data.

CVD, as displayed in Figure 7. In both cases, the South West region is the exception to this trend, with the region having seen a similar number of excess deaths involving CVD in the third year of the pandemic as the first, possibly reflecting the relatively low number of Covid-19 deaths in the first year.

Figure 6 also shows that deaths involving CVD where Covid-19 was the underlying cause outnumbered excess deaths involving CVD in 6 out of the 9 regions in the first year of the pandemic (with London, West Midlands, and East Midlands the exceptions). Likewise, in the second year, excess deaths involving CVD outnumbered deaths involving CVD where Covid-19 was the underlying cause of death in 6 out of the 9 regions (with the East of England, North East, and South East the exceptions). In the final year of the pandemic, excess deaths involving CVD outnumbered deaths involving CVD where Covid-19 was the underlying cause of death in all nine regions.

Therefore, there is some observed divergence, at a regional level, from the observed national trend identified in Section 1.1, whereby there were more deaths involving CVD where Covid-19 was the underlying cause of death than excess deaths involving CVD in the first year of the pandemic, with this relationship reversing in the second year and third year of the pandemic. Though, as described in detail in Section 3, there is reason to believe that

Figure 19 - Ratio of registered to expected deaths involving CVD (any mention on death certificate), by region and year of pandemic



deaths involving CVD where the underlying cause was Covid-19 were undercounted in the first year of the pandemic (specifically, at the very beginning of the pandemic) due to the lack of established Covid-19 testing infrastructure. Given that London was impacted earliest of the nine regions by the Covid-19 pandemic, there is particular reason to believe this was the case in London, so this observation may not accurately reflect reality.

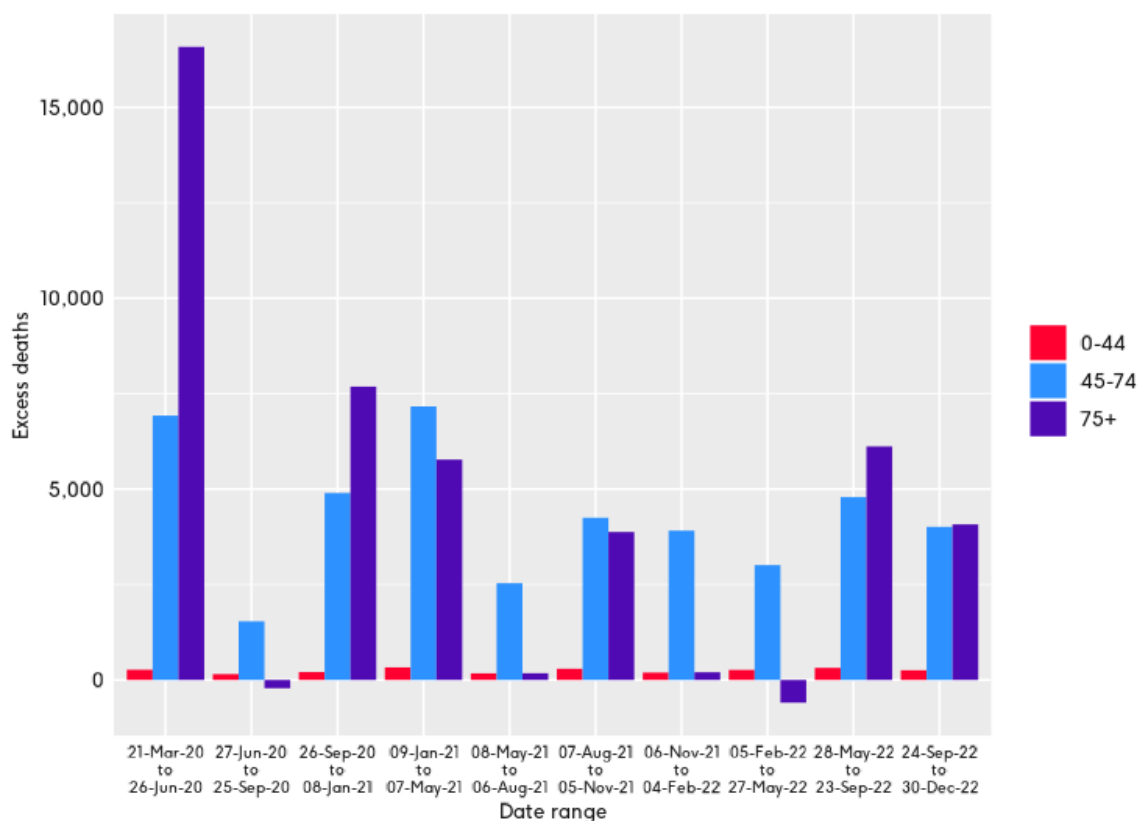
In summary, the regional analysis reveals a continuing issue of excess deaths involving CVD across all geographic regions in England, with the increase in excess deaths involving CVD in the third year of the pandemic compared to the preceding year making clear that this is very much an ongoing issue.

A.2. Age and excess deaths - Analysis

Data from OHID's bespoke cut of their excess mortality data for the period 21st March 2020 to 30th December 2022⁶³ can be used to examine the relationship between age and excess deaths involving CVD. Analysis of these data shows excess deaths involving CVD have been concentrated amongst the over-45s (n=86,696), and have been far more limited amongst people aged under 45 (n=2,452). Notably, however, in the period of 21st March 2020 to 30th December 2022, there were almost as many excess deaths involving CVD amongst people aged 45-74 (n=43,023) as there were amongst people aged 75 and over (n=43,673).

