# COSTS OF CARDIOVASCULAR DISEASE IN GREATER MANCHESTER

Report for Health Innovation Manchester

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# Contents



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# EXECUTIVE SUMMARY

Health Innovation Manchester commissioned Frontier Economics to explore the costs of cardiovascular disease (CVD) in Greater Manchester. This report explores the following issues.

- The annual costs to the healthcare and social care sectors associated with CVD.
- The wider costs to individuals, the economy and society associated with CVD.
- The variation in these costs across subpopulations.
- The potential avoided costs if prevalence of CVD were lower.

Our approach was underpinned by an impact framework, based upon a rapid review of academic, clinical and grey literature and discussions with the Steering Group[1] for this work.

This report focuses on the **costs which are due to cardiovascular disease**. These are the additional or **incremental costs**, which are experienced by CVD patients relative to otherwise similar individuals without CVD.

We define CVD as patients with at least one the following conditions: coronary heart disease, heart failure, peripheral arterial disease, stroke, transient ischaemic attack, heart valve disease and vascular dementia. This report analyses costs in adults aged 18 and over

It is important to note that we do not measure the costs associated with undiagnosed cases of CVD or those incurred by individuals without CVD who are living with risk factors such as hypertension.

## Annual costs of cardiovascular disease in Greater Manchester

# £2.5 billion

Costs of cardiovascular disease in Greater Manchester in 2024

We estimate that the costs of CVD in Greater Manchester in 2024 are **£2.53 billion**. See Sections 2 and 3 for full details of the results, calculations and underlying sources.

These costs are broken down as follows:

1 The Steering Group for this work was comprised by a range of experts at NHS GM and HIM with relevant experience in the topic, including clinicians, health economists and data scientists.

## Table 1 Costs of CVD in Greater Manchester in 2024

| Cost area | Description | Cost per CVD patient | Total |
|---|---|---|---|
| Healthcare | Cost of healthcare treatments | £2,561 | £472m |
| Social care | Cost of formal social care | £2,294 | £432m |
| Individuals | Non-financial cost of reduced quality of life and mortality | £6,016 | £1,110m |
| Family / carers | Non-financial opportunity cost of informal care | £1,155 | £213m |
| Economic activity | Sick-days, economic inactivity, mortality | £1,678 | £309m |
| **Total** | | **£13,704** | **£2.53 bn** |

*Source: Frontier Economics*

Mortality is an important driver of these costs. Indeed, we find that each year there are **5,460** deaths attributable to CVD in Greater Manchester, leading to an estimated loss of **63,190 years of life**.

For comparison, in another study prepared by Frontier Economics, we estimated the cost of obesity in Greater Manchester to be £3.21bn, with an average cost per person living with obesity of £5,297[2]. The lower total costs for CVD are driven by a significantly higher prevalence of obesity across Greater Manchester (27.1%) compared to the CVD in scope of this report (7.5%), despite CVD leading to higher costs per person.

Limitations from this study include that fact that we were not able to consider all cardiovascular conditions. Our intention was to select a range of conditions which collectively account for the vast majority of costs associated with CVD. We therefore focused on diseases with relatively high prevalence and/or average treatment cost. We were also constrained by the availability of data and evidence for each condition considered. In addition, we have not modelled the costs of undiagnosed CVD. Finally, as a general rule, it is not always possible to distinguish impacts and costs which are generally *associated with* CVD from those which are specifically *due to* CVD. This is unsurprising, given the range of factors (including societal factors) which contribute to and are caused by CVD and the complexity of these relationships. We have attempted to mitigate this issue as far as possible, by basing our analysis on published literature which attempts to control for the issue of causality.

[2] https://healthinnovationmanchester.com/wp-content/uploads/2024/06/UK_Obesity_Healtheconomicreport_ManchesterReimagining_Dec23_PP-MG-GB-0461.pdf

## Variation in costs across subpopulations

The cost of CVD varies significantly across the population in Greater Manchester.

CVD disproportionately affects older populations. Disease prevalence is as low as 0.3% for individuals aged between 18 and 19, and as high as 42.3% for individuals aged 80 and over. Alongside prevalence, total societal costs increase with age. Healthcare and social care costs per patient increase with age, reflecting a higher incidence of multimorbidity and a higher need for social care services amongst older CVD patients. Productivity costs converge to zero for older populations due to retirement.

Certain boroughs are particularly affected by CVD. Reflecting disease prevalence, total costs per thousand inhabitants are highest in Stockport (£1,292,449), and lowest in Manchester (£748,077). There is a clear association between prevalence and average age per borough. Total costs reflect population size and are highest in Manchester (£427 million), and lowest in Bury (£174 million).

CVD disproportionately affects more deprived individuals. Amongst the same age groups, disease prevalence is highest in more deprived areas: for example, for individuals aged 65 and above, prevalence is as low as 24.3% for individuals in the 10$^{th}$ deprivation decline (least deprived) and as high as 30.9% for those in the 1$^{st}$ deprivation decline (most deprived). However, deprived areas tend to have younger populations, which more than offsets this effect. As a result, the average cost per 1000 inhabitants is lower for the most deprived decile (£1,000,516) relative to the least deprived decile (£1,158,427).

CVD prevalence is higher amongst men (8.5%) than women (6.5%). Accordingly, average costs per 1000 inhabitants are higher for man (£1,173,083) than for women (£877,917).

Individuals with White British ethnicity account for the majority of the costs derived from CVD (83.4%). This reflects both a higher number of individuals of White British ethnicity and a higher disease prevalence (9.6%). Costs per thousand inhabitants are also highest for individuals with White British ethnicity (£1,304,795), followed by individuals with Asian ethnicity (£623,208). This disparity is likely influenced, at least in part, by differences in engagement with healthcare services among certain ethnic groups, leading to a higher proportion of undiagnosed CVD cases – and hence lower estimated costs – for certain populations.[3]

[3] Our overall cost estimates and our costs per subpopulation are based on data on the number of patients in Greater Manchester diagnosed with CVD. To the extent that certain individuals with CVD are not diagnosed (e.g. as a result of under-engagement with healthcare services) we would not be capturing the costs associated with CVD for those patients. It is plausible that those individuals would not lead to incremental healthcare costs, at least in the short run, implying our estimated healthcare costs may reflect true costs. However, we would be underestimating the costs associated with the remaining cost categories – e.g. the individuals costs associated with reductions in quality of life.

## Potential avoided costs if rates of CVD were lower

We estimate that if CVD prevalence in Greater Manchester was reduced by 5%, 10% or 20% the overall annual costs savings would amount to £126 million, £253 million and £506 million, respectively. Table 2 below illustrates these alternative prevalence scenarios.

### Table 2 Potencial avoided costs in GM if CVD levels were decreased

| | CVD prevalence scenario | | | |
|---|---|---|---|---|
| | **Current** | **Scenario 1 (5% reduction)** | **Scenario 2 (10% reduction)** | **Scenario 3 (20% reduction)** |
| Healthcare costs | £472 million | £449 million | £425 million | £378 million |
| Formal social care | £423 million | £402 million | £381 million | £339 million |
| Individual costs | £1110 million | £1054 million | £999 million | £888 million |
| Informal care | £213 million | £202 million | £192 million | £170 million |
| Productivity costs | £309 million | £294 million | £279 million | £248 million |
| **Total** | **£2.5n** | **£2.4bn** | **£2.3bn** | **£2.0bn** |

*Source: Frontier Economics*

These figures provide insight into the ‘prize’ (in terms of avoided costs) which could be realised by interventions which reduce CVD. This report is a ‘cost of illness’ or ‘burden of disease’ study. To understand the benefits of any particular intervention requires a complementary analysis, which explores the impact of that intervention. These interventions can be deployed at different stages or levels e.g. focusing on risk factors, individual behaviour and primary prevention (e.g. improving diet and exercise), or early diagnosis/risk stratification and secondary prevention (e.g. targeted support for those with risk markers), or in improved treatment for those with CVD. The scenario analysis above is agnostic to specific interventions. We note that these interventions would also involve costs, which would also need to be considered.

# 1 Introduction

Cardiovascular disease (CVD) places a profound burden on individuals and broader society. With over 7 million people living with cardiovascular disease in the UK[4], it is a significant driver of disability and death[5]. The NHS recognises the importance of preventing CVD. Accordingly, the NHS Long Term Plan has designated CVD as a clinical priority and the single biggest condition where lives can be saved by the NHS over the next decade,[6] and the NHS Greater Manchester Multi-Year Prevention Plan places CVD as one of its prevention priorities for 2024/2025[7].

This report, commissioned by Health Innovation Manchester, aims to contribute to this topic by estimating the current costs of cardiovascular in Greater Manchester. This report considers the economic and societal costs of CVD.

This report explores the following issues:

- The annual costs to the NHS and social care sectors associated with CVD.
- The wider costs to individuals, the economy and society associated with CVD.
- The variation in these costs across subpopulations.
- The potential avoided costs if prevalence of CVD were lower.

For the purposes of this report, we define CVD patients as those with at least one the following conditions: coronary heart disease, heart failure, peripheral arterial disease, stroke, transient ischaemic attack, heart valve disease and vascular dementia. This report analyses costs in adults aged 18 and over.

4 BHF (2024), https://www.bhf.org.uk/-/media/files/for-professionals/research/heart-statistics/bhf-cvd-statistics-uk-factsheet.pdf

5 NHS (2024), https://www.nhs.uk/conditions/cardiovascular-disease/

6 NHS (2024), https://www.england.nhs.uk/ourwork/clinical-policy/cvd/#:~:text=The%20NHS%20Long%20Term%20Plan,over%20the%20next%2010%20years.

7 NHS GM (2024) https://democracy.greatermanchester-ca.gov.uk/documents/s31606/Implementing%20the%20Integrated%20Care%20Strategy%20Appendix%20-%20Mission%20on%20Recovery%20of%20Core%20NHS%20and%20Care%20Servic.pdf

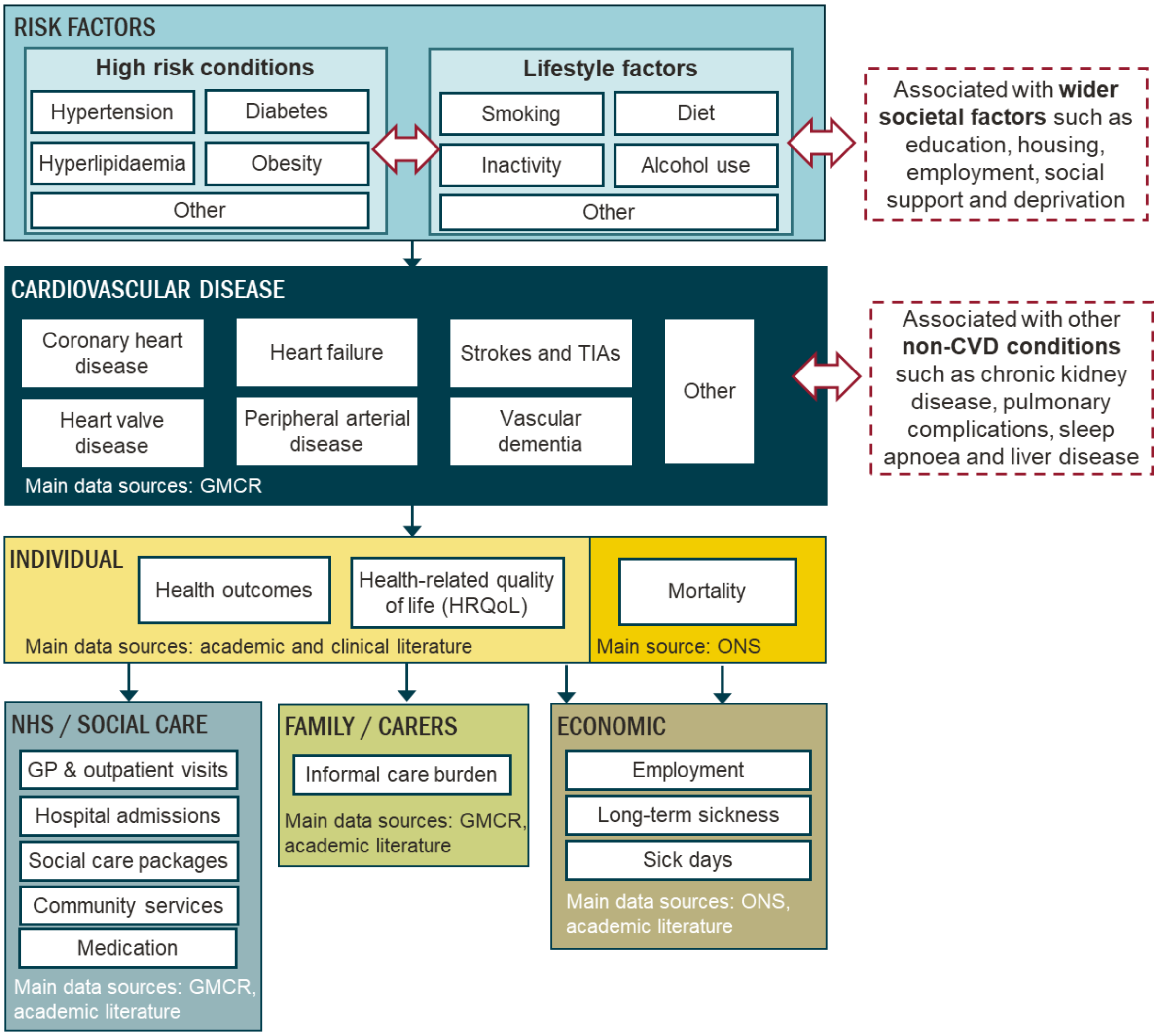
# 2 Approach

This section outlines the approach we have taken to estimate the costs of cardiovascular disease in Greater Manchester.

