



COSTS OF OBESITY IN GREATER MANCHESTER

Report for Lilly and Health Innovation Manchester

03 JUNE 2024

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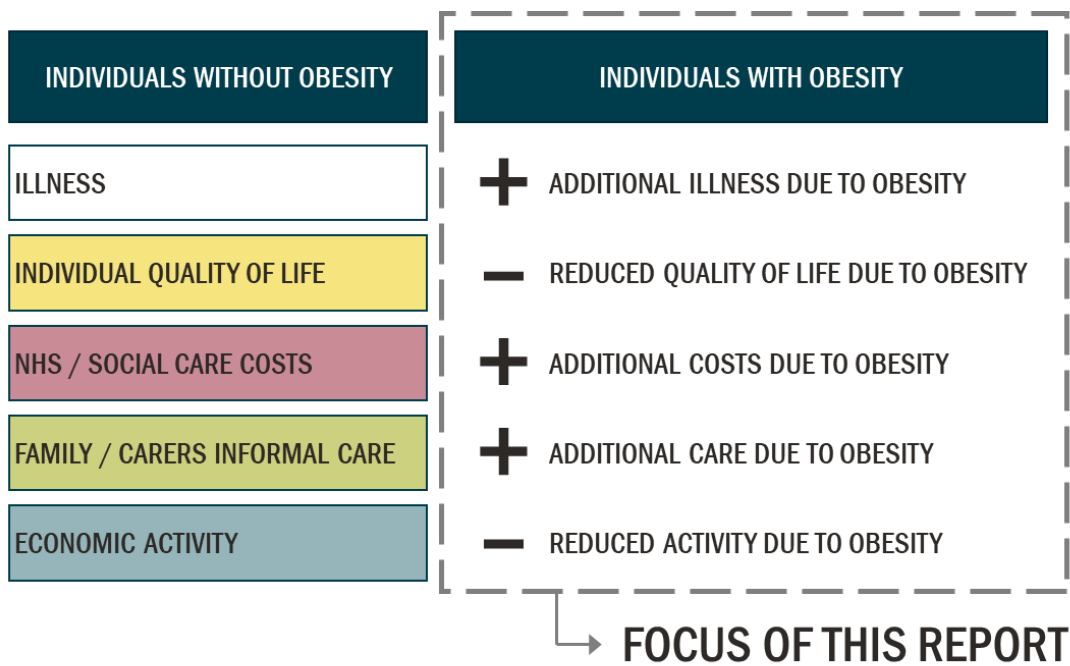
EXECUTIVE SUMMARY

Lilly, in partnership with Health Innovation Manchester, commissioned Frontier Economics to explore the costs of obesity in Greater Manchester. This report explores the following issues.

- The annual costs to the NHS and social care sector associated with obesity.
- The wider costs to individuals, the economy and society associated with obesity.
- The variation of these costs across subpopulations.
- The potential avoided costs if rates of obesity 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 for this work.

This report focuses on the **costs which are due to obesity**. These are the additional or **incremental costs**, which are experienced by individuals living with obesity which are not experienced by individuals not living with obesity.



Annual costs of obesity in Greater Manchester

£3.21 billion

Costs of obesity in Greater Manchester in 2023

We estimate that the costs of obesity in Greater Manchester in 2023 are **£3.21 billion**. See Sections 2 and 3 for full details of the results, calculations and underlying sources.

These costs are broken down as follows.

Table 1 Costs of obesity in Greater Manchester in 2023

Cost area	Description	Average cost per person living with obesity	Total
NHS	Cost of NHS treatments for obesity-related conditions	£567	£344m
Social care	Cost of formal social care	£45	£27m
Individuals	Non-financial cost of reduced quality of life	£811	£492m
Family / carers	Non-financial cost of informal care	£937	£568m
Economic activity	Sick-days and economic inactivity	£2,937	£1.78bn
Total		£5,297	£3.21bn

Source: Frontier Economics

Note: Due to data limitations, we did not directly estimate the cost of providing NHS services for treating obesity. The NHS costs included in this analysis reflect a much broader range of costs due to conditions associated with obesity.

For comparison, a study by Action on Smoking and Health estimated that the cost of smoking to society was £2,773 per smoker, including £391 in healthcare costs, £2,143 in productivity costs and £194 in formal social care costs.¹

¹ Frontier Economics calculations based upon <https://ash.org.uk/media-centre/news/press-releases/smoking-costs-society-17bn-5bn-more-than-previously-estimated>

Variation in costs across subpopulations

The NHS and social care costs of obesity vary significantly across the population of Greater Manchester. Our analysis considered variation across borough, BMI level, deprivation decile, age and ethnicity.

The healthcare and social care costs of obesity varies across boroughs, due to variations in population size, and prevalence of obesity and severe obesity. Individuals living with obesity represent 32.1% of adults in Rochdale but only 23.4% in Bolton.² Total healthcare and social costs are highest in the Manchester borough (£78.8 million), while costs per thousand inhabitants are highest in Rochdale (£226,757).

Incremental healthcare and social care annual costs amongst individuals with BMI 30-34 were estimated to be £450 per person. For individuals with BMI 35-39 this increases to £785 and for BMI 40+ this increases to £1,127. Individuals with BMI 40+ account for 14% of all individuals living with obesity, but account for 26% of the total costs due to obesity to the NHS.

Deprived populations are significantly more likely to be affected by obesity. Indeed, obesity prevalence is as high as 32.2% amongst those living in the first deprivation decile (which includes individuals living in the most deprived 10% of Lower Super Output Areas in England) and 19.4% amongst those in the last deprivation decile. As a result, the average NHS and social care costs per thousand inhabitants is highest among the most deprived populations (£199,497 in decile 1), and lowest among the least deprived (£113,217 in decile 10).

Prevalence of obesity is highest for individuals between 45 and 54 years (34.4%) and lowest for those aged between 18 and 24 (14.0%). The associated healthcare and social care cost per thousand inhabitants is highest for individuals between 55 and 64 years (£237,078).

Females have a slightly higher prevalence of obesity compared to males, of 27.7% and 26.3% respectively. However, we estimate a significantly higher healthcare and social care cost per thousand inhabitants for females (£185,092) relative to males (£133,690). As explained in more detail in the results section, this differential may be in part be explained by an underrepresentation of males living with obesity in our dataset.

The NHS and social care costs of obesity vary significantly across ethnic groups. For example, we find the average cost per thousand inhabitants to be £227,639 for individuals of Black or Black British ethnicity, and £152,888 for individuals of White ethnicity.

Section 3 of this report provides full details of all of these results.

² Bolton has the lowest obesity prevalence based on the source data used in this analysis (GMCR), as explained in more detail throughout the report. We note that prevalence by borough varies by source.