A time series analysis of the data, however, makes clear that whilst there have been similar numbers of excess deaths involving CVD amongst people aged 45-74 as those aged 75 and over across the entire reporting period, these groups have been affected by excess deaths differently over time. From March 2020 to early January 2021, excess deaths involving CVD amongst people aged 75 and over were significantly higher than for adults aged 45-74 (Figure 7). In contrast, the 45-74 age bracket has seen a more consistent number of excess deaths involving CVD across the course of the pandemic in England, compared to the 75+ age bracket.

Figure 22 - Excess deaths involving CVD (any mention on death certificate) in England, 21st March 2020 - 30th December 2022, by age group and time period



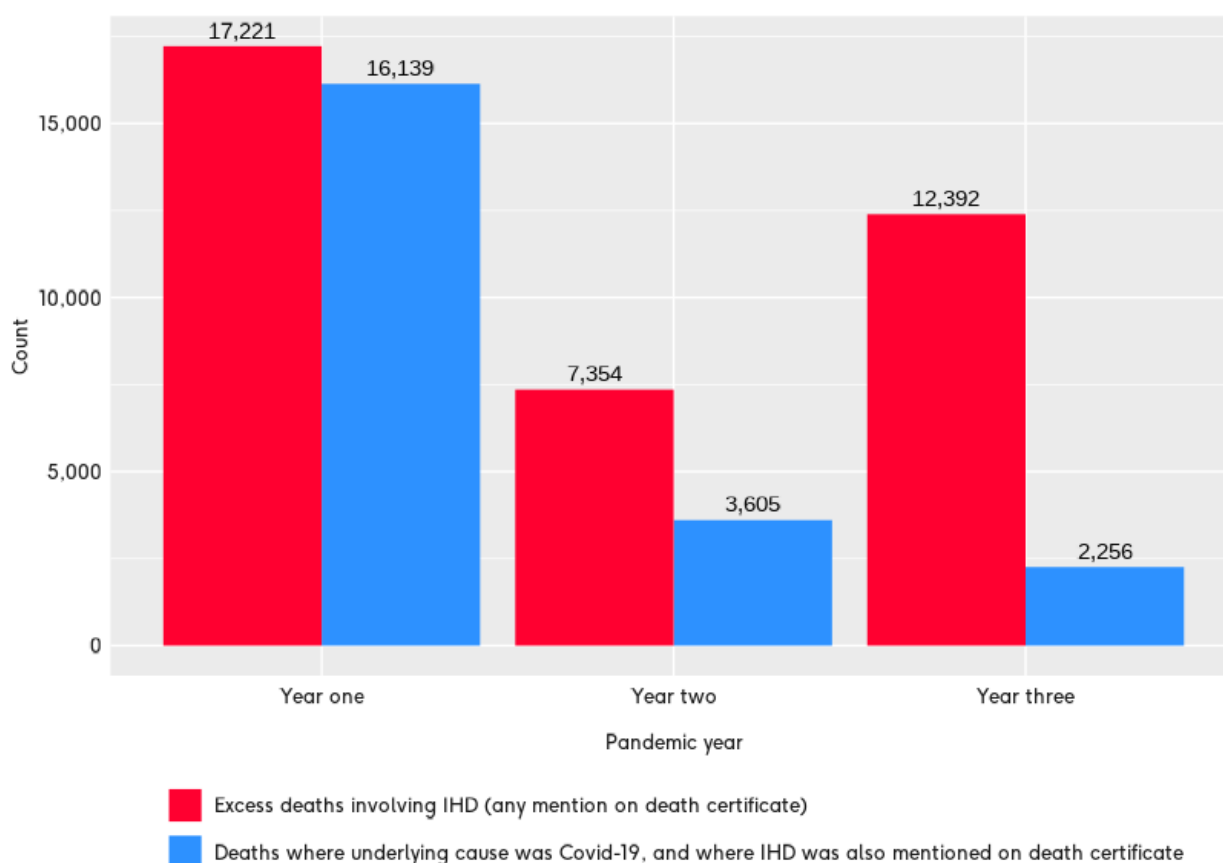
⁶³ As per standard reporting, OHID do not cut their excess deaths data by both age *and* cause. However, they have produced a number of bespoke analyses of the data, that make this available, albeit for a narrower period of time than the full data.

A.3. Excess deaths involving ischaemic heart disease

As of the time of publication, and since the 21st March 2020 (when OHID's reporting began), there have been 38,207 excess deaths involving ischaemic heart disease⁶⁴ (IHD) in England. Figure 9 visualises these data by year of the pandemic, and alongside the number of deaths in England involving IHD where Covid-19 was the underlying cause of death. The current, fourth year of the pandemic is excluded due to incomplete data.

It shows that excess deaths were largest in the first year of the pandemic, declined in the second year, and then rebounded in the third year of the pandemic. It also shows that the number of deaths involving IHD where Covid-19 was the underlying cause of death has fallen in each subsequent year of the pandemic.

Figure 25 - Excess deaths involving IHD (any mention on death certificate) in England, compared to deaths where the underlying cause was Covid-19 and where IHD was also mentioned on the death certificate



⁶⁴ The ICD-10 classification of ischaemic heart disease (ICD-10 I20-I25) is used here, as in *Tipping Point*.