## 2.1 Impact framework

Our approach to exploring the costs of cardiovascular disease in Greater Manchester was underpinned by an impact framework. Based upon reviewing academic, clinical and grey literature relating to CVD and in discussion with the Steering Group for this work, we developed the impact framework shown in Figure 1.

## Figure 1 Impact framework




*Source: Frontier Economics*

The framework starts by setting out **risk factors** to CVD. These include high risk conditions such as hypertension, and lifestyle factors such as smoking. The framework also includes wider societal factors such as the level of education or deprivation that are linked with these risk factors and therefore have implications on the prevalence of CVD.

The second element of the framework relates to **cardiovascular disease.** Following the NHS classification of CVD[8] we exclude related illnesses such as diabetes and hypertension (which are categorised as risk factors) or chronic kidney disease (which has important bidirectional links to CVD). These conditions will have direct health implications on individuals, including in terms of the burden associated with living with CVD, as well as premature mortality.

The framework further sets out other **financial and non-financial costs** derived from CVD, including:

- **Costs to individuals.** Reductions in health-related quality of life (HRQoL) due to living with CVD (morbidity) and premature death (mortality).
- **Costs to healthcare, social care and community services sectors.** Increased demand for healthcare, social care services and community services from individuals living with cardiovascular disease.
- **Costs to family and carers.** Increased burden of informal care for CVD patients.
- **Costs to the wider economy and employers.** Higher rates of sickness absence and lower rates of employment among CVD patients, and lost employment due to mortality.

This report focuses on the **costs which are due to cardiovascular disease**. These are the additional or **incremental costs**, which are experienced by CVD patients relative to otherwise similar individuals without CVD. For example, we consider healthcare costs which are *associated with* CVD and not all healthcare costs incurred by CVD patients. Not all costs due to CVD were considered in this report (e.g. costs associated with in-work productivity reductions, or costs associated with cardiovascular illnesses not in scope of the definition in this report) and the figures included are best estimates. Furthermore, we did not account for indirect healthcare costs arising from the onset of conditions linked with CVD, such as chronic kidney disease.

Understanding these costs is a valuable part of the evidence base to inform policy-making. Our estimates provide insight into the total magnitude of costs associated with CVD, which indicates the size of the ‘prize’ (in terms of avoided costs) which could be realised by interventions which reduce CVD. This report is a ‘cost of illness’ or ‘burden of disease’ study. To understand the benefits of any particular intervention requires a complementary analysis, which explores the impact of that intervention. This would test, for example, whether the intervention reduces rates of CVD as planned. This type of ‘intervention study’ can then be combined with the analysis here, to understand the benefits of the intervention (which, in turn, can be weighed against its costs). Our impact framework also reflects the fact that interventions can be deployed at different stages or levels e.g. focusing on risk factors, individual behaviour and primary prevention (e.g. improving diet and exercise), or early

8 NHS (2024), https://www.nhs.uk/conditions/cardiovascular-disease/

diagnosis/risk stratification and secondary prevention (e.g. targeted support for those with risk markers), or in improved treatment for those with CVD. There is no single 'right answer' for the appropriate targeting of interventions, however the above framework and the cost estimates below, provide a valuable part of the evidence base to inform these decisions. In addition, our estimates also indicate how costs vary by location, age groups, sex, and ethnicity. This can inform targeting of interventions to where they may be most beneficial.

The following sections describe in more detail the costs which are explored in this report. Specific assumptions, calculations and evidence sources are provided in Annex A.

## 2.2 Costs to the healthcare sector

We estimated the impact of CVD on healthcare costs by considering the number of cases of each condition in scope of our study, and the associated healthcare costs per case.

- **Number of patients per illness:** we used local NHS data (ADSP)[9] to derive the number of adults patients in GM with each cardiovascular disease.
- **Average treatment cost**: we drew upon published data which estimates the average annual healthcare costs per patient for each condition, including primary care, secondary care and prescriptions costs. [10]

The overall healthcare costs in Greater Manchester are the product of these two components for each of the cardiovascular conditions listed in the Introduction to this report, with the exception of heart valve disease for which we have conservatively assumed healthcare costs to be zero due to lack of reliable data on average annual healthcare costs.[11] Average costs-per-patient were obtained by dividing total costs with the number of CVD patients in Greater Manchester.

We further present healthcare costs associated with CVD, with a breakdown across the following cost categories: primary care costs, secondary care costs (disaggregated between outpatient care, inpatient care and emergency admissions) and medication costs. For this we

9 Analytics and Data Science Platform (ADSP) is a dataset that compiles NHS and social care services information from all boroughs in Greater Manchester. This data combines GP records (from the GM Care Record data) and secondary care (from NHS England's Secondary Uses Service) at patient level.

HIM (2024) https://healthinnovationmanchester.com/our-work/the-gm-care-record/

10 We further differentiate average healthcare cost differ for individuals living with multiple cardiovascular conditions (multimorbidity) based on an analysis of healthcare usage. This is further explained in Annex A.2..

11 The annual average costs for patients with heart valve disease are likely to be significant. NHS Reference Costs lists a complex single heart valve replacement or repair to cost between £12,600-£17,600, a standard single heart valve replacement or repair to cost £10,700-£13,900 and a transfemoral transcatheter aortic valve implantation to cost between £5,000-£6,000 https://www.nice.org.uk/guidance/ng208/evidence/tavi-economic-analysis-pdf-10890776557#:~:text=NHS%20Reference%20Costs%20lists%20a,between%20%C2%A35%2C000%2D%C2%A36%2C000.

apply the proportions of CVD healthcare costs estimated across categories in the UK in the European Heart Network cost study from 2017.[12]

Other cardiovascular illnesses that were not included in the CVD definition used in this report due to data limitations, such as congenital heart disease or pulmonary embolism, provide an additional burden to the healthcare system over and above what was estimated. Furthermore, we exclude healthcare costs that may indirectly surge as a result of cardiovascular disease, such as through related conditions (e.g. chronic kidney disease).

## 2.3 Costs to the social care sector

In addition to healthcare costs, CVD patients are likely to have a greater need for social care services, as these conditions can sometimes affect their ability to function independently.

We estimated the impact of CVD on the social care sector by analysing the additional social care needs per CVD patient and the financial cost associated with providing those additional social care services. We consider social care needs related to home care and residential care.

For **home care** costs, we have estimated:

- **Care hours per person:** we drew upon academic literature to estimate the average additional formal social care needs due to CVD for individuals aged 35 and over. These estimates were based on an analysis of self-reported social care usage amongst participants on the English Longitudinal Study of Ageing, comparing social care usage across populations with diverse demographics and health conditions. These estimates take into account the fact that not all CVD patients require social care, which drives down the average. As the underlying literature did not cover individuals aged below 35, we have conservatively assumed there was no increase in home care for these individuals.
- **Cost of care per hour:** we used well-established sector estimates of the cost of delivering an hour of social care in England, adjusted to 2024 prices.

For **residential care** costs, we have relied on local NHS data care costs, we have estimated:

- **Increased likelihood of living in a residential care home:** we have calculated the increased proportion of CVD patients living in a residential care home relative to individuals without CVD and within the same age group. Since CVD patients may be more likely to suffer from other illnesses, which themselves can also lead to increased residential care usage, we have conservatively assumed that only 50% of the difference observed is attributable to CVD.
- **Annual cost of residential care:** we used well-established sector estimates of the annual cost of delivering institutional care in England, adjusted to 2024 prices.

12 https://ehnheart.org/library/cvd-statistics/european-cardiovascular-disease-statistics-2017/

The components above provide our estimate of incremental home care and residential care costs per CVD patient. We have multiplied these figures by the number of CVD patients in Greater Manchester to reach an overall cost figure to the social care sector. These costs will be borne either by local authorities or by individuals, depending upon each individual case.

We have not modelled costs from other forms of formal care, including day care or community support, due to lack of reliable data.

## 2.4 Costs to individuals due to Health-related Quality of Life (HRQoL) losses

CVD patients experience poorer health-related quality of life (HRQoL) outcomes. These are non-financial costs, but can be valued in monetary terms. We consider costs from reductions in health-related quality of life (HRQoL) amongst CVD patients, as well as costs associated with mortality.

We estimated these costs as follows:

- **Morbidity:** we drew upon published literature which has considered the average reduction in quality of life associated with CVD. This evidence explores how HRQoL compares for CVD patients against those in a reference population, controlling for factors such as ethnicity, weight, income, education or the presence of other illnesses. HRQoL losses are reported as a reduction in Quality-Adjusted Life Years (QALYs).
- **Mortality:** we used data on mortality statistics by cause to understand the number of CVD-related deaths per each age group in Greater Manchester, and combined these with life expectancy data by age group to estimate the numbers of life-years lost as a result of mortality. In the absence of CVD these deaths would have been prevented and, to calculate costs, these individuals are conservatively assumed to have experienced quality of life equivalent to the average HRQoL amongst individuals aged 75 and above in England[13]. We report these as losses in Quality-Adjusted Life Years (QALYs).
- **QALY valuation:** We follow UK Government best-practice in valuing these QALY reductions. Conservatively, we value each QALY lost using the National Institute of Health and Care Excellence 'threshold value' of £20,000 per QALY.[14,15] Future life-years lost due to mortality are discounted using the Green Book discount rate.

13 These individuals have the lowest have HRQoL across the age groups covered in the literature that we have used to provide reference statistics in England.

14 https://www.nice.org.uk/media/default/guidance/lgb10-briefing-20150126.pdf

15 We note that the UK Government's 'Green Book for appraisal and evaluation in Central Government' (2022) recommends a higher value of £70,000 per QALY. We have conservatively used the NICE threshold value of £20,000 per QALY, which is used to determine whether the NHS should offer a given form of treatment, based on the cost to achieve each QALY gained.

## 2.5 Costs to family / carers due to informal care burden

We noted above that alongside – or as a substitute for – formal social care, many individuals rely upon informal care provided by family or carers. This creates non-financial, 'opportunity costs', borne by these family or carers, based upon the time spent providing informal care which could have instead been spent in another way (e.g. additional work, or additional leisure).

We rely on published research on informal care costs that estimates informal care costs in the UK based where (i) the incremental hours of informal care hours were estimated based on survey data where participants with different health conditions reported the amount of hours of informal care received, and (ii) the monetary value of hours of care provided was valued at the average hourly wage rate.

We have considered the ratio of informal care costs relative to healthcare care costs estimated for the UK and applied this to our estimates of healthcare costs in Greater Manchester to reach an estimate of informal care costs in Greater Manchester. We have chosen this approach given the limitations and data gaps encountered with further disaggregated data, and provide more details in Annex A.4.

## 2.6 Costs to the economy due to productivity losses

We have estimated the costs to the economy due to three factors: reduced employment rates among CVD patients, increased sickness absences amongst employed CVD patients, and lost employment due to mortality. We note that there are also potential in-work productivity impacts (presenteeism) which we have not considered in the analysis due to insufficient high-quality evidence and data. We also note that there are potential knock-on impacts for welfare payments (e.g. unemployment benefits, or disability-related benefits), however following UK Government best practise, these are considered 'transfers' (from Government to individuals) and are not considered as societal costs, so excluded from this analysis.

We estimated the costs to the economy as follows:

- **Employment rate:** we used published literature which considers the increased probably of workers leaving the workforce upon diagnosis of CVD, and apply this to the employment rate in Greater Manchester to estimate the decrease in employment rate associated with CVD[16]. We value this reduction in employment at the median annual wage in Greater Manchester.
- **Sickness absence:** we drew on data from the Cabinet Office on the average number of short term and long term sick leave days per worker in the UK civil service due to CVD. We deflate these figures to account for the higher sickness absence observed across civil

16 While this evidence focuses on immediate impact in the year following diagnosis, we have validated our approach by comparing it against alternative methodologies, yielding similar results. This consistency provides reassurance to our results. Further details are provided in Annex A.5.

servants relative to overall workforce, and further adjust these to reflect region-specific sickness absence patterns. We value lost days of work at the median daily wage in Greater Manchester.

- **Mortality:** we draw on mortality statistics by cause to understand the number of CVD-related deaths per each age group in Greater Manchester, and combine these with the employment rate in Greater Manchester and the average age of exit from the labour market in the UK to approximate the current and future employment lost as a result of current CVD-related mortality. We value lost employment at the median annal wage in Greater Manchester, and discount future lost employment based on Green Book discount rates.

## 2.7 Costs among subpopulations in Greater Manchester

The analysis described so far provides estimates for the total population and on an 'average per person' basis. However, it is well-established that CVD disproportionately affects certain groups, such as older populations. We therefore also estimated how costs vary across subpopulations depending on the following factors: (i) age; (ii) borough of residence; (iii) deprivation; (iv) sex; and (v) ethnicity.

For this we have combined the above estimates with data from ADSP, which includes patient-level data on health, as well as age, borough of residence, deprivation decile, sex and ethnicity. Costs among subpopulations were estimated based on:

- The **number of CVD patients** in each subpopulation (e.g. number of CVD patients in Trafford), split by the average number of cardiovascular illnesses per patient, and
- The **average incremental cost per CVD patient** in each subpopulation. Cost estimates are specific to each subpopulation as they account for variation in the share of patients of working age, as well as variation in healthcare costs for people with a different number of cardiovascular illnesses[17].

## 2.8 Estimating potential avoided costs

Lastly, we have undertaken a scenario-based analysis on the costs which could be avoided if rates of CVD were lower than those currently observed in Greater Manchester. This might occur as a result of effective policy interventions, although we have not analysed any specific interventions.[18]

We modelled 3 scenarios:

- **Scenario 1:** If CVD prevalence in Greater Manchester decreased by 5%.