Potential avoided costs if rates of obesity were lower

We estimate that if prevalence in Greater Manchester was similar to the England average, overall costs would be **£3.07 billion** per year, £142 million (4.4%) lower than the current costs of obesity.

If prevalence in Greater Manchester was instead at the level currently observed in the borough with lowest prevalence (Bolton)³, we estimate overall costs would be **£2.77 billion** per year, £442 (13.8%) lower than the current costs of obesity.

Table 2 illustrates these alternative prevalence scenarios.

Table 2 Costs in Greater Manchester if rates of obesity were lower

GM obesity prevalence scenario			
Cost area	Current	England average	Bolton
NHS	£344.0m	£328.8m	£296.7m
Social care	£27.2m	£26.0m	£23.5m
Individuals	£491.7m	£469.9m	£424.0m
Family / carers	£568.1m	£543.0m	£490.0m
Economic activity	£1780.5m	£1701.7m	£1535.5m
Total	£3.21bn	£3.07bn	£2.77bn

Source: Frontier Economics

Note: These are not intended to provide accurate estimates of 'savings' which could be achieved if prevalence of obesity is reduced. To estimate any such savings would require an intervention study to observe the impact of reducing rates of obesity, accounting for interactions between obesity and other characteristics, conditions and behaviours.

³ Bolton has the lowest obesity prevalence based on the source data used in this analysis (GMCR), as explained in more detail throughout the report. We note that prevalence by borough varies by source.

1 Introduction

The prevalence of obesity has increased steadily in recent years⁴, which warrants further exploration of current and future obesity treatment pathways. This report, commissioned by Lilly in partnership with Health Innovation Manchester, aims to contribute to this topic by estimating the current costs of adult obesity in Greater Manchester. This report considers the economic and societal costs of obesity, with a particular focus on the costs to the NHS and social care organisations.

Individuals living with obesity have an increased risk of developing other health conditions, such as type 2 diabetes, coronary heart disease, stroke and some types of cancers.⁵ In turn, this will lead to higher costs to the NHS. In addition to the healthcare costs, individuals living with obesity are likely to have a greater need for social care services. This is both because of a higher likelihood of developing long term conditions but also because obesity itself can sometimes affect the ability to function independently.⁶ More widely, obesity and associated conditions can lead to reduced health-related quality of life for individuals, can affect those individuals' ability to work, and can create a care burden for family or friends.⁷

This report explores the following issues:

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

For the purposes of this report, in line with NHS England⁸, obesity is defined as having a Body Mass Index (BMI) of 30 or higher, or 27.5 or higher for individuals of Asian, Middle Eastern, Black African or African-Caribbean family background. The report analysed obesity in adults aged 18 and over.

⁴ House of Commons Research Briefing: Obesity Statistics (2023), <https://commonslibrary.parliament.uk/research-briefings/sn03336>

⁵ NHS (2023), <https://www.nhs.uk/conditions/obesity>

⁶ NHS (2023), <https://www.nhs.uk/conditions/obesity>

⁷ See, for example, Frontier Economics (2022), <https://www.frontier-economics.com/uk/en/news-and-articles/articles/article-i9130-the-annual-social-cost-of-obesity-in-the-uk/>

⁸ NHS (2023), <https://www.nhs.uk/conditions/obesity>

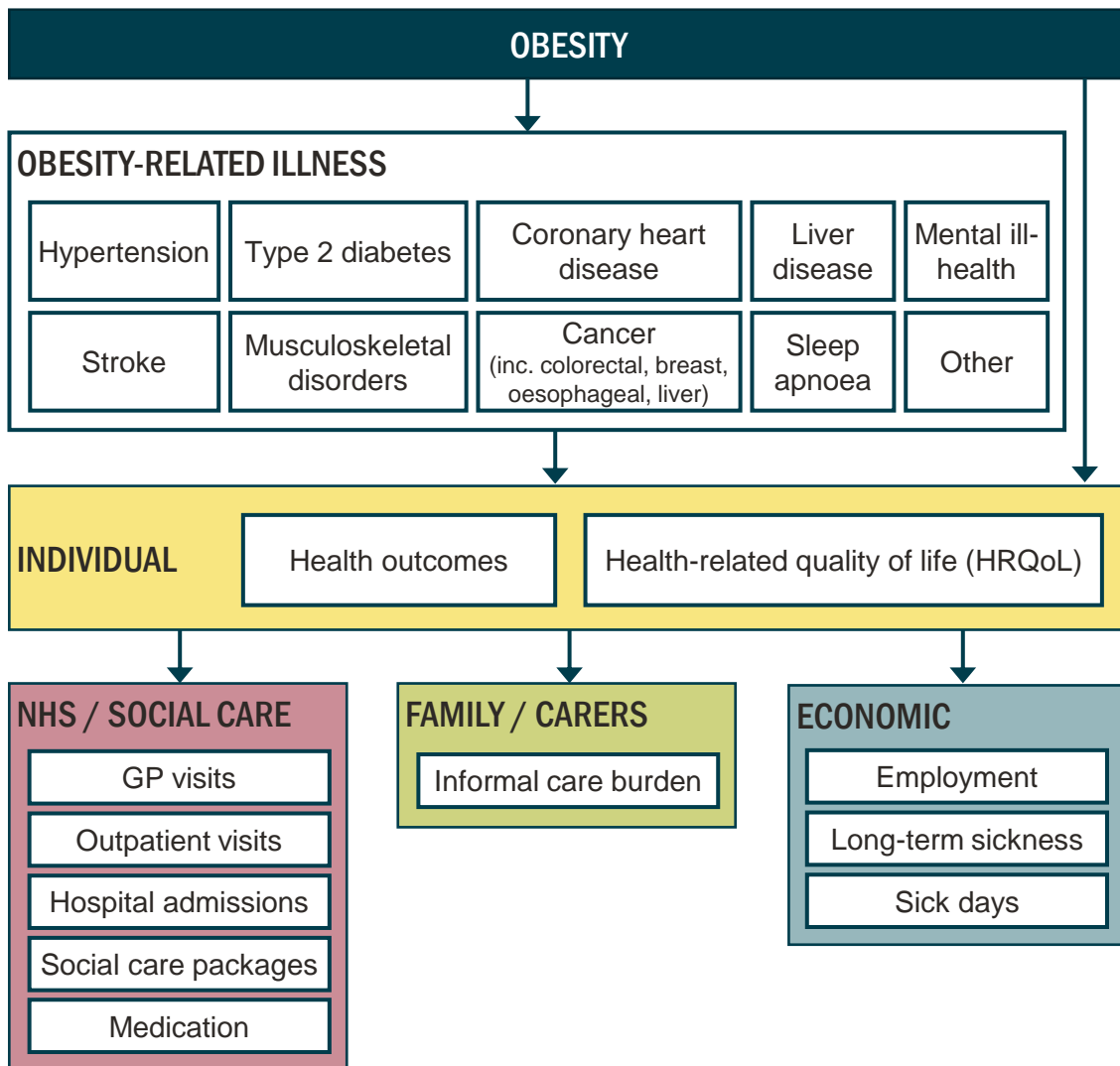
2 Approach

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

2.1 Impact framework

Our approach to exploring the costs of obesity in Greater Manchester was underpinned by an impact framework. Based upon reviewing academic, clinical and grey literature relating to obesity 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