17 Fr example, if CVD patients in Trafford have an average lower number of cardiovascular illnesses relative to patients in Stockport, then the average healthcare costs due to CVD per patient in Trafford will be higher than in Stockport.

18 The effectiveness and cost-effectiveness of any policy interventions should be considered in a separate analysis.

- **Scenario 2:** If CVD prevalence in Greater Manchester decreased by 10%.
- **Scenario 3:** If CVD prevalence in Greater Manchester decreased by 20%.

Under each scenario, we estimated the difference in societal costs across all cost components in scope of this report. These potential avoided costs give an indication of the 'prize' which could be achieved through effective policy interventions which prevent or reduce CVD. For this exercise, we have assumed a linear relationship between CVD costs and the number of CVD patients.

## 2.9 Limitations

The analysis described above is limited in a few respects.

- As a general point, it is not always possible to distinguish impacts and costs which are generally *associated with* CVD from those which are specifically *due to* CVD. This is unsurprising, given the range of factors (including societal factors) which contribute to and are caused by CVD and the complexity of these relationships. We have attempted to mitigate this issue as far as possible, by basing our analysis on published literature which attempts to control for the issue of causality.

- Within the scope of this analysis, we were not able to consider all cardiovascular conditions. Our intention was to select a range of conditions which collectively account for the vast majority of costs associated with CVD. We therefore focused on diseases with relatively high prevalence and/or average treatment cost. We were also constrained by the availability of data and evidence for each condition considered.

- Our overall cost estimates and our costs per subpopulation are based on data on the number of patients in Greater Manchester diagnosed with CVD, based on ADSP. To the extent that certain individuals with CVD are not diagnosed (e.g. as a result of under-engagement with healthcare services) we would not be capturing the costs associated with CVD for those patients. It is plausible that those individuals would not lead to incremental healthcare costs, at least in the short run, implying our estimated healthcare costs may reflect true costs. However, we would be underestimating the true costs associated with the remaining cost categories – e.g. the individuals costs associated with reductions in quality of life.

- Our cost estimates are based on data from ADSP on the number of patients in Greater Manchester diagnosed with CVD. However, individuals with undiagnosed CVD—such as those who under-engage with healthcare services—are not included in our analysis. It is plausible that undiagnosed individuals do not lead to significant incremental healthcare costs, implying our estimated healthcare costs may reflect true costs. Nonetheless, this approach likely underestimates the total costs associated with CVD in other categories, such as the individual burden from reduced quality of life.

- It is challenging to estimate social care costs resulting from CVD with precision. This is because social care services are diverse and fragmented, varying significantly across providers which makes standardised data collection difficult. While we were able to directly estimate residential care costs based on data from ADSP, data for home care is based on survey data - which may introduce variability and potential biases - and is only available for patients aged 35 or older. Informal care costs are also based on survey data and further require making an assumption on the average opportunity cost of the time spent by carers. This means that the social care cost estimates are a little more uncertain than those for other areas of cost.

- We have not considered the potential cost savings associated with premature death driven by CVD. Premature death may lead to lower healthcare as well as lower formal and informal social care costs in the years that those individuals would otherwise have been alive. However, analysing these potential savings would be complex and require additional evidence and assumptions (for example around the cost that would have been incurred had these individuals lived longer).

- We have not considered the potential impact of presenteeism. It is plausible that CVD hinders the hourly productivity of workers, although we have not modelled this specifically due to lack of robust evidence.

- To calculate healthcare cost per person for individuals with different numbers of cardiovascular diseases (multimorbidity) we have analysed differences in non-elective secondary healthcare costs amongst individuals with a different number of CVD, attributing the differences observed to the number of CVD. However, it is not certain that the observed variation in healthcare activity is fully explained by number of illnesses, rather than by other factors correlated with number of illnesses. This may lead to overstating the difference in costs across patients with different number of illnesses. This affects our breakdown of costs per subpopulation, but not our estimates of overall costs in Greater Manchester.

- Finally, our analysis of potential future avoided costs is based on the range of healthcare services – and costs of those services – which exist today. This does not account for any changes to healthcare services which could be made in future. For example, services may be redesigned to be more efficient or effective. This would affect our estimates of costs and the potential avoided costs if rates of CVD were lower. Furthermore, interventions aimed at reducing CVD would involve costs, which would also need to be considered.

Nevertheless, we believe the analysis presented in this report provides a reasonable estimate of the costs associated with CVD in Greater Manchester. These limitations also indicate areas where further work would be particularly valuable.

# 3 Results

## 3.1 Main results: costs in Greater Manchester

Our analysis suggests that the costs of cardiovascular disease in Greater Manchester in 2024 are £2.53 billion. These costs are broken down as follows:

### Table 3 Annual cost of cardiovascular disease in Greater Manchester

| Cost category | Cost per CVD patient (£) | Total costs due to CVD (£) |
|---|---|---|
| **Healthcare costs** | **£2,561** | **£472 million** |
| Primary care | £340 | £63 million |
| Outpatient visit | £223 | £41 million |
| Elective admission | £1,349 | £249 million |
| Emergency admission | £83 | £15 million |
| Prescription | £567 | £105 million |
| **Formal social care costs** | **£2,294** | **£423 million** |
| Residential care | £943 | £174 million |
| Home care | £1,351 | £249 million |
| **Costs to individuals due to HRQoL losses** | **£6,016** | **£1110 million** |
| Morbidity | £1,684 | £311 million |
| Mortality | £4,332 | £799 million |
| **Costs of informal care** | **£1,155** | **£213 million** |
| **Productivity costs** | **£1,678** | **£309 million** |
| Leaving Employment | £987 | £182 million |
| Short-term Sickness Absence | £10 | £2 million |
| Long-term Sickness Absence | £36 | £7 million |
| Mortality | £645 | £119 million |
| **Total cost of cardiovascular disease** | **£13,704** | **£2.53 billion** |

*Source: Frontier Economics*

*Note: The cost per person figures presented are average across all ages and subpopulations. The numbers for particular groups of individuals will differ.*

For comparison, in another study prepared by Frontier Economics, we estimated the cost of obesity in Greater Manchester to be £3.21bn, with an average cost per person living with obesity of £5,297[19]. The lower total costs for CVD are driven by a significantly higher prevalence of obesity across Greater Manchester (27.1%) compared to the CVD in scope of this report (7.5%).

### 3.1.1 Costs to the healthcare sector

Table 4 provides estimates of average incremental cost attributable to CVD per person.

Note that while the cost per case of treating certain diseases may be high, its overall impact on average incremental costs per habitant may be low due to relatively low levels of disease prevalence. For example, while the healthcare costs associated with treating one heart failure patient are higher than those of treating a CHD patient, its overall contribution to costs across Greater Manchester are lower due to a lower disease prevalence.

#### Table 4 Healthcare costs - incremental average cost per adult inhabitant in Greater Manchester

| Condition | Incremental annual healthcare cost |
|---|---:|
| Stroke and TIA | £61 |
| Coronary heart disease (CHD) | £60 |
| Heart failure | £40 |
| Peripheral arterial disease | £24 |
| Vascular dementia | £10 |
| **Total** | **£194** |

*Source: Frontier Economics*

The cost estimates above are based on diagnosed disease prevalence and may underestimate true costs. To the extent that certain diseases are not diagnosed, but nonetheless lead to incremental healthcare usage, these costs are not captured in our analysis. For example, the literature[20] suggests a portion of patients with vascular dementia are misdiagnosed with Alzheimer's disease. The costs associated with those patients would be not be captured in our modelling.

19 https://healthinnovationmanchester.com/wp-content/uploads/2024/06/UK_Obesity_Healtheconomicreport_ManchesterReimagining_Dec23_PP-MG-GB-0461.pdf

20 https://content.iospress.com/articles/journal-of-alzheimers-disease/jad150685#jad-53-jad150685-t003

### 3.1.2 Costs to the social care sector

We have estimated costs to the social care sector from **residential care** and **home care**:

- We find that CVD patients aged 35 and older incur an average **49.4 additional hours of social care provided at home** per year, which translates into an average cost of £1,374 per patient aged 35 or older.
- An **additional 3.0% of CVD patients live a residential care home** when compared to patients without CVD. Assuming that only half of the increase observed is attributable to CVD, this translates into an average cost of £943 per patient.

**Table 5 Proportion of patients living a residential care home**

| | Living without CVD | Living with CVD | Increment amongst CVD patients |
|---|---|---|---|
| 18 to 64 | 0.2% | 1.1% | **0.9%** |
| 65 or older | 2.1% | 6.0% | **4.0%** |
| All ages (weighted average amongst CVD patients) | 1.5% | 4.5% | **3.0%** |

*Source: Frontier Economics*

*Note: Figures are rounded to the nearest decimal, explaining why the increment does not always appear exactly equal to the difference between the groups*

### 3.1.3 Costs to individuals due to Health-related Quality of Life (HRQoL) losses

We consider costs to individuals from reductions in health-related quality of life (HRQoL) amongst CVD patients (**morbidity**) as well as costs associated with premature death (**mortality**).

- We find that living with CVD is associated with a disutility of **0.084** in the HRQoL of patients, which translates into average costs of £1,684 per CVD patient.
- We further find that each year there are **5,460** deaths attributable to CVD in Greater Manchester, leading to an estimated loss of **63,190 years of life**. The cost of these premature deaths translated into an average £4,332 per CVD patient.

While the NHS and formal social care costs reported so far represent financial costs, as indicated in section 2.4, the costs described in this section are non-financial costs.

### 3.1.4 Costs to family / carers due to informal care burden

We find that the cost of providing informal care to CVD patients amounts to £1,125 per patient, amounting to 45% of the healthcare costs associated with CVD in GM. These costs are non-financial, 'opportunity costs', where the time of carers is valued at the median GM wage.

### 3.1.5 Costs to the economy due to productivity losses

We find that CVD diagnosis amongst working age individuals (i.e. below 65) is linked with a **10.7% reduction in the likelihood of being employed**. The resulting costs to the economy amount to £3,210 per CVD patient in this age range.

In addition to the productivity costs resulting from decreased employment rates, CVD patients who are employed take a higher number of short-term and long-term sickness absence. On average, CVD patients **take an additional 0.27 days of short-term absence** per year **and 1.01 days of long-term absence** per year, resulting in an economic cost of £148 per CVD patient. These numbers are likely an underestimation of the true costs related to sickness absence resulting from CVD. As explained in further detail in the Annex A.5, we have considered lost days for which the primary absence reason relates to CVD. It is likely that worse health outcomes driven by CVD have implications on mental ill-health, which may at times be recorded as the primary absence reasons (particularly as directly obtaining sickness absence from CVD can be perceived as challenging in certain circumstances).

We further find that each year there are **721** deaths of working age individuals attributable to CVD in Greater Manchester, leading to an estimated **4,758 years of work lost**. These are translated into an economic cost of £2,097 per CVD patient.

## 3.2 Multimorbidity

### 3.2.1 Multiple cardiovascular conditions

Individuals living with multiple cardiovascular conditions are likely to incur higher healthcare costs relative costs relative to individual with a single cardiovascular condition. In this section we explore how healthcare costs differ for individuals with a different number of CVD.

We estimate the average healthcare cost per patient with 1, 2, and 3 or more cardiovascular illnesses based on an analysis secondary healthcare usage for individuals living with a different number of cardiovascular illnesses (further details in the Annex A.2). We find that CVD-related costs, increase less than proportionally with the number of conditions, reflecting possible economies of scope in treating multiple conditions (e.g. a single visit to the doctor can address multiple conditions).

Table 6 sets out healthcare usage patterns amongst patients with a different number of cardiovascular illnesses

## Table 6 Average annual healthcare usage and NHS calls per patient

| | Outpatient attendances | A&E attendances | Emergency admissions (CVD related) | NHS 111 calls | NHS 999 calls |
|---|---|---|---|---|---|
| No CVD | 1.51 | 0.37 | 0.00 | 0.15 | 0.08 |
| 1 CVD | 4.10 | 0.77 | 0.07 | 0.26 | 0.37 |
| 2 CVD | 5.46 | 1.08 | 0.12 | 0.35 | 0.64 |
| 3+ CVD | 6.88 | 1.46 | 0.19 | 0.49 | 1.00 |

*Source: Frontier Economics*
*Note: [Insert Notes]*

Table 7 sets out our estimates of incremental healthcare costs due to CVD by number of cardiovascular illnesses.

## Table 7 Incremental healthcare costs per patient

| | **One** cardiovascular illness | **Two** cardiovascular illnesses | **Three or more** cardiovascular illnesses |
|---|---|---|---|
| Number of patients | 134,325 | 37,216 | 12,921 |
| Healthcare costs due to CVD per patient | **£2,028** | **£3,516** | **£5,359** |

*Source: Frontier Economics*

An analysis of multimorbidity by age further shows that, conditional on having CVD, older individuals are significantly more likely to suffer from multimorbidity. For instance, only 1% of CVD patients aged 18 or 19 have more than one cardiovascular condition, whereas this proportion rises to 39% among those aged 80 or older. This indicates that CVD-related healthcare costs per CVD patient are higher in older populations.