frontier economics | Confidential

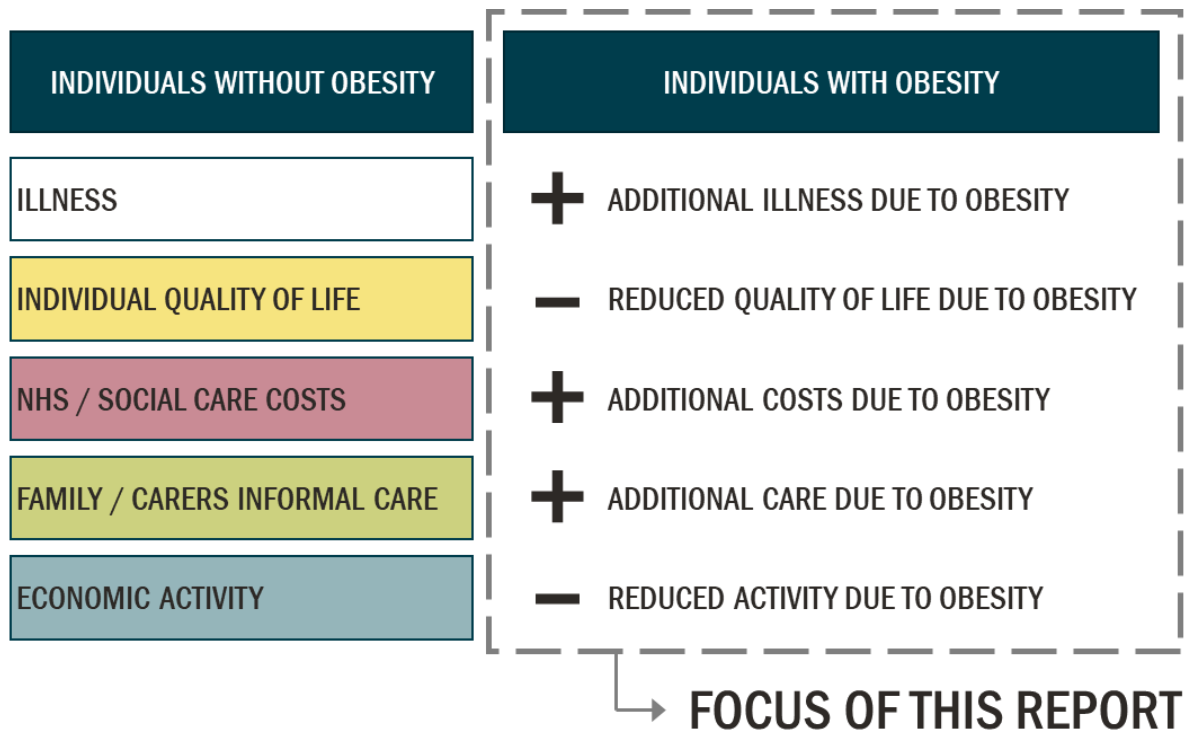
The framework includes the following categories of costs:

- **Costs to individuals living with obesity.** Reductions in health-related quality of life (HRQoL) due to obesity, both directly and due to obesity-related illness.
- **Costs to NHS and social care sector.** Increased demand for NHS and social care services from individuals living with obesity.
- **Costs to family and carers of individuals living with obesity.** Increased burden of informal care for individuals living with obesity.
- **Costs to the wider economy and employers.** Reduced rates of employment, higher rates of sickness absence and lower rates of productivity among individuals living with obesity.

This report focuses on the **costs which are due to obesity**. These are the additional or **incremental costs**, which are experienced by individuals living with obesity which are not experienced by individuals not living with obesity. Considering NHS and social care costs, for example, we therefore only consider costs which are *due* to obesity, rather than considering all NHS and social care costs for individuals living with obesity (e.g., visits to the GP which are unrelated to obesity).⁹ It is important to note that not all costs due to obesity were considered in this report (e.g. costs associated with fertility) and the figures included are best estimates. Figure 2 summarises the costs considered in this report.

⁹ Pearson-Stuttard et al. (2023) explored the total care and treatment costs to the NHS among individuals living with obesity (including costs which are not *due to* obesity). This analysis found average costs of £1,455 per person living with obesity and significantly higher costs for individuals with higher BMI compared with lower BMI. Pearson-Stuttard et al. (2023) presented at the 30th European Congress on Obesity, 17–20 May 2023, Dublin, Ireland. Presentation number: AD02.05

Figure 2 Costs considered in this report



Source: Frontier Economics

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 NHS

We estimated the impact of obesity on NHS costs by considering health conditions which are associated with obesity.¹⁰

To do this, we drew upon published data to estimate (i) the number of cases of obesity-related conditions which are due to obesity, and (ii) the average cost per case to the NHS per obesity-related condition:

- **Number of cases:** for each of the obesity-related conditions identified in our impact framework, we drew upon published data reporting the prevalence or incidence of these conditions in Greater Manchester. Where prevalence data for Greater Manchester is not

¹⁰ We have considered the most common comorbidities associated with obesity, as explained in further detail in the Annex, meaning that the list of conditions included (and resulting costs) is not fully comprehensive.

available, we used data at the wider regional or national level. We also drew upon published data to estimate the proportion of all cases of these conditions which are due to obesity, rather than other factors.¹¹ We used these two data sources to calculate the number of cases of each condition in Greater Manchester which are due to obesity. We also drew upon data which estimates the number of people who have more than one obesity-related condition (e.g. stroke and hypertension), which is called multi-morbidity.

- **Average cost per case:** we drew upon published data which estimates the average cost to the NHS of obesity-related conditions, per case per year. These estimates include the costs of multi-morbidity, for conditions where this data was available.

The overall costs to the NHS in Greater Manchester are the product of these two components for all of the obesity-related conditions identified in our impact framework. Average costs-per-person were subsequently obtained by dividing total costs with the number of adults living with obesity in Greater Manchester.

As a last step, we estimate how the overall costs to the NHS due to obesity in Greater Manchester are split across cost categories, including: primary care costs, secondary care costs (disaggregated between outpatient visits, elective admissions and emergency admissions) and prescription costs. It is important to note that, due to data limitation issues, the allocation of costs across categories should be considered indicative.¹²

1. For this, we take figures from the National Audit Office on the proportions of NHS cost across primary care, secondary care and prescriptions costs in England¹³, and assume equal proportions apply to obesity costs.
2. We further disaggregate secondary care costs based on GM care data (GMCR) on individuals living with obesity.
 - GMCR is a dataset that compiles NHS and social care services information from all 10 Greater Manchester boroughs in a single and consistent record from where it is possible to extrapolate information on, amongst other things, NHS usage.
 - We have extracted information on the number of outpatient visits, elective admissions and emergency admissions for adults living with obesity and combined those with our

¹¹ For most conditions we used data on Population Attributable Fractions (PAFs), which directly estimates the proportion of cases which are *due* to obesity. This was our preferred approach. For some conditions (depression, liver disease and sleep apnoea) data on PAFs was not available. In these cases we instead used Odds Ratios (ORs) or Hazard Ratios (HRs) to estimate the increased incidence of these conditions among individuals with obesity compared with individuals without obesity. We note that this approach does not account for other confounding factors.

¹² The allocation of costs due to obesity across cost categories may differ from the national average. However, in the absence of better data, we assume this allocation to be the same.

¹³ <https://www.nao.org.uk/wp-content/uploads/2022/08/Departmental-Overview-2020-21-Department-of-Health-Social-Care.pdf>

own estimates of the average cost to the NHS for each type of visit, to find the proportions of costs for individuals living with obesity.

- Implicitly, we are assuming that the *incremental* obesity costs are allocated across these categories in the same proportions as *overall* costs to the NHS from individuals living with obesity.

Within the scope of this analysis of NHS costs, we were not able to consider all health conditions which are associated with obesity. Our intention was to select a range of conditions which collectively account for the vast majority of NHS costs due to obesity. We therefore focused on diseases with relatively high prevalence; relatively high costs per case; and a relatively high proportion of cases which are due to obesity. We were also constrained by the availability of data and evidence for each condition considered. We expect that the conditions not included in our analysis represent a relatively ‘long tail’ of conditions for which the costs due to obesity are low, relative to those conditions included.

In addition, due to data limitations, we did not directly estimate the cost of providing NHS services for treating obesity (e.g. tiered weight-management services, or bariatric surgery). The NHS costs included in this analysis reflect a much broader range of costs due to conditions associated with obesity.

2.3 Costs to the social care sector

In addition to the healthcare costs associated with treating associated diseases, individuals living with obesity are likely to have a greater need for social care services. This is both because of a higher likelihood of developing long term conditions but also because obesity itself can sometimes affect the ability to function independently.¹⁴

We estimated the impact of obesity on the social care sector by analysing (i) the additional social care needs per person due to obesity and (ii) the monetary cost associated with providing those additional social care services.

Our analysis focused on the costs of formal social care funded by local authorities. The cost of privately-funded social care is not included in our analysis. However, the ‘opportunity cost’¹⁵ of providing informal social care, for example by family members of people living with obesity, is considered below in section 2.5.

Two components were estimated:

¹⁴ NHS (2023), <https://www.nhs.uk/conditions/obesity>

¹⁵ Opportunity costs relate to the loss of potential gain from other alternatives when one alternative is chosen. For example, if a person needs to leave the workforce in order to take care of a relative, the opportunity cost of providing this care is the salary that could have been earned if the person had not left the workforce.

- **Care hours per person:** we drew upon academic literature to estimate the average additional local-authority funded formal social care needs due to obesity for individuals aged 65 and over. Care needs were estimated based on self-reported needs of individuals with BMI levels between 30 and 40¹⁶, and are measured in terms of hours of care per year. These estimates take into account the fact that not all individuals living with obesity aged 65 and over require social care services, which drives down the average. As the underlying literature for these estimates is based upon self-reported social care needs, we have applied a downwards adjustment to account for the fact that not everyone who requests formal social care support actually receives it.¹⁷
- **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 2023 prices.

The product of the two components above gives our monetary estimate of annual social care costs funded by the local authority, per person living with obesity due to obesity. We multiplied this figure by the number of individuals over 65 living with obesity in Greater Manchester to reach an overall cost figure to the social care sector in Greater Manchester for adults over 65.

We also consider the potential obesity costs associated with social care services for adults under 65. For this, we use GMCR data to compare the relative usage of social care packages between adults with obesity under 65 to usage of those over 65. We apply this proportion to social care costs of elder individuals to estimate costs of those under 65, recognising that there is more uncertainty around social care costs due to obesity for individuals under 65 than for those over 65.¹⁸

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

Individuals living with obesity experience poorer health-related quality of life (HRQoL) outcomes. These are non-financial costs, but can be valued in monetary terms. We estimated these costs by combining the following components:

¹⁶ <https://link.springer.com/article/10.1186/s12889-017-4665-1>

The underlying literature did not cover individuals with BMI levels above 40. We have assumed a uniform distribution of individuals across the BMI range 30-40 for the purposes of calculating a single average care burden per person living with obesity.

¹⁷ For this, we consider the proportion of applications for LA-funded social care services that receive social care. Further details in the annex.

¹⁸ This is because there is less literature available in relation to social care usage due to obesity for individuals under 65. The approach we have undertaken to estimate costs of individuals under 65 relies on the assumption that the proportion of packages provided due to obesity (and not, for example, work-related injuries) does not differ across those over and under 65.

- **Quality of life loss per individual:** we drew upon published literature which has considered the quality of life of individuals living with obesity, compared with individuals not living with obesity. This evidence explores how HRQoL compares for individuals with BMI 30-35 (i.e. non-severe obesity) and BMI above 40 (i.e. severe obesity). HRQoL losses are reported as a reduction in Quality-Adjusted Life Years (QALYs).
- **Average cost per case:** these are non-financial costs borne by individuals. 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.^{19,20}

The overall costs to individuals in Greater Manchester are the product of these two components.

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 estimated these costs in monetary terms by combining the following components:

- **Informal care burden per individual:** we drew upon published literature which estimates the number of hours of informal care required by individuals living with obesity, compared with individuals not living with obesity.
- **Average cost per case:** these are non-financial costs borne by individuals. We convert these costs into monetary terms by valuing each hour of informal care provided at the median hourly wage for Greater Manchester.

The average cost per individual living with obesity is the product of these two components. The overall costs in Greater Manchester are obtained by multiplying these costs by the number of individuals living with obesity.