## Table 8 Proportion of CVD patients with one, two or three or more cardiovascular ilnesses, by age

| | **One** cardiovascular illness | **Two** cardiovascular illnesses | **Three or more** cardiovascular illnesses |
|---|---|---|---|
| 18-19 | 99% | 1% | 0% |
| 20-24 | 98% | 2% | 0% |
| 25-29 | 96% | 3% | 0% |
| 30-34 | 94% | 4% | 1% |
| 35-39 | 91% | 7% | 1% |
| 40-44 | 90% | 9% | 1% |
| 45-49 | 88% | 11% | 1% |
| 50-54 | 86% | 12% | 2% |
| 55-59 | 83% | 15% | 3% |
| 60-64 | 80% | 17% | 4% |
| 65-69 | 76% | 18% | 5% |
| 70-74 | 73% | 21% | 6% |
| 75-79 | 69% | 23% | 8% |
| 80+ | 61% | 27% | 12% |

*Source: Frontier Economics based on ADSP*
*Note: The proportions sum to 100% across each age group, focusing on the distribution of illness amongst CVD patients.*

We have then explored whether multimorbidity is associated with deprivation. We find that CVD patients living in more deprived areas tend to have an increased number of cardiovascular illnesses. This may reflect challenges amongst more deprived population in effectively managing and preventing the progression of illnesses due to socioeconomic barriers. In the next section we explore how overall costs vary by deprivation.

**Table 9 Average number of cardiovascular ilnesses amongst CVD patients living in the least and most deprived areas in GM, by age**

| | 1st decile (most deprived) | 10th decile (least deprived) |
|---|---|---|
| 18-19 | 1.03 | 1.00 |
| 20-24 | 1.02 | 1.00 |
| 25-29 | 1.07 | 1.00 |
| 30-34 | 1.06 | 1.00 |
| 35-39 | 1.11 | 1.03 |
| 40-44 | 1.14 | 1.09 |
| 45-49 | 1.14 | 1.09 |
| 50-54 | 1.18 | 1.12 |
| 55-59 | 1.23 | 1.13 |
| 60-64 | 1.28 | 1.16 |
| 65-69 | 1.35 | 1.24 |
| 70-74 | 1.40 | 1.28 |
| 75-79 | 1.46 | 1.35 |
| 80+ | 1.58 | 1.53 |

*Source: Frontier Economics based on ADSP*

### 3.2.2 Mental health conditions

Cardiovascular disease and mental health conditions are closely interconnected, with a bidirectional relationship between the two.[21] In this section we explore multimorbidity derived from living with CVD and mental health conditions.

CVD can contribute to the development of mental health conditions, such as depression and anxiety. Indeed, the physical and emotional burden of living with a chronic cardiovascular condition can affect mental well-being. For example, individuals recovering from a stroke can experience emotional distress, which may evolve into clinical depression.

21 https://www.bhf.org.uk/what-we-do/our-research/research-successes/mental-health-and-heart-health

In the opposite direction, mental health conditions can increase the risk of developing CVD. For example, mental health conditions can be associated with behaviours that raise cardiovascular risk, including poor diet and physical inactivity.

We have analysed non-elective secondary healthcare usage data for patients living with a mental health condition[22] and without CVD, and compared that against patients living with both conditions. The data indicates that the cost of CVD may be higher in patients with mental health conditions: patients living with CVD and a mental health condition incur an estimated **additional cost of £2,915 per year** compared to those with a mental health condition but without CVD. This figure is higher than the average incremental healthcare cost due to CVD of £2,561 amongst all CVD patients.

### Table 10 Incremental annual healthcare cost per patient, by health condition

| | Cardiovascular disease (regardless of mental health condition) | Cardiovascular disease and mental health condition |
|---|---|---|
| Number of patients | 184,462 | 52,356 |
| Healthcare costs due to CVD | £2,561 | £2,915 |

*Source: Frontier Economics*

*Note: The figures in this table represents average healthcare cost for CVD patients, regardless of the number of CVD. This include patients living with a single as well as various cardiovascular illnesses.*

This indicates that CVD may be more expensive to manage in patients with mental health conditions than in those without. For instance, patients with mental health conditions may be less likely to engage in preventive care or adopt lifestyle changes that help mitigate the impact of CVD, resulting in higher healthcare costs, compared to CVD patients without mental health conditions. However, these estimates should be interpreted with caution, as we have not controlled for potential differences in the prevalence of other conditions, such as cancer or respiratory diseases, or other characteristics, such as ethnicity or sex, which could influence cost variations.

## 3.3 Costs by subpopulation

This section explores how the costs presented in Section 3.1 are split across different subpopulations in Greater Manchester.

22 Defined as patients coded in the ADPS data as having a mental health condition, including anxiety, depression or a serious mental illness. Anxiety and Depression uses the definition from the Cambridge Multimorbidity Score,

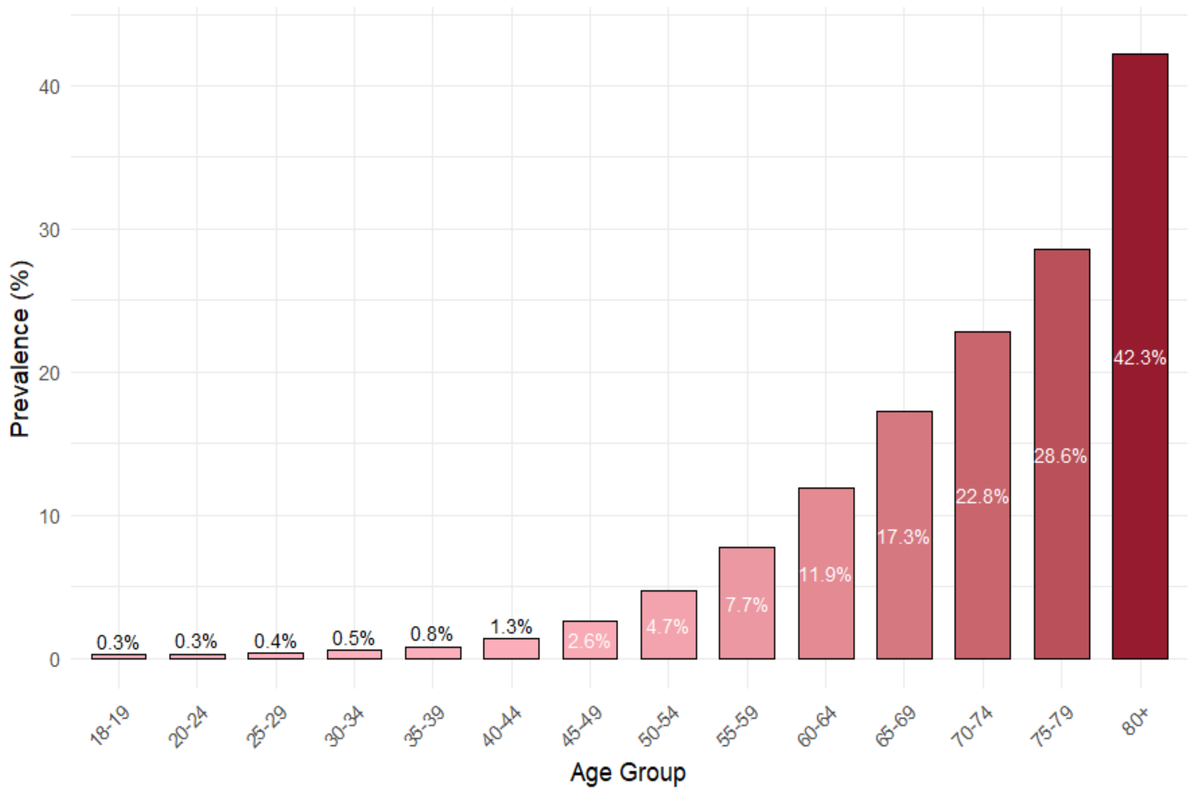
We calculated these costs by combining estimates of costs per patient with ADSP data on the number of diagnosed CVD patients[23] within each subpopulation. However, if certain groups—such as specific ethnicities or age demographics—are less likely to engage with healthcare services and therefore have a higher proportion of undiagnosed CVD cases, the associated costs for these individuals may be underestimated. [24]

This highlights underlying health inequalities amongst certain populations, as barriers to accessing care such as socioeconomic factors and language barriers can contribute to disparities in diagnosis and treatment.

### 3.3.1 Breakdown of costs by age

CVD disproportionately affects older populations. Figure 2 shows that disease prevalence is as low as 0.3% for individuals aged between 18 and 19, and as high as 42.3% for individuals aged 80 and over.

## Figure 2 Prevalence of CVD by age group in Greater Manchester




*Source: Frontier Economics based on ADSP*

23 Considering as well the incidence of multimorbidity and the share of working age population.

24 While undiagnosed cases might result in lower immediate healthcare costs in certain populations, they are likely to lead to disproportionately higher costs in other areas. For example, undiagnosed CVD patients may face significant personal costs due to a reduced quality of life caused by unmanaged and worsening CVD.

Table 11 below presents our breakdown of CVD costs split by age.

## Table 11 Incremental annual costs by age

| | 18-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65-74 | 75+ |
|---|---|---|---|---|---|---|---|
| CVD prevalence | 0.3% | 0.4% | 1.1% | 1.9% | 9.7% | 19.8% | 36.0% |
| Healthcare costs | £1.7 million | £4.7 million | £11.0 million | £31.4 million | £82.4 million | £122.1 million | £219.3 million |
| Formal care costs | £.2 million | £.6 million | £8.4 million | £23.2 million | £57.9 million | £126.3 million | £206.5 million |
| Informal care costs | £1.0 million | £2.5 million | £5.8 million | £16.1 million | £40.1 million | £56.0 million | £91.5 million |
| Individual costs | £5.1 million | £13.2 million | £30.2 million | £83.7 million | £209.1 million | £291.6 million | £476.8 million |
| Productivity costs | £4.6 million | £12.0 million | £27.4 million | £75.9 million | £189.6 million | £.0 million | £.0 million |
| **Total costs** | **£12.6 million** | **£33.1 million** | **£82.6 million** | **£230.3 million** | **£579.1 million** | **£596.0 million** | **£994.1 million** |
| *Proportion* | *0.50%* | *1.31%* | *3.27%* | *9.11%* | *22.91%* | *23.58%* | *39.33%* |
| Average cost per 1000 inhabitants | £43,984 | £67,220 | £174,213 | £600,641 | £1,613,653 | £2,428,309 | £4,514,578 |

*Source: Frontier Economics*

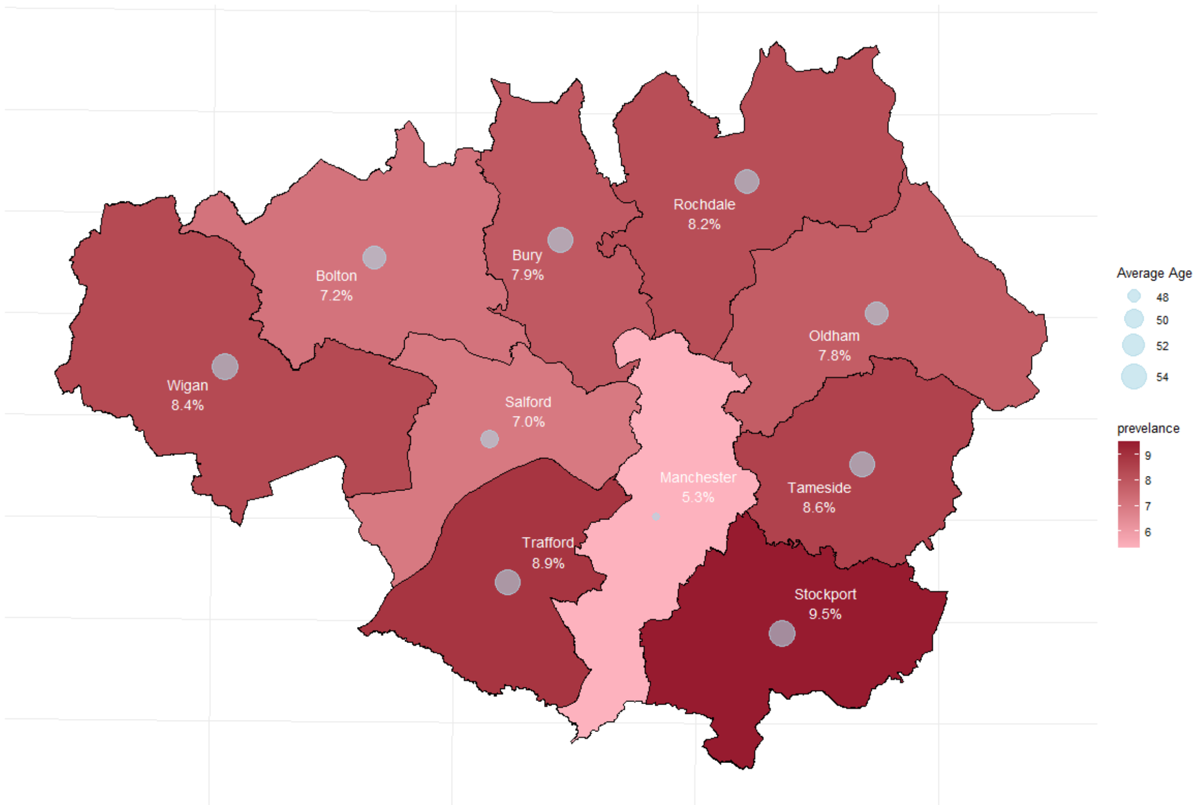
Alongside prevalence, total costs and average cost per thousand habitants directly increase with age. Healthcare and social care costs per patient disproportionally increase with age to reflect a higher prevalence of multimorbidity and need for social care services amongst older populations. Productivity costs increase with age up to 65, at which point they are reduced to zero due to an assumed exit from employment at this point.[25]

25 We note the split of individual costs and productivity costs across age groups are an extent underestimated for younger populations and overestimated for older populations. This is because mortality costs are higher in younger populations to reflect a large amount of life-years and work-years lost; however the cost by subpopulations figures assume an equal

### 3.3.2 Breakdown of costs by borough

Certain boroughs are particularly affected by CVD. Figure 3 shows that CVD prevalence is lowest in Manchester (5.3%) and highest in Stockport (9.5%), and that this prevalence is to a large extent correlated with average age.