2.6 Costs to the economy due to productivity losses

We have estimated the costs to the economy due to three factors: increased sickness absences; increased unemployment; and economic inactivity (including early retirement) due to obesity. We note that there are also potential in-work productivity impacts, however we did

¹⁹ <https://www.nice.org.uk/media/default/guidance/lgb10-briefing-20150126.pdf>

²⁰ 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.

not consider these impacts in this 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 practice, 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:

- **Productivity losses per individual:** we used published literature which estimates the increases in number of sick days, higher rate of unemployment, and higher rate of economic inactivity among individuals living with obesity, compared with individuals not living with obesity. This evidence accounts for some potential confounding factors, such as age and education level.
- **Average cost per case:** we value each additional sick day at the median daily wage in Greater Manchester, and value each individual not working (either due to unemployment or inactivity) at the median annual wage in Greater Manchester.

The overall costs to individuals in Greater Manchester are the product of these two components. We have only considered productivity costs due to sick leave days for individuals aged 18-64, and productivity costs due to a higher rate of unemployment and economic inactivity for those aged between 50-64.

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 obesity disproportionately affects certain groups, such as more deprived populations. We therefore also estimated how costs vary across subpopulations depending on the following factors: (i) borough of residence; (ii) BMI score; (iii) deprivation decile; (iv) age; (v) sex; and (vi) ethnicity.

For this we have combined the above estimates with data from GMCR, which includes patient-level data on BMI, as well as borough of residence, deprivation decile, age, sex and ethnicity. It is important to note that while we received access to GMCR data for individuals living with obesity, we did not have equivalent data for individuals with a healthy weight.

Costs among subpopulations were estimated based on:

- The **number of people living with obesity** in each subpopulation (e.g. number of people living with obesity in Trafford); and
- The **average cost of living with obesity per person** in each subpopulation. Cost estimates are specific to each subpopulation as they account for variation in average BMI levels (e.g. if people living with obesity in Trafford have an average BMI of 36, while people

living with obesity in Stockport have an average BMI of 35, then the average cost of obesity per person will be higher in Trafford than in Stockport).

We expand on each of these points in Annex A.

2.8 Estimating potential avoided costs

Lastly, we have undertaken a scenario-based analysis on the costs which could be avoided if rates of obesity 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.²¹

We modelled 2 scenarios:

- **Scenario 1:** If obesity prevalence in Greater Manchester equalled the national average;
- **Scenario 2:** If obesity prevalence in Greater Manchester was at the level observed in the borough with lowest prevalence (Bolton).²²

Under each scenario, we estimated the difference in NHS and social care organisation costs. These potential avoided costs give an indication of the 'prize' which could be achieved through effective policy interventions which reduce, or slow the growth of, obesity rates.

For this exercise, we have assumed a linear relationship between obesity costs and the number of individuals living with obesity. In other words, that if obesity prevalence were X% lower this would result in obesity costs being X% lower.

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* obesity from those which are specifically *due to* obesity. This is unsurprising, given the range of factors (including societal factors) which contribute to and are caused by obesity 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 directly attempts to control for the issue of causality.
- Using Body Mass Index (BMI) to define obesity. BMI may be considered an imperfect measure of body fat as it does not distinguish, for example, muscle and fat. Despite this limitation, we rely on BMI as it is most commonly used measure in the literature. The use

²¹ The effectiveness and cost-effectiveness of any policy interventions should be considered in a separate analysis.

²² Bolton has the lowest obesity prevalence based on the source data used in this analysis (GMCR), as explained in more detail throughout the report. We note that prevalence by borough varies by source.

of any alternative measure of body fat would lead to significant data limitation issues in our analysis.

- We have not considered the potential impact of premature death due to obesity on our cost estimates.²³ Premature death may lead to lower NHS costs (e.g. costs of treating LTCs in the years that those individuals would otherwise have been alive), lower formal and informal social care costs, higher individual HRQoL costs (due to years of life lost) and higher economic/productivity costs (due to lost economic output – noting that many individuals would not have been economically active in the last years before death). However, analysing each of the above costs would be complex and require additional evidence and assumptions (for example around the age profile of premature death and interaction with other individual characteristics).

The breakdown of costs by subpopulation has some further caveats.

- Firstly, the GMCR dataset is drawn from multiple other data sources and the quality of the GMCR data is only as good as the data from these sources.

Specifically, the data which has fed into GMCR does not include all adults living with obesity in Greater Manchester. Our analysis indicates that GMCR includes records for around 71% of adults living with obesity, meaning there is no data available for the remaining 29%. To the extent that some groups of people (e.g. more deprived populations) are more likely not to be recorded in GMCR, we may be misrepresenting the true proportion of people living with obesity across subpopulations.

To some extent, this issue is attenuated by the fact that individuals' obesity diagnosis is less likely to be recorded in GMCR if they use NHS services less frequently (and are therefore also less costly to the NHS, at least in the short-term). This means that while GMCR might misrepresent the true number of people across subpopulations, it might more accurately reflect the actual cost to the NHS associated with these subpopulations, which is the primary focus of the subpopulation analysis.

- Secondly, to calculate our cost-per-person estimates for each subpopulation, we are effectively comparing the NHS activity of individuals with different levels of BMI, and attributing the differences observed to their BMI level. However we can't say for certain that the observed variation in NHS activity (and therefore costs) is fully explained by BMI, rather than by other factors correlated with BMI. This means that we might be overstating the difference in costs across classes of obesity. This will affect our breakdown of costs per subpopulation, although our estimates of overall costs in Greater Manchester would not be affected.

²³ For example, an analysis from NICE suggests that life expectancy is reduced by 2-4 years for those with a BMI of 30-35 and 8-10 years for those with a BMI 40-50, in relation to individuals without obesity.

<https://www.nice.org.uk/guidance/ng7/resources/preventing-excess-weight-gain-pdf-51045164485>

Finally, our analysis of potential future avoided costs is based on the range of NHS services – and costs of those services – which exist today. This does not account for any changes to NHS 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 obesity were lower.

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

3 Results

3.1 Main results: costs of obesity in Greater Manchester

Our analysis suggests that the costs of obesity in Greater Manchester in 2023 are £3.21 billion. These costs are broken down as follows:

Table 3 Annual cost of obesity in Greater Manchester by cost category

Cost category	Cost per person living with obesity (£)	Total costs due to obesity (£)
NHS costs	£567	£344 million
primary care costs	£44	£28 million
outpatient visit costs	£137	£88 million
elective admission costs	£142	£91 million
emergency admission costs	£197	£127 million
prescription costs	£47	£30 million
Formal social care costs	£45	£27 million
Costs to individuals due to HRQoL losses	£811	£492 million
Costs of informal care	£937	£568 million
Productivity costs	£2,937	£1,781 million
sickness absence costs	£267	£162 million
economic inactivity costs	£2,670	£1619 million
Total cost of obesity	£5,297	£3,212 million

Source: Frontier Economics

For comparison, a study by Action on Smoking and Health estimated that the cost of smoking to society was £2,773 per smoker, including £391 in healthcare costs, £2,143 in productivity

costs and £194 in formal social care costs.²⁴ These figures indicate that the costs per individual due to living obesity may be at least as high as those due to smoking. The prevalence of smoking across Greater Manchester – 14.3% of adults in 2022²⁵ – is also significantly lower than the prevalence of obesity (27.1%).