## Figure 3 Prevalence of CVD by borough in Greater Manchester




*Source: Frontier Economics based on ADSP*

*Note: The numbers in the map represent average CVD prevalence. Average age is reflected on the size of the bubbles.*

Table 12 below presents our breakdown of CVD costs split by borough.

average cost of mortality per person (accounting solely for whether the person is of working age, for the case of productivity loses). This does not affect the overall cost figures in Greater Manchester which accurately considers the age at which mortality occurs.

## Table 12 Incremental annual costs by borough

| | Manchester | Salford | Bolton | Bury | Oldham | Wigan | Rochdale | Tameside | Trafford | Stockport |
|---|---|---|---|---|---|---|---|---|---|---|
| CVD prevalence (all adults) | 5.3% | 7.0% | 7.2% | 7.9% | 7.8% | 8.4% | 8.2% | 8.6% | 8.9% | 9.5% |
| *CVD prevalence (18-64)* | *2.3%* | *2.7%* | *2.8%* | *2.8%* | *3.1%* | *2.9%* | *3.2%* | *3.4%* | *3.2%* | *3.3%* |
| *CVD prevalence (65+)* | *28.8%* | *30.3%* | *23.7%* | *25.3%* | *27.1%* | *25.7%* | *27.6%* | *28.3%* | *28.8%* | *29.1%* |
| Healthcare costs | £77.55 million | £45.08 million | £43.14 million | £32.86 million | £37.13 million | £57.71 million | £39.50 million | £33.20 million | £43.60 million | £62.66 million |
| Formal care costs | £67.24 million | £39.35 million | £40.04 million | £29.98 million | £33.26 million | £53.48 million | £35.14 million | £29.90 million | £38.89 million | £55.92 million |
| Informal care costs | £35.15 million | £20.01 million | £20.09 million | £14.84 million | £16.82 million | £26.41 million | £17.67 million | £15.06 million | £19.35 million | £27.59 million |
| Individual costs | £183.16 million | £104.25 million | £104.67 million | £77.30 million | £87.63 million | £137.59 million | £92.09 million | £78.45 million | £100.83 million | £143.75 million |
| Productivity costs | £63.93 million | £30.79 million | £29.05 million | £19.03 million | £25.30 million | £33.41 million | £25.70 million | £22.29 million | £25.71 million | £34.25 million |
| **Total costs** | **£427.02 million** | **£239.47 million** | **£237.00 million** | **£174.01 million** | **£200.15 million** | **£308.59 million** | **£210.10 million** | **£178.90 million** | **£228.39 million** | **£324.17 million** |
| *Proportion* | *16.89%* | *9.47%* | *9.38%* | *6.88%* | *7.92%* | *12.21%* | *8.31%* | *7.08%* | *9.03%* | *12.82%* |
| Average cost per 1000 inhabitants | £748,077 | £967,091 | £974,282 | £1,071,782 | £1,074,153 | £1,127,442 | £1,130,052 | £1,174,749 | £1,216,536 | £1,292,449 |

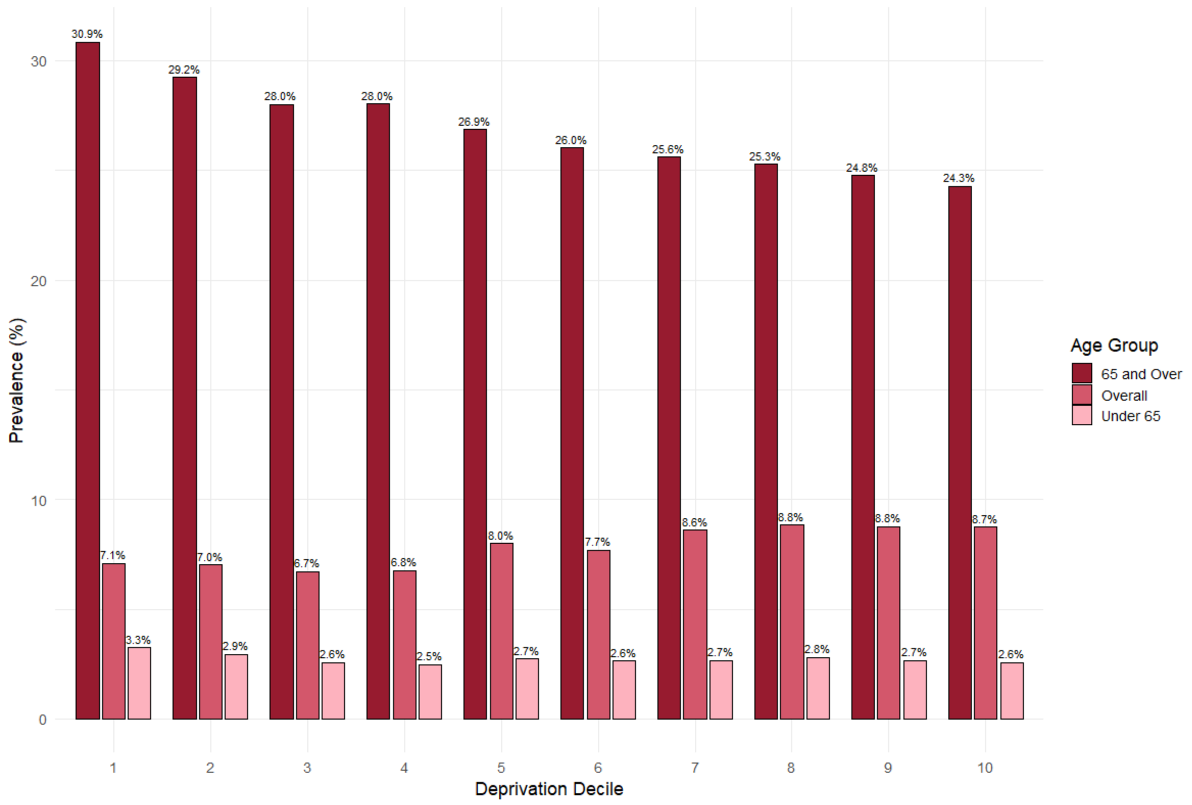
*Source: Frontier Economics*

Following the trends in prevalence, Table 12 shows that total costs per thousand inhabitants are highest in Stockport (£1,292,449), and lowest in Manchester (£748,077). However, total costs are highest in Manchester (£427 million), the borough with the largest population, and lowest in Bury (£174 million), the borough with the lowest population.

### 3.3.3 Breakdown of costs by deprivation decile

CVD disproportionately affects more deprived individuals. For example. Figure 4 shows that disease prevalence is as low as 24.3% for individuals aged 65 and over in the 10th deprivation decline (least deprived) and as high as 30.9% for individuals aged 65 and over in the 1st deprivation decline (most deprived). Conversely, total prevalence amongst all age groups is highest in the least deprived areas (e.g. 8.7% in last deprivation decline), reflecting an older population in less deprived areas.

#### Figure 4 Prevalence of CVD by deprivation decile in Greater Manchester




*Source: Frontier Economics based on ADSP*
*Note: [Insert Notes]*

Table 9 below presents our breakdown of CVD costs split by deprivation decile.

## Table 13 Incremental annual costs by deprivation decile

| Decile | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | ← Most deprived | | | | | | | | Least deprived → | |
| CVD prevalence (all adults) | 7.1% | 7.0% | 6.7% | 6.8% | 8.0% | 7.7% | 8.6% | 8.8% | 8.8% | 8.7% |
| *CVD prevalence (18-64)* | *3.3%* | *2.9%* | *2.6%* | *2.5%* | *2.7%* | *2.6%* | *2.7%* | *2.8%* | *2.7%* | *2.6%* |
| *CVD prevalence (65+)* | *30.9%* | *29.2%* | *28.0%* | *28.0%* | *26.9%* | *26.0%* | *25.6%* | *25.3%* | *24.8%* | *24.3%* |
| Healthcare costs | £113.93 million | £67.56 million | £52.40 million | £39.99 million | £35.62 million | £29.84 million | £34.23 million | £38.74 million | £33.27 million | £26.43 million |
| Formal care costs | £98.14 million | £58.85 million | £46.65 million | £35.65 million | £32.33 million | £27.36 million | £31.58 million | £36.23 million | £31.13 million | £24.90 million |
| Informal care costs | £51.33 million | £30.24 million | £23.66 million | £17.96 million | £15.99 million | £13.55 million | £15.36 million | £17.64 million | £15.06 million | £12.00 million |
| Individual costs | £267.45 million | £157.54 million | £123.26 million | £93.57 million | £83.33 million | £70.57 million | £80.04 million | £91.89 million | £78.48 million | £62.54 million |
| Productivity costs | £95.83 million | £50.59 million | £35.85 million | £25.89 million | £20.18 million | £17.16 million | £16.70 million | £19.29 million | £15.66 million | £11.89 million |
| **Total costs** | **£626.68 million** | **£364.78 million** | **£281.83 million** | **£213.07 million** | **£187.44 million** | **£158.48 million** | **£177.90 million** | **£203.78 million** | **£173.59 million** | **£137.76 million** |
| *Proportion* | *24.82%* | *14.44%* | *11.16%* | *8.44%* | *7.42%* | *6.28%* | *7.04%* | *8.07%* | *6.87%* | *5.46%* |
| Average cost per 1000 inhabitants | £1,000,516 | £978,174 | £924,708 | £925,487 | £1,080,904 | £1,040,474 | £1,151,655 | £1,180,493 | £1,166,110 | £1,158,427 |

*Source: Frontier Economics based on ADSP data*

More deprived populations account for a larger proportion of CVD costs. Indeed, 24.82% of all NHS costs in Greater Manchester due to CVD arise in the first deprivation decile (which includes individuals living in the most deprived 10% of LSOAs in England). By contrast, only 5.46% of the costs relate to individuals in the $10^{th}$ deprivation decile (i.e. the least deprived). This is largely driven the fact that a large proportion of the population in Greater Manchester lives in more deprived areas.

Interestingly, the average cost per 1000 inhabitants is lower for the most deprived decile (£1,000,516) relative to the least deprived decile (£1,158,427). This is because deprived areas tend to have younger populations: indeed, while prevalence for each individual age groups is lowest for the least deprived populations (as seen in Figure 4), as a whole prevalence is highest amongst least deprived areas (e.g. 8.7% in the least deprived areas compared to 7.1% in the most deprived areas).

### 3.3.4 Breakdown of costs by sex

Table 14 below presents our breakdown of CVD costs split by sex:

## Table 14 Incremental annual costs by sex

| | Male | Female |
|---|---|---|
| CVD Prevalence (all adults) | 8.5% | 6.5% |
| *CVD Prevalence (18-64)* | *3.4%* | *2.2%* |
| *CVD Prevalence (65+)* | *32.1%* | *23.3%* |
| NHS costs | £272 million | £200 million |
| Formal care costs | £239 million | £184 million |
| Informal care costs | £122 million | £91 million |
| Individual costs | £634 million | £475 million |
| Productivity costs | £193 million | £116 million |
| **Total costs** | £1461 million | £1067 million |
| *Proportion* | *57.8%* | *42.2%* |
| Average cost per 1000 inhabitants | £1,173,083 | £877,917 |

*Source: Frontier Economics*

CVD prevalence is higher amongst men (8.5%) than women (6.5%). Accordingly, average costs per 1000 inhabitants are higher for man (£1,173,083) than for women (£877,917).

### 3.3.5 Breakdown of costs by ethnicity

Table 15 below presents our breakdown of CVD costs split by ethnicity.

#### Table 15 Incremental annual NHS and social care costs by ethnicity

| | Unknown | Mixed or multiple ethnic groups | Other Ethnic Groups | Black, African, Caribbean, or Black British | Asian or Asian British | White British |
|---|---|---|---|---|---|---|
| CVD Prevalence (all adults) | 2.8% | 2.7% | 2.9% | 3.0% | 4.3% | 9.6% |
| *CVD Prevalence (18-64)* | *1.1%* | *1.6%* | *1.6%* | *1.8%* | *2.3%* | *3.5%* |
| *CVD Prevalence (65+)* | *15.6%* | *22.5%* | *24.6%* | *21.6%* | *27.8%* | *28.4%* |
| NHS costs | £18 million | £3 million | £4 million | £8 million | £38 million | £400 million |
| Formal care costs | £16 million | £3 million | £4 million | £7 million | £33 million | £361 million |
| Informal care costs | £8 million | £1 million | £2 million | £4 million | £18 million | £179 million |
| Individual costs | £42 million | £8 million | £11 million | £21 million | £94 million | £933 million |
| Productivity costs | £13 million | £4 million | £5 million | £11 million | £41 million | £235 million |
| **Total** | **£9 million** | **£19 million** | **£27 million** | **£51 million** | **£225 million** | **£2109 million** |
| *Proportion* | *3.86%* | *0.74%* | *1.07%* | *2.02%* | *8.91%* | *83.41%* |
| Average cost per 1000 inhabitants | £381,194 | £394,871 | £417,667 | £439,551 | £623,208 | £1,304,795 |

*Source: Frontier Economics*

*Note: The figures for the Unknown ethnicity group are potentially less reliable. This is because there may be worse access to information on the health state (and any CVD diagnostic) for individuals for which ethnicity information is not known.*

Individuals with White ethnicity account for the majority of the costs derived from CVD (83.4%). This reflects a higher population size but also a higher disease prevalence (9.6%). Meanwhile individuals with Mixed ethnicity account for the smallest proportion of costs (0.74%), reflecting population size and relatively low prevalence.

Considering costs on a 'per thousand inhabitants' basis, costs are lowest for individuals with unknown ethnicity, reflecting a lower CVD prevalence by age group (1.1% and 15.6% for those below and age 65, accordingly). Costs per thousand inhabitants are also highest for individuals with White British ethnicity (£1,304,795), followed by individuals with Asian ethnicity (£623,208). This disparity is likely influenced, at least in part, by differences in engagement with healthcare services among certain ethnic groups, leading to a higher proportion of undiagnosed CVD cases in some populations.[26] Indeed, based on practical experience, the Steering Group for this work indicated it is plausible that individuals of Black, African, Caribbean, or Black British likely had a higher prevalence of CVD than indicated by the available data. This highlights underlying health inequalities amongst certain populations, as undiagnosed disease can lead to a disproportionally higher burden of CVD to individuals – particularly in relation to individual costs associated with diminished health-related quality of life due to unmanaged disease.

## 3.4 Risk factors

The impact framework sets out a variety of risk factors to CVD, including high risk conditions such as hypertension, and lifestyle factors such as smoking. While we have not explicitly modelled the contribution of individual risk factors on costs, it is reasonable to assume a large correlation between the impact of these risk factors on the burden for individuals and on wider societal costs.

Table 16 sets out estimates from the Global Burden of Disease on the percentage of the burden on individuals caused by CVD, measured in terms of disability adjusted life years (DALYs), that is attributable to a variety of modifiable risk factors. The latest figures available, relative to 2021, indicate that nearly 70% of the burden on individuals is attributable to preventable factors, highlighting the importance of prevention. Assuming a similar risk profile amongst patients in the UK and in Greater Manchester, and direct relationship between DALYs and economic costs, this data suggests that hypertension, unhealthy diet and high LDL cholesterol are leading causes of the costs of CVD in Greater Manchester.

### Table 16 Percentage of CVD burden on individuals (in terms of DALYs) attributable to modifiable risk factors, UK

| | 2011 | 2016 | 2021 |
|---|---|---|---|
| **All modifiable risk factors** | **71.9%** | **69.9%** | **69.5%** |
| High systolic blood pressure (hypertension) | 40.8% | 39.9% | 39.9% |
| Dietary risks (lack of wholegrains, nuts, seeds, fruit, veg, etc; excess salt, sugar) | 27.0% | 26.3% | 25.9% |

26 Our overall cost estimates and our costs per subpopulation are based on data on the number of patients in Greater Manchester diagnosed with CVD, based on ADSP. To the extent that certain individuals with CVD are not diagnosed (e.g. as a result of under-engagement with healthcare services) we would not be capturing the costs associated with CVD for those patients. It is plausible that those individuals would not lead to incremental healthcare costs, at least in the short run, implying our estimated healthcare costs may reflect true costs. However, we would be underestimating the true costs associated with the remaining cost categories – e.g. the individuals costs associated with reductions in quality of life.

| | 2011 | 2016 | 2021 |
|---|---|---|---|
| High LDL (bad) cholesterol | 22.3% | 21.1% | 20.8% |
| Impaired kidney function (dysfunction; renal failure) | 10.1% | 9.5% | 9.6% |
| High body-mass index (obesity and excess weight) | 11.8% | 12.1% | 12.4% |
| Tobacco (cigarette smoking, second-hand smoke) | 15.8% | 14.1% | 13.5% |
| High fasting plasma glucose (diabetes) | 8.6% | 8.7% | 9.3% |
| Non-optimal (low/high) temperature | 4.7% | 4.9% | 4.8% |
| Air pollution (particulate matter) | 7.2% | 5.5% | 5.1% |
| Low physical activity (inactivity, sedentary behaviour) | 3.8% | 3.6% | 3.6% |
| Other environmental risks (e.g. lead exposure) | 3.0% | 2.8% | 2.6% |
| High alcohol use (misuse; binge drinking) | 1.3% | 1.5% | 1.6% |
| Other (non-modifiable) risk factors/unknown | 28.1% | 30.1% | 30.5% |

Source: *Global Burden of Disease Collaborative Network, Global Burden of Disease Study 2021 Results.*
Note: *[Insert Notes]*

An analysis of patient level data from Greater Manchester using ADSP provides further evidence on the associated between high risk conditions and CVD. Across all high risk conditions condition, we find that patients living with the high risk condition (e.g. hypertension) have a higher incidence of CVD.

## Table 13 CVD prevalence by diagnosis of high risk conditions, split by age

| | 65 or older | | Under 65 | |
|---|---|---|---|---|
| | **With high risk condition** | **Without high risk condition** | **With high risk condition** | **Without high risk condition** |
| Hypertension | 40.13% | 26.59% | 7.19% | 2.08% |
| Atrial Fibrillation | 43.02% | 23.78% | 6.60% | 2.67% |
| Diabetes | 32.84% | 27.39% | 5.17% | 2.55% |
| Non-Diabetic Hyperglycaemia | 31.92% | 30.81% | 4.27% | 2.85% |

| | 65 or older | | Under 65 | |
|---|---|---|---|---|
| Chronic Kidney Disease | 35.78% | 25.72% | 4.63% | 2.76% |

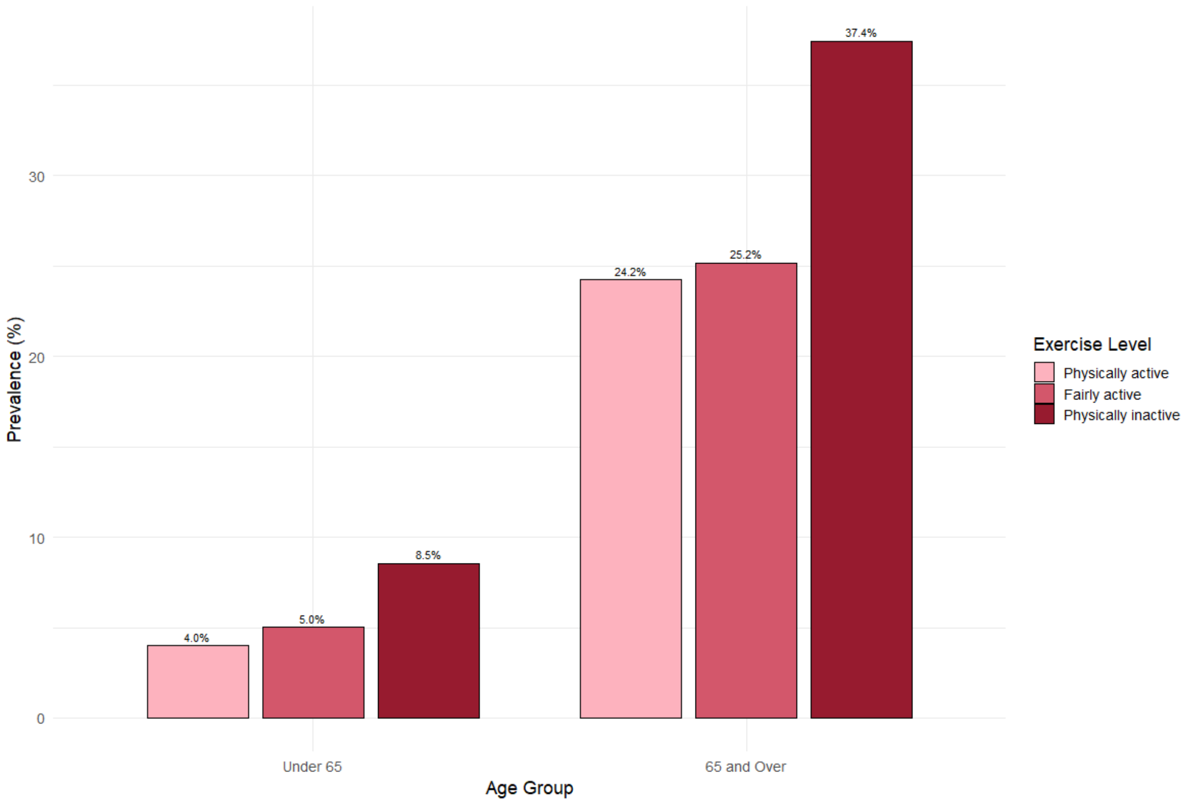
*Source: Frontier Economics*

*Note: As indicated earlier in the report, we consider atrial fibrillation to be a risk factor rather than CVD. We note that there is divergence in how this condition is treated (risk factor or CVD) across the literature.*

We have further explored the link between prevalence and lifestyle factors using ADSP data. As information on lifestyle factors was not available for all patients in Greater Manchester, we restricted the analysis to the subset of patients for which such data was available. To the extent there are systematic differences amongst individuals for which this information is reported and those it is not, the true prevalence by lifestyle may differ.

We find that CVD prevalence is lowest amongst more active individuals. For example, amongst patients over 65, CVD prevalence is as high as 37.4% for those physically inactive and as low as 24.2% for those physically active.

## Figure 5 CVD prevalence by Exercise Level, split by age

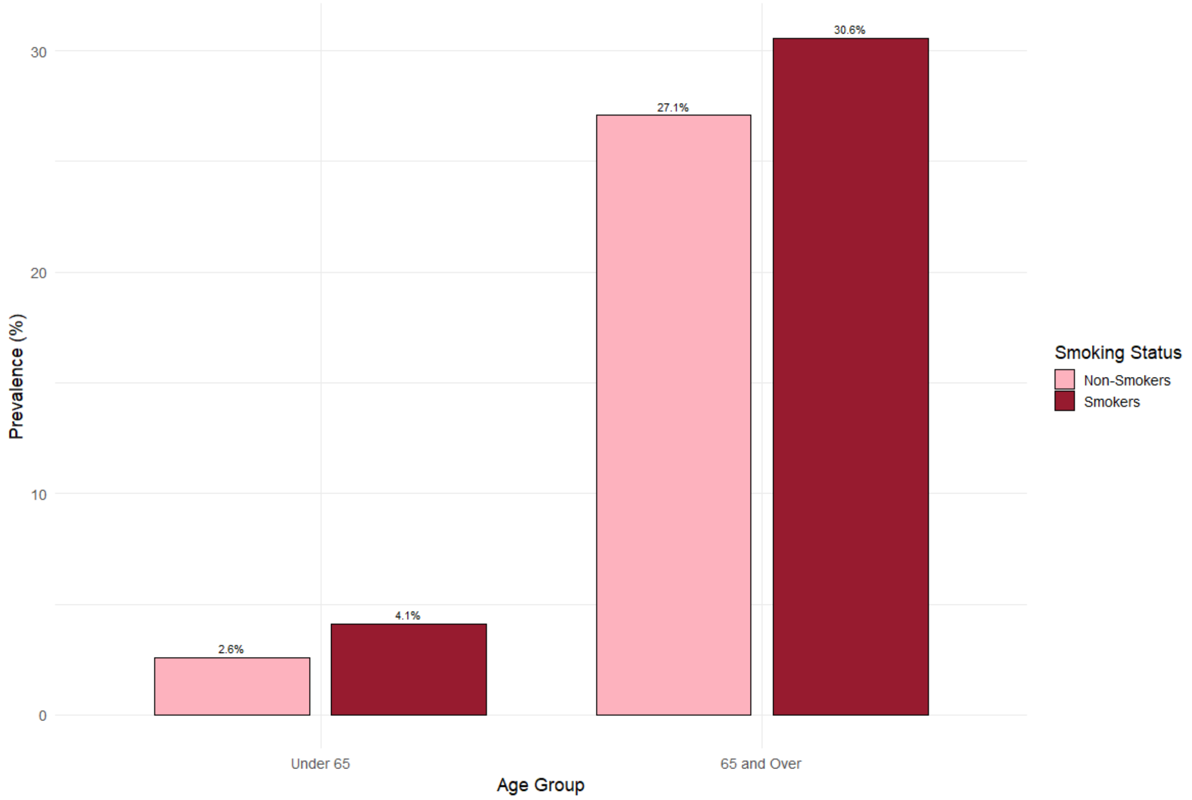



*Source: Frontier Economics based on ADSP*

*Note: Prevalence is compiled only amongst the subset of patients for which exercise data is available*

We find that CVD prevalence is lowest amongst non-smokers relative to smokers. For example, amongst patients over 65, CVD prevalence is 30.6% for smokers and 27.1% for non-smokers.