3.1.1 Costs to the NHS

Table 4 provides estimates of average incremental cost attributable to obesity per disease associated with obesity, per person.

Note that while the cost per case of treating certain diseases (e.g. oesophageal cancer) may be high, its overall impact on average incremental costs may be low due to either relatively low levels of disease prevalence or due to a low population attributable fraction (PAF)²⁶ to obesity. For the purpose of our modelling, we have calculated the average cost to the NHS per person living with obesity as the simple average amongst men and women (i.e. £567).

Table 4 Costs to the NHS - cost attributable to obesity per illness, per person

Condition	Incremental cost (men)	Incremental cost (women)
Hypertension	£207.1	£214.7
Type 2 diabetes	£150.7	£146.7
Musculoskeletal disorders	£66.1	£47.8
Sleep apnoea	£43.7	£43.7
Liver disease	£33.9	£28.3
Depression	£17.2	£18.7
CHD (w/o diabetes)	£23.6	£22.8
CHD and Diabetes	£13.5	£13.3
Stroke (w/o hypertension)	£5.9	£5.3
Stroke and Hypertension	£8.7	£7.5
Colorectal cancer	£6.1	£4.3
Oesophageal cancer	£2.8	£0.6

²⁴ Frontier Economics calculations based upon <https://ash.org.uk/media-centre/news/press-releases/smoking-costs-society-17bn-5bn-more-than-previously-estimated>

²⁵ <https://gmintegratedcare.org.uk/health-news/smoking-falls-to-record-low-in-greater-manchester>

²⁶ The PAF is an estimate of the proportion of cases of a disease (e.g. oesophageal cancer) which are due to obesity, rather than due to other factors.

Condition	Incremental cost (men)	Incremental cost (women)
Breast cancer	-	£1.3
Ovarian Cancer	-	£0.2
Kidney cancer	£0.1	£0.1
Total	£579	£555

Source: Frontier Economics

3.1.2 Costs to the social care sector

Table 5 sets out the formal social care costs attributable to obesity for an adult over 65 living with obesity, by level of BMI. For simplicity, and due to data availability limitations, we have assumed that all individuals living with obesity aged over 65 have a constant incremental annual cost of £113.

Table 5 Costs to the social care sector – local authority funded social care costs attributable to weight, per person aged 65 and over

BMI level	Incremental annual cost
18.5-24.9	£0
25-30	£14
30-35	£69
35-40	£142
30-40	£113

Source: Frontier Economics

Note: The figures in this table represent estimates of average costs of individuals across different BMI ranges (e.g. 30-35) assuming an equal distribution of individuals across these ranges (e.g. it is assumed there are as many individuals with a BMI level of 31 as of 32, and so forth, for the purposes of providing an average figure across the range 30-35).

Data from GMCR on the usage patterns of social care packages from individuals living with obesity indicates that those aged under 65 receive around 24% as many packages relative to those aged 65 and over. We therefore estimate that the average social care cost for individuals living with obesity under 65 to be around £27 per person, assuming an equal proportion of packages derived from obesity across the two age groups.

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

Table 6 sets out estimates of costs to individuals due to Health-related Quality of Life (HRQoL) per person by age group and severity of obesity. In our modelling we consider the average monetary value lost due to obesity of £811 per individual living with obesity.

Table 6 Monetary value lost due to HRQoL per person living with obesity

Age group	Value lost per person living with non-severe obesity (BMI <40)	Value lost per person living with severe obesity (BMI > 40)	Average value lost per person living with obesity
18-54	£640	£2,140	£832
55+	£620	£2,140	£781
Avg. all ages	£631	£2,140	£811

Source: Frontier Economics

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 associated with decreases in HRQoL due to obesity are non-financial costs.

3.1.4 Costs to family / carers due to informal care burden

Table 7 sets out the costs to family / carers due to the additional informal care burden attributable to obesity per obese adult aged over 65, by level of BMI. For simplicity, and due to data availability, we have assumed that all individuals living with obesity aged over 65 have a constant incremental annual cost of £2,361.

Table 7 Costs to the social care sector – local authority funded social care costs attributable to weight, per person aged 65 and over

BMI level	Incremental annual cost
18.5-24.9	£0
25-30	£293

BMI level	Incremental annual cost
30-35	£1,440
35-40	£2,980
30-40	£2,361

Source: Frontier Economics

Note: The figures in this table represent estimates of average costs of individuals across different BMI ranges (e.g. 30-35) assuming an equal distribution of individuals across these ranges (e.g. it is assumed there are as many individuals with a BMI level of 31 as of 32, and so forth, for the purposes of providing an average figure across the range 30-35).

The costs reported above 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 individuals living with obesity aged between 50 and 64 are **9.6% more likely to leave the workforce** relative to individuals not living with obesity, of which 1.3% is linked to unemployment and 8.3% with economic inactivity. The resulting costs to the economy amount to £2,660 per individual in this age range living with obesity. We conservatively assume that individuals aged 18-49 do not have an increased probability of leaving the workforce, meaning the modelled cost is likely an underestimate.²⁷

In addition to the productivity costs resulting from economic inactivity, individuals living with obesity **take an average 4 additional days of sickness absence** per year, resulting in an economic cost of £267 per individual living with obesity.

These economic impacts will affect all sectors of the economy, including the NHS in its role as employer. For example, we estimate that the NHS in Greater Manchester incurs productivity costs related to sickness absences amounting to 93,000 work days lost per year.²⁸

3.2 Deep dive: costs of obesity by subpopulation

This section explores how the costs to the NHS and social care sector are split across different subpopulations in Greater Manchester. We do not analyse the breakdown of the wider societal

²⁷ The estimate of average cost per individual aged 18-64 due to productivity losses is therefore lower than the cost per individual aged 50-64 due to productivity losses, as the former includes a group of individuals (i.e. those aged 16-49) for which we assume no costs associated with leaving the workforce due to obesity.

²⁸ This is calculated through the application of 4 additional sickness absence days per year to an estimate of FTE individuals living with obesity employed by the NHS of 23,364. This estimate considers the FTE staff employed by NHS in Greater Manchester (86,213 in July 2023 as per NHS digital, <https://digital.nhs.uk/data-and-information/publications/statistical/nhs-workforce-statistics/july-2023>), and assumes that obesity prevalence amongst NHS staff in Greater Manchester is equal to the regional average (27.1% as per Fingertips).

costs (to individuals, family / carers and to the economy), except for a high-level analysis by Greater Manchester borough.

We also present in this section estimates of obesity prevalence per subpopulation. These were calculated based on a combination of (i) the number of GMCR records of obesity in each subpopulation, (ii) the number of GMCR records with any BMI reading in each subpopulation, and (iii) the average obesity prevalence in Greater Manchester as per Fingertips.²⁹ However, we note that these prevalence estimates are not directly used in our cost estimates, which as explained in the Approach section, were calculated based on GMCR proportions of obesity cases by subpopulation (and not based on our estimates of obesity prevalence).³⁰

3.2.1 Breakdown of costs by borough

Table 8 presents our breakdown of obesity costs split by borough, including all cost components. Table 9 presents a focused breakdown of NHS and social care costs (in line with the results presented for the remaining subpopulations).

²⁹ Fingertips Obesity Profiles, Office for Health Improvement and Disparities; 27.1% in Greater Manchester.
<https://fingertips.phe.org.uk/profile/national-child-measurement-programme>

³⁰ This is because there is not necessarily a 1 to 1 relationship between prevalence and costs. For example, a subpopulation with a comparatively high obesity prevalence might not necessarily lead to higher healthcare costs, to the extent individuals in that subpopulation are less likely to go to the doctor and use the healthcare services. On the other hand, BMI records in GMCR might be better correlated with costs, to the extent that people who use healthcare services more often are more likely to have their BMI reading recorded.

Table 8 Incremental annual costs due to obesity by borough

	Rochdale	Oldham	Manchester	Stockport	Wigan	Bolton	Trafford	Tameside	Salford	Bury
NHS cost	£35.9 million	£33.1 million	£73.4 million	£35.6 million	£40.2 million	£33.2 million	£25.5 million	£25.3 million	£28.8 million	£13.0 million
Formal social care cost	£2.9 million	£2.6 million	£5.4 million	£3.0 million	£3.2 million	£2.6 million	£2.2 million	£1.9 million	£2.2 million	£1.1 million
Individual cost	£52.1 million	£48.0 million	£106.6 million	£50.6 million	£55.8 million	£48.4 million	£37.1 million	£35.2 million	£39.6 million	£18.3 million
Informal social care cost	£60.4 million	£54.2 million	£113.0 million	£62.5 million	£67.3 million	£54.8 million	£46.2 million	£40.4 million	£45.8 million	£23.6 million
Productivity cost	£188.6 million	£173.8 million	£385.9 million	£183.3 million	£202.2 million	£175.2 million	£134.4 million	£127.4 million	£143.4 million	£66.1 million
Total cost of obesity	£339.9 million	£311.7 million	£684.3 million	£335.1 million	£368.8 million	£314.2 million	£245.4 million	£230.1 million	£259.9 million	£122.1 million
Avg. cost per 1000 inhabitants	£1.99 million	£1.71 million	£1.60 million	£1.43 million	£1.40 million	£1.38 million	£1.34 million	£1.27 million	£1.21 million	£.81 million

Source: Frontier Economics

Table 9 Incremental NHS and social care annual costs due to obesity by borough

	Rochdale	Oldham	Manchester	Stockport	Wigan	Bolton	Trafford	Tameside	Salford	Bury
Obesity prevalence	32.1%	30.1%	27.8%	25.4%	25.0%	23.4%	24.9%	28.3%	27.6%	28.7%
NHS cost	£35.9 million	£33.1 million	£73.4 million	£35.6 million	£40.2 million	£33.2 million	£25.5 million	£25.3 million	£28.8 million	£13.0 million
<i>Proportion</i>	<i>10%</i>	<i>10%</i>	<i>21%</i>	<i>10%</i>	<i>12%</i>	<i>10%</i>	<i>7%</i>	<i>7%</i>	<i>8%</i>	<i>4%</i>
Social cost	£2.9 million	£2.6 million	£5.4 million	£3.0 million	£3.2 million	£2.6 million	£2.2 million	£1.9 million	£2.2 million	£1.1 million
NHS and social care total cost	£38.8 million	£35.7 million	£78.8 million	£38.6 million	£43.5 million	£35.8 million	£27.7 million	£27.2 million	£31.0 million	£14.1 million
Average cost per 1000 inhabitants	£226,757	£196,037	£184,324	£164,253	£164,383	£157,835	£151,647	£149,583	£144,653	£93,232

Source: Frontier Economics

As indicated in Table 8 , total costs due to obesity per thousand inhabitants are highest in Rochdale (£1.99 million), and lowest in Bury (£0.81 million). Total costs are highest in Manchester (£684.3 million) – the borough with the largest population. A similar picture arises when considering the subset of NHS and formal social care costs, as can be observed in Table 9.

As noted in section 2.9, a limitation of GMCR data is that it does not contain records of all individuals living with obesity in Greater Manchester. Our analysis may therefore misrepresent the true proportion of costs across subpopulations, to the extent that some groups of individuals living with obesity (e.g. in a certain borough) are more likely not to be recorded in GMCR. This is likely to be the case with Bury, for which we would expect to observe a higher cost estimate considering its population size and our estimate of obesity prevalence.

3.2.2 Breakdown of NHS and social care costs by BMI score

Table 10 below presents our breakdown of NHS and social care costs split by BMI score.

Table 10 Incremental annual NHS and social care costs due to obesity by BMI level

	BMI 30-34*	BMI 35-39	BMI 40+
Number of individuals living with obesity	396,473	127,950	81,869
<i>Proportion</i>	<i>65%</i>	<i>21%</i>	<i>14%</i>
NHS total cost	£160 million	£95 million	£89 million
<i>Proportion</i>	<i>47%</i>	<i>28%</i>	<i>26%</i>
Social care total cost	£18 million	£6 million	£3 million
NHS and social care total cost	£178 million	£100 million	£92 million
Average NHS and social care cost per person	£450	£785	£1,127

Source: Frontier Economics

Note: This group includes individuals with BMI 27.5 to 34 for people of Asian, Middle Eastern, Black African or African-Caribbean family background.

We find that the majority of individuals living with obesity in Greater Manchester (65%) are within our lowest BMI range of obesity (BMI 30-34). Individuals in the BMI ranges 35-39 and 40+ represent 21% and 14% of all obesity cases, respectively.

However, higher levels of BMI are costlier to the healthcare system. On a per person basis, we estimate the average NHS and social care cost due to obesity to be £450 for individuals in the lowest BMI range, and over two times higher (£1,127) for individuals in the highest BMI

range. As a result, we find that the highest BMI group, accounting for 14% of people living with obesity, represents 26% of the total NHS costs attributable to obesity.

3.2.3 Breakdown of NHS and social care costs by deprivation decile

Table 11 below presents our breakdown of obesity costs split by deprivation decile.