## Figure 6 CVD prevalence by Smoking Status, split by age

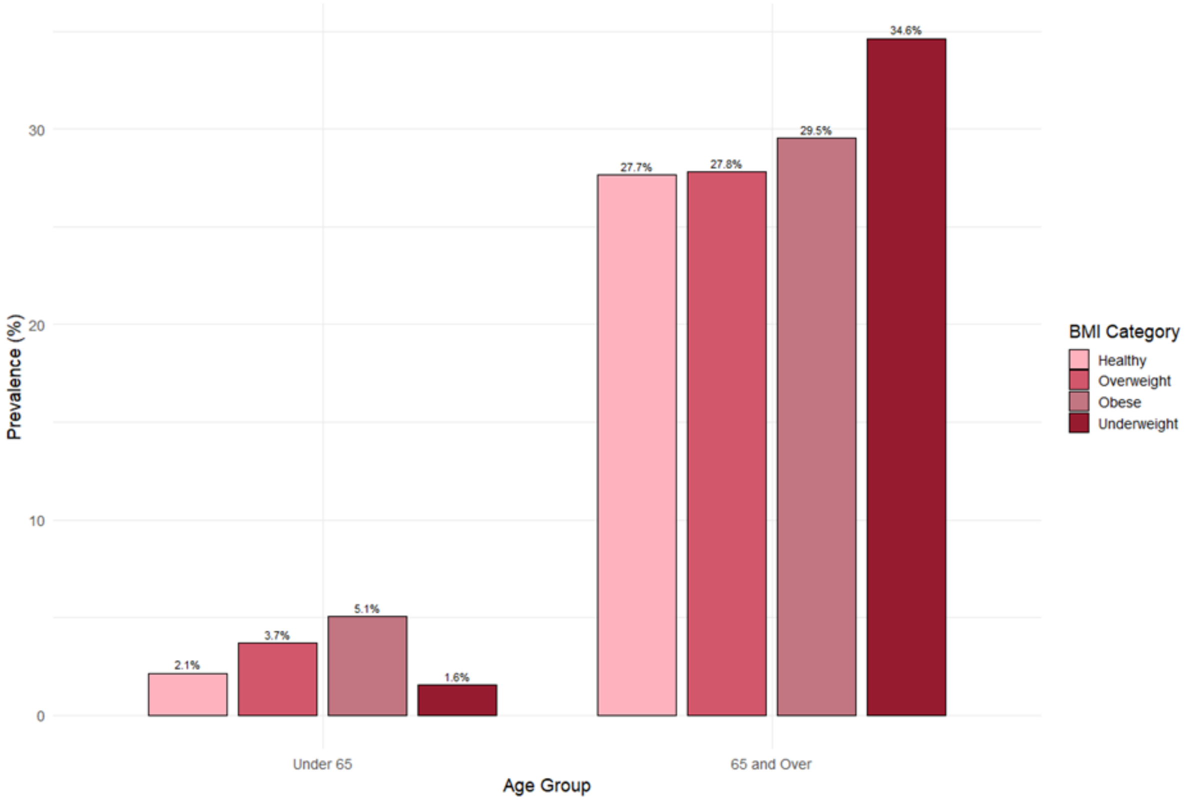



*Source: Frontier Economics based on ADSP*

*Note: Prevalence is compiled only amongst the subset of patients for which smoking status is available*

We find that CVD prevalence tends to increase for individuals with overweight and obesity when compared to individuals with healthy weight. For example, amongst patients over 65, CVD prevalence is lowest for healthy weight individuals (27.7%), increasing for individuals with obesity (29.5%). For underweight individuals, the results are more volatile: CVD prevalence is lowest amongst underweight below 65, but highest amongst underweight at or above 65. This may reflect a relative small sample size for individuals in this weight category, or a varying correlation with other factors associated with CVD (e.g. smoking) that change with age amongst underweight patients.

### Figure 7 CVD prevalence by BMI Category, split by age




*Source: Frontier Economics based on ADSP*
*Note: Prevalence is compiled only amongst the subset of patients for which BMI data is available*

Wider societal factors, such as the level of education or deprivation, are linked to the risk factors discussed above and therefore have implications on the prevalence of CVD.

- As explored with further detail in section 3.3.3, wider societal factors such as the level of deprivation are related to varying degrees of CVD prevalence and therefore costs.
- As explored with further detail in section 3.2, CVD patients living in poorer areas tend to have a higher number of cardiovascular illnesses.

## 3.5 Potential avoided costs if rates of CVD were lower

We have modelled three scenarios on the costs which could potentially be avoided if rates of CVD were lower than those currently observed in Greater Manchester. The scenarios are as follows:

- **Scenario 1:** If CVD prevalence in Greater Manchester was reduced by 5%;
- **Scenario 2:** If CVD prevalence in Greater Manchester was reduced by 10%;
- **Scenario 3:** If CVD prevalence in Greater Manchester was reduced by 20%;

## Table 17 Potential avoided costs in GM if CVD levels were decreased

| | CVD prevalence scenario | | | |
|---|---|---|---|---|
| | **Current** | **Scenario 1 (5% reduction)** | **Scenario 2 (10% reduction)** | **Scenario 3 (20% reduction)** |
| Healthcare costs | £472 million | £449 million | £425 million | £378 million |
| Formal social care | £423 million | £402 million | £381 million | £339 million |
| Individual costs | £1110 million | £1054 million | £999 million | £888 million |
| Informal care | £213 million | £202 million | £192 million | £170 million |
| Productivity costs | £309 million | £294 million | £279 million | £248 million |
| **Total** | **£2.5n** | **£2.4bn** | **£2.3bn** | **£2.0bn** |

*Source: Frontier Economics*

We estimate that if CVD prevalence in Greater Manchester was reduced by 5%, 10% or 20% the overall annual costs savings would amount to £126 million, £253 million and £506 million, respectively.

These potential avoided costs indicate the potential 'prize' which could be achieved through effective policy interventions. However, these are not intended to provide accurate estimates of 'savings' which could be achieved if prevalence of CVD is reduced. To estimate any such savings would require an intervention study to observe the impact of reducing rates of CVD, accounting for interactions between CVD and other characteristics, conditions and behaviours. We note that these interventions would also involve costs, which would also need to be considered.

# Annex A – Modelling assumptions and evidence sources

## A.1 General statistics

**CVD patients**: We used local NHS data (ADSP) to obtain the number of adult patients with CVD in Greater Manchester. We define CVD patients as those with at least one the following conditions: coronary heart disease, heart failure, peripheral arterial disease, stroke, transient ischaemic attack, heart valve disease and vascular dementia.

**Population**: We used ADSP data to obtain the total number of adults patients in Greater Manchester. These numbers may differ to those in other sources, including census data.

**Prices:** The analysis was carried out in August 2024 prices. The inputs used in the analysis are based on the most recent evidence available. Where inputs refer to years prior to August 2024, the analysis used the CPI index (from the ONS) to bring inputs to August 2024 prices using the following formula:

Adjusted input = Original input * (CPI August 2024/CPI reference date)

## A.2 Costs to the healthcare sector

The data sources informing our calculations are summarised in the following tables.

### Table 18 Incremental annual healthcare cost per ilness (2024 prices)

| | Male | Female | Source and notes |
|---|---|---|---|
| Stroke/TIA | £3,016 | £2,412 | PHE – The health and social care costs of a selection of health conditions and multi-morbidities. Tables 3 and 4[27]<br>Available here |
| CHD | £1,774 | £1,426 | See Above |
| Heart Failure | £3,379 | £3,379 | Estimating the economic burden of cardiovascular events in patients receiving |

[27] In the estimation of costs using this source, Definition B is used as it includes a wider base of patients covering a longer timeframe (except for Colorectal cancer, the results for which are not statistically significant under Definition B, so Definition A costs are used). The baseline result is subtracted from the regression results for cost per case for each related illness, so that only the costs relating to the specific illness in question are captured. It was assumed that the cost a TIA would be equivalent to the cost of a stroke.

| | Male | Female | Source and notes |
|---|---|---|---|
| | | | lipid-modifying therapy in the UK.[28] Available here. |
| Peripheral Arterial Disease | £2,952 | £2,952 | Long-term cardiovascular outcome, use of resources, and healthcare costs in patients with peripheral artery disease: results from a nationwide Swedish study.[29]<br>Available here. |
| Vascular Dementia | £3,824 | £3,824 | Excess Costs Associated with Possible Misdiagnosis of Alzheimer's Disease Among Patients with Vascular Dementia in a UK CPRD Population [30], see here.<br>This literature indicates that there are cases where vascular dementia patients are misdiagnosed and incur higher costs as a result. We exclude these cases and assume that all vascular dementia patients incur costs associated with the correct treatment. |

*Source: Frontier Economics based on ADSP*

In preparing this report, we have carefully considered a range of evidence sources. Our focus has been on higher-quality, more robust evidence. Where there was uncertainty, we have consistently opted for more conservative estimates. For example:

- research published on the European Stroke Journal (available here) suggest the average annual incremental healthcare costs associated with Stroke in the first five years to be £4,666 (2024 prices); considerably above the cost estimates used in our analysis.
- research published on the International Journal of cardiology (available here) suggest the average annual incremental healthcare costs associated with Heart Failure in patient's last five years of life to be £7,730 (2024 prices); considerably above the cost estimates used in our analysis.

28 Costs in this paper were split into the costs of the first and second event. The costs were then further disaggregated into the costs for the first 6 months after the event and then an annualised cost for the following 2.5 years. To calculate the annual costs of heart failure, the average costs between the first and the second event were calculated. Then, the total cost over the three years was calculated, and then divided by three, to produce an annual cost of heart failure.

29 Health care costs prior to the diagnosis of PAD, and the average costs in the two years following a PAD diagnosis, were provided. To produce an annualised incremental cost to PAD, the average cost was calculated for the two years post diagnosis, subtracting to these average healthcare cost prior to the diagnosis was subtracted.

30 Healthcare Costs for the 5 years after a correct Vascular Dementia diagnosis were divided by 5 to get an annualised healthcare cost. Average Baseline Healthcare costs between men and women from the PHE report (available here) were then subtracted to get an incremental annual cost of Vascular Dementia.

Costs were estimated based on diagnosed disease prevalence, as per ADSP data. The table below sets out prevalence figures across the illnesses considered in this report.

### Table 19 Prevalence per cardiovascular disease

| Cardiovascular disease | Male prevalence | Female prevalence |
|---|---|---|
| Coronary heart disease | 4.67% | 2.58% |
| Stroke and TIA | 2.36% | 2.11% |
| Heart failure | 1.38% | 0.96% |
| Peripheral arterial disease | 1.04% | 0.59% |
| Vascular dementia | 0.21% | 0.30% |
| Heart valve disease | 1.72% | 1.93% |

*Source: Frontier Economics based on ADSP*

To explore multimorbidity, we have compared non-elective secondary healthcare usage for individuals living with a different number of cardiovascular illnesses. We have then estimated the monetary cost associated with this incremental non-elective secondary healthcare usage for patients with multimorbidity, and assumed that the overall incremental healthcare costs (including primary care and medications) for individuals with a different number of conditions are proportion that of non-elective secondary healthcare costs.

### Table 20 Average non-elective secondary healthcare usage per adult

| | Outpatient attendances | A&E attendances | Emergency admissions (CVD related) |
|---|---|---|---|
| No CVD | 1.51 | 0.37 | 0.00 |
| 1 CVD | 4.10 | 0.77 | 0.07 |
| 2 CVD | 5.46 | 1.08 | 0.12 |
| 3+ CVD | 6.88 | 1.46 | 0.19 |

*Source: Frontier Economics based on ADSP*

*Note: We have examine healthcare usage separately for patients in different age groups and observed that the incremental healthcare usage for different number of CVD's is comparable across patients below 65 and above 65. We have therefore analysed and compared health usage for all patients together, not splitting by age.*

### Table 21 Non-elective secondary healthcare unit cost

| Healthcare activity | Unit cost (2024£) |
|---|---|
| Outpatient visit | 189.97 |
| A&E attendance | 278.62 |
| Emergency admission (CVD related) | 5043.49 |

*Source: NHS England, National Schedule of NHS Costs, 2021-22; ADSP*

*Note: Outpatient visit costs calculated as the total weighted average unit cost of "outpatient attendances"*
*Elective admission costs calculated as the total weighted average unit cost of "elective inpatient" and "day cases"*
*Emergency admission costs were provided in the NHS SUS data. These are focused on the cost of admissions amongst CVD patients for which the primary diagnosis start with letter I (ICD-10 code).*

## A.3 Costs of formal social care

The inputs and assumptions for our estimates are based on the data sources listed below.

### Table 22 Costs of formal social care – inputs and assumptions

| Inputs and assumptions | Estimate | Source |
|---|---:|---:|
| Hourly cost of a social care worker (2024 prices) | £28 | Unit Costs of Health and Social Care programme (2022 – 2027), Available here. |
| Annual cost of institutional care cost (2024 prices) | £61,862 | Unit Costs of Health and Social Care programme (2022 – 2027), Available here.<br>The Institutional care cost used was the average cost of Private Nursing Homes and Private residential care homes. |

*Source: Frontier Economics*

The additional hours of home social care resulting from CVD were estimated based on published literature[31] which analyses self-reported social care usage for participants of the English Longitudinal Study of Ageing (ELSA). Table 23 below presents the regression results from this research, where the Probit model results provide evidence on the likelihood of patients requiring social care services, and the OLS model provides evidence on the amount of hours of social care used by patients that require social care.

31 https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0268766

## Table 23 Econometric outputs - factors linked with home social care usage (ELSA)

| Variable | Probit model (coefficient & SEs) | OLS model (coefficient & SEs) |
|---|---|---|
| *Sex* | | |
| Male | -0.31*** | 2126.2** |
| | (0.0382) | (1073.9) |
| *Age group* | | |
| 55-59 | 0.0882 | 3713.6 |
| | (0.121) | (4437.2) |
| 60-64 | 0.188 | 1938 |
| | (0.115) | (4208.7) |
| 65-69 | 0.234** | -35.51 |
| | (0.113) | (4145.1) |
| 70-74 | 0.375*** | -1156.3 |
| | (0.113) | (4087.9) |
| 75-79 | 0.748*** | -1750.8 |
| | (0.109) | (3927.4) |
| 80-84 | 0.914*** | -1035.9 |
| | (0.112) | (3950.9) |
| 85+ | 1.409*** | -529 |
| | (0.11) | (3867.5) |
| CVD | 0.335*** | -1230.9 |
| | (0.0613) | (1875.8) |
| CVD+CI | 0.462*** | -400.5 |
| | (0.147) | (3733.5) |
| CI | 0.172 | 1722.6 |
| | (0.105) | (3116.7) |
| CVD+FI | 1.070*** | 6292.9*** |
| | (0.0625) | (1587.8) |
| CVD+CI+FI (CVD+Dementia) | 1.243*** | 9374.2*** |

| | | |
|---|---|---|
| | (0.0863) | (1910.9) |
| CI+FI (Dementia) | 1.042*** | 8827.8*** |
| | (0.0827) | (1891.7) |
| FI without CVD or dementia | 0.929*** | 4053.9*** |
| | (0.0486) | (1404.9) |
| Constant | -2.478*** | 3405.2 |
| | (0.102) | (3851.1) |
| Observations | 19,863 | 19,863 |

Source: *Collins, B., Bandosz, P., Guzman-Castillo, M., Pearson-Stuttard, J., Stoye, G., McCauley, J., Ahmadi-Abhari, S., Araghi, M., Shipley, M. J., Capewell, S., French, E., Brunner, E. J., & O'Flaherty, M. (2022). What will the cardiovascular disease slowdown cost? Modelling the impact of CVD trends on dementia, disability, and economic costs in England and Wales from 2020-2029. PloS one, 17(6), e0268766. https://doi.org/10.1371/journal.pone.0268766*

Note: *Reference groups are: Female, Age 35-54, Free of all. Heteroskedasticity robust standard errors are displayed in parentheses. * p < 0.1, ** < 0.05, *** p < 0.01.*

The regression outputs above indicate that CVD is linked a statistically significant increased probability of using home social care services (Probit model). Amongst those using home social care services, the presence of CVD is not linked with a statistically significant difference in the number of hours of care taken (OLS model).