Table 11 Incremental annual NHS and social care costs due to obesity by deprivation decile

Decile	1	2	3	4	5	6	7	8	9	10
	← Most deprived					Least deprived →				
Obesity prevalence	32.2%	29.6%	27.1%	26.2%	25.2%	24.5%	24.0%	23.0%	21.3%	19.4%
NHS total cost	£104.9 million	£56.2 million	£41.6 million	£29.9 million	£23.0 million	£18.8 million	£20.0 million	£21.3 million	£16.8 million	£11.5 million
<i>Proportion</i>	30.5%	16.3%	12.1%	8.7%	6.7%	5.5%	5.8%	6.2%	4.9%	3.3%
Social care total cost	£7.4 million	£4.1 million	£3.2 million	£2.4 million	£2.0 million	£1.6 million	£1.8 million	£2.0 million	£1.6 million	£1.1 million
NHS and social care total cost	£112.3 million	£60.3 million	£44.8 million	£32.3 million	£24.9 million	£20.4 million	£21.8 million	£23.3 million	£18.4 million	£12.6 million
Average cost per 1000 inhabitants	£199,497	£182,319	£166,818	£160,172	£154,922	£149,347	£145,139	£137,901	£126,706	£113,217

Source: Frontier Economics

We can observe that more deprived populations are significantly more likely to be affected by obesity. Indeed, 30.5% of all NHS costs in Greater Manchester due to obesity arise in the first deprivation decile (which includes individuals living in the most deprived 10% of LSOAs in England). By contrast, only 3.3% of the obesity costs relate to individuals in the last deprivation decile (i.e. the least deprived).

While part of this is explained by differences in population sizes within each deprivation decile, we can observe that the average cost per 1000 inhabitants is nearly twice as high for the most deprived decile (£199,497) in relation to the least deprived decile (£113,217).

3.2.4 Breakdown of NHS and social care costs by age

Table 12 below presents our breakdown of obesity costs split by age.

Table 12 Incremental annual NHS and social care costs due to obesity by age

	18-24	25-34	35-44	45-54	55-64	65-74	75+
Obesity prevalence	14.0%	22.8%	30.5%	34.4%	34.3%	25.2%	18.6%
NHS total cost	£14 million	£48 million	£65 million	£73 million	£76 million	£41 million	£26 million
<i>Proportion</i>	4.1%	14.0%	18.8%	21.3%	22.1%	12.0%	7.7%
Social care total cost	£1 million	£2 million	£3 million	£3 million	£4 million	£8 million	£6 million
NHS and social care total cost	£15 million	£51 million	£68 million	£77 million	£80 million	£50 million	£32 million
Average cost per 1000 inhabitants	£56,682	£120,737	£173,820	£207,905	£237,078	£196,008	£154,383

Source: Frontier Economics

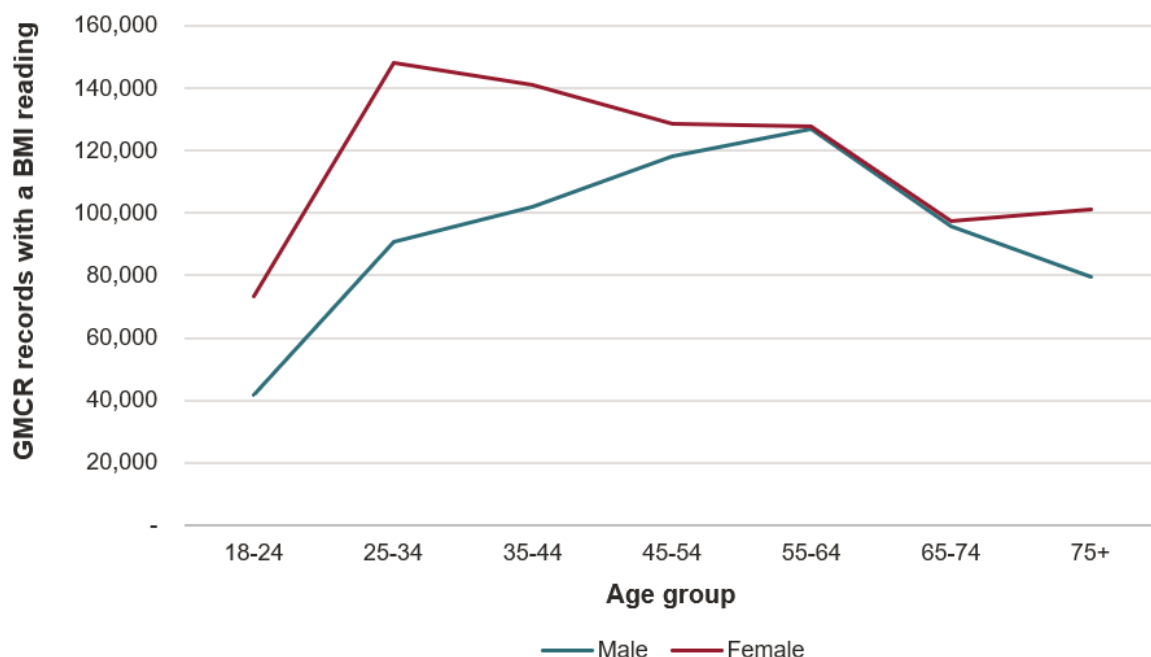
The prevalence of obesity tends to increase with age for adults up to 54 years old, with individuals aged 18-24 having the lowest prevalence (14.0%) and those aged 45-54 having the highest (34.4%). At older ages, prevalence follows a downwards trend (25.2% for those between 65 and 74 years, and 18.6% for those 75 and above). The average cost per thousand inhabitants follows the same trend as prevalence.

It is important to note that, due to data limitations, our analysis does not consider differences in healthcare costs due to obesity for individuals living with obesity in different age groups (e.g., due to different impacts of obesity on prevalence of obesity-related diseases).

3.2.5 Breakdown of NHS and social care costs by sex

For the remaining subpopulations, we base our analysis of cost estimations by sex based on GMCR proportions of obesity cases across groups. However, we note that an analysis of the number of GMCR records with a BMI reading by sex and age indicates that there may potentially be a significant share of undiagnosed men below 55 living with obesity. This disparity may be due to women attending primary care for routine screening programmes or family planning services leading to increased interactions with doctors at a younger age (and therefore a higher proportion of BMI readings), whereas men are usually only invited for routine health checks from age 40 onwards.

Figure 3 Number of GMCR records with a BMI reading by sex and age



Source: Frontier Economics

For example, we can observe that there are around twice as many GMCR records with a BMI reading for females in the age group 18-24 (74,433) relative to males in the same age group (41,827). However, given that people living with obesity are more likely to have a BMI reading, we are not able to confirm the extent to which this difference is driven by true differences in obesity prevalence or due to under-recording in GMCR for specific sex and age groups (or a combination of both aspects). We therefore based our cost calculations on GMCR proportions of