We have applied these results to calculate the incremental average hours per patients with CVD (and without cognitive impairment or functional impairment) relative to patients without CVD (and without cognitive impairment or functional impairment), by age group and sex. We have calculated average incremental hours of care resulting from CVD (estimated at 49.44 hours per year) through averaging incremental hours amongst male and female (simple average) and amongst age groups (weighted average based on CVD prevalence by age).

The evidence for home social care usage is likely less robust than the remaining. This evidence is based on survey data, which can suffer from various sources of issues, including response bias (when respondents provide inaccurate or misleading answers) and measurement bias (arising from the way questions are framed, interpreted, or administered). The data is furthermore focused on the subset of the population who participated in the ELSA survey, potentially leading to sampling bias.

## A.4 Costs of informal social care

We base our informal care costs on the ratio of healthcare to informal care costs from the European Cardiovascular Disease Statistics from the European heart network (available here). This study finds that informal care costs associated with CVD in the UK account for approximately 45% of healthcare costs.

We have considered alternative evidence sources. For example:

- Research published on the European Heart Journal (available here) indicates that informal care costs associated with CVD in the EU account for approximately 50% of healthcare costs.
- Research published on the PLOS (available here) indicates that informal care costs associated with CVD in the UK account for approximately 62% of healthcare costs.[32]

In our modelling we have conservatively opted to rely on the proportion derived from the first paper (45% estimate) following a lower-bound approach. None of the sources we reviewed provided detailed or disaggregated data to justify prioritizing the higher estimates.

## A.5 Costs due to productivity losses

Costs due to productivity losses are estimated for CVD patients under 65. The data sources informing our assumptions and calculations are summarised below.

### Table 2324 Data sources – losses from reduced employment

| Inputs and assumptions | Estimate | Source |
|---|---|---|
| Probability of worker leaving the workforce at CVD onset | 22.0% | Broken Hearted, Institute for Public Policy Research (IPPR)<br>Available here. |
| Probability of worker leaving the workforce (no health condition) | 7.0% | Broken Hearted, Institute for Public Policy Research (IPPR)<br>Available here. |
| Additional probability of leaving workforce due to CVD (worker) | 15.0% | calculated |
| Employment rate in GM 2023 | 71.4% | Employment, Unemployment and Economic inactivity in Manchester, Office for National Statistics (ONS) Available here.<br>Employment rate for Manchester was used for all of Greater Manchester. |
| Additional probability of leaving the workforce due to CVD (working-age person) | **10.7%** | calculated |
| Median annual salary in GM | £29,973 | ASHE Table 8, Available here. |

32 We note that the underlying disaggregated results from the regressions undertaken to arrive at these numbers were not provided by the authors.

| Inputs and assumptions | Estimate | Source |
|---|---|---|
| **Foregone annual salary per working-age person with CVD** | **£3,210** | calculated |

*Source: Frontier Economics*

We have validated our approach by comparing it against an alternative methodology, presented in the table below. This alternative approach – which was not used in our modelling - provides similar results, providing reassurance to our results.

## Table 2425 Cross check – losses from reduced employment

| | | Source |
|---|---|---|
| Proportion out of work in GM (overall population)<br><br>(One minus the Employment Rate in GM, 2023) | 28.6% | Employment, Unemployment and Economic inactivity in Manchester, Office for National Statistics (ONS),<br><br>Available here.<br><br>Employment rate for Manchester was used for all of Greater Manchester. |
| Prevalence Ratio of those out of work with a CVD (vs without a CVD) | 1.36 | Cardiovascular disease subtypes, physical disability and workforce participation: A cross-sectional study of 163,562 middle-aged Australians, Available here. |
| Proportion out of work (amongst CVD patients) | 38.9% | As above |
| Lost economic activity due to CVD | **10.3%** | calculated |

*Source: Frontier Economics*

*Note: These calculations support our analysis but were not included in the main results. Instead, we opted for the alternative UK-based source presented earlier in this section for greater relevance.*

Costs due to productivity losses associated with CVD due to sickness absence are estimated for patients below 65. The data sources informing our assumptions and calculations are summarised below.

## Table 2526 Data sources – sickness absence losses[33]

| Inputs and assumptions | Estimate | Source |
|---|---|---|
| Days per staff year lost to long term sickness in the civil service | 4.4 | Civil service sickness absence, 2023 report, Cabinet Office, Available here. |
| Days per staff year lost to short term sickness in the civil service | 3.7 | Civil service sickness absence, 2023 report, Cabinet Office, Available here |
| Percent of long term absence due to CVD (“circulatory system”) in the civil service | 3.7% | Civil service sickness absence, 2023 report, Cabinet Office, Available here |
| Percent of short term absence due to CVD (“circulatory system”) in the civil service | 1.2% | Civil service sickness absence, 2023 report, Cabinet Office, Available here |
| long-term CVD-related work days lost per employee in the civil service | 0.16 | Calculated |
| short-term CVD-related work days lost per employee in the civil service | 0.04 | Calculated |
| employment rate for people with CVD | 60.7% | Calculated[34] |
| CVD prevalence | 7.5% | ADSP Data |
| long-term CVD-related work days lost per year person with CVD (UK) in the Civil Service | 1.32 | Calculated[35] |
| short-term CVD-related work days lost per year person with CVD (UK) in the Civil Service | 0.36 | Calculated[36] |

33 The civil service provide percentage of long term and short term sick days due to different conditions. Sick days in the UK civil service due to CVD was calculated. The estimates were adjusted to account for GM having higher than UK average sick days so that the estimates reflect the GM civil service. The estimates were then adjusted proportionally to account for the civil service taking higher than average sick days so that the estimates reflect the whole GM workforce.

34 This was calculated in Table 23. It is the employment rate in GM minus the additional probability of leaving the workforce due to CVD.

35 This is the employment rate multiplied by the average long term days lost in the civil service amongst those with a CVD. The latter can be calculated by dividing the average days lost per employee due to CVD by CVD prevalence in GM.

36 Same calculation as above but instead using short term days lost.

| | | |
|---|---|---|
| Civil servants sickness absence days in UK | 8.10 | Civil service sickness absence, 2023 report, Cabinet Office, Available here |
| Civil servants sickness absence days in North West | 8.80 | Civil service sickness absence, 2023 report, Cabinet Office, Available here |
| long-term CVD-related work days lost per year per Civil Servant with CVD (North West) | 1.43 | Calculated<br>Ratio of UK sickness absence days to North west used to scale up estimate to reflect higher than average sickness absence days in the North West than the UK. |
| short-term CVD-related work days lost per year per Civil Servant with CVD (North West) | 0.39 | Calculated<br>Ratio of UK sickness absence days to North west used to scale up estimate to reflect higher than average sickness absence days in the North West than the UK. |
| Average sick leave days UK (not just civil servants), 2022 | 5.70 | Sickness absence in the UK labour market, Available here. |
| Ratio of average civil service sick days to general population | 1.42 | Calculated |
| long-term CVD-related work days lost per year per person with CVD (North West) | **1.01** | Calculated<br>Ratio of average civil service sick days to UK wide sick days used to scale down the estimate due to the civil service taking higher than average sick days |
| short-term CVD-related work days lost per year per person with CVD (North West) | **0.27** | Calculated<br>Ratio of average civil service sick days to UK wide sick days used to scale down the estimate due to the civil service taking higher than average sick days |
| Median daily wage in GM, 2024 | £115.4 | ASHE Survey, Table 8<br>Available here |
| long-term CVD-related lost economic activity per year person with CVD (North West) | **£116.25** | Calculated |
| short-term CVD-related lost economic activity per year person with CVD (North West) | **£31.70** | Calculated |

*Source: Frontier Economics*

Costs of loss of productivity due to mortality are estimated based on mortality statistics of adults below 65 in Greater Manchester. The data sources informing our assumptions and calculations are summarised below.

## Table 2627 Mortality related to CVD in GM, by age

| Age group | Deaths per year |
|---|---|
| Aged 18-34 | 0 |
| Aged 35-39 | 5 |
| Aged 40-44 | 5 |
| Aged 45-49 | 73 |
| Aged 50-54 | 129 |
| Aged 55-59 | 234 |
| Aged 60-64 | 275 |
| Aged 65-69 | 391 |
| Aged 70-74 | 509 |
| Aged 75-79 | 863 |
| Aged 80-84 | 967 |
| Aged 85-89 | 1,018 |
| Aged 90 and over | 991 |

*Source: ONS Mortality statistics*

*Note: We have considered mortality from the cardiovascular illnesses in scope of the definition of this report, through the following ICD-10 codes: F01 Vascular dementia, G45 Transient cerebral ischaemic attacks and related syndromes, I70.0 Atherosclerosis of aorta, I70.1 Atherosclerosis of renal artery, I70.2 Atherosclerosis of arteries of extremities I73 Other peripheral vascular diseases, LC12 Cerebrovascular diseases, LC24 Heart failure and complications and ill-defined heart disease, LC30 Ischaemic heart diseases, LC34 Nonrheumatic valve disorders and endocarditis*

To estimate years of employment lost, we consider mortality statistics alongside the employment rate in GM, the median annual salary in GM, and average age of exit from employment in the UK:

## Table 2728 Evidence and assumptions for mortality producity losses

| | Value | Source |
|---|---|---|
| Employment rate in GM, 2023 | 71.4% | Employment, Unemployment and Economic inactivity in Manchester, Office for National Statistics (ONS) Available here.<br>Employment rate for Manchester was used for all of Greater Manchester. |

| | | |
|---|---|---|
| Median annual salary GM, 2024 prices | £29,973 | ASHE Table 8, Available here |
| Average age of exit from employment | 65.1 | ONS (available here) |
| Standard discount rate | 0.035 | Green book (available here) |

*Source: Frontier Economics*
*Note: [Insert Notes]*

## A.6 Costs due to loss of QALYs

The data sources informing our assumptions and calculations for QALY losses associated with CVD are summarised in Table 2829.

### Table 2829 Data sources – QALY losses

| Inputs and assumptions | Estimate | Notes and sources |
|---|---|---|
| QALYs lost due to living with Stroke/TIA | -0.081 | Estimating Long-Term Health Utility Scores and Expenditures for Cardiovascular Disease From the Medical Expenditure Panel Survey, Available here<br>The same disutility was assumed for TIA/ stroke |
| QALYs lost due to living with Heart Failure | -0.073 | Estimating Long-Term Health Utility Scores and Expenditures for Cardiovascular Disease From the Medical Expenditure Panel Survey, Available here |
| QALYs lost due to living with Coronary heart disease | -0.068 | What will Cardiovascular disease slowdown cost? Modelling the impact of CVD trends on dementia, disability, and economic costs in England and Wales from 2020-2029, Available here |
| QALYs lost due to living with Peripheral arterial disease | -0.044 | Estimating Long-Term Health Utility Scores and Expenditures for Cardiovascular Disease From the Medical Expenditure Panel Survey, Available here |

| | | |
|---|---|---|
| QALYs lost due to living with Vascular dementia[37] | -0.041 | Estimating Long-Term Health Utility Scores and Expenditures for Cardiovascular Disease From the Medical Expenditure Panel Survey, Available here<br>Assumed equal to the average estimation for Any CVD in model 3. |
| QALYs lost due to living with Heart valve disease | -0.041 | Estimating Long-Term Health Utility Scores and Expenditures for Cardiovascular Disease From the Medical Expenditure Panel Survey, Available here<br>Assumed equal to the average estimation for Any CVD in model 3 |
| EQ-D5 for person aged 75+ in England | 0.706 | Self-Reported Population Health: An International Perspective based on EQ-5D<br>Available here. |
| Monetary value of one QALY | £70,000 | Green Book (2022), page vii<br>Available here |
| NICE's cost effectiveness threshold | £20,000 | NICE Briefing (2013), page 3<br>Available here |

*Source: Frontier Economics*

*Note: We have assumed patients living with vascular dementia and heart valve disease experience a disutility equal to the estimation for the average amongst a range of cardiovascular illnesses considered, which is likely a conservative estimation. It is possible that patients with vascular dementia may experience reductions in their HRQoL similar to patients with Alzheimer's disease – which the evidence available suggests may entail larger disabilities (reserach shows patients living with moderate Alzheimer's disease experience HRQoL utilities as low as 0.53, considerably below the average for a person age 75+ in England of 0.706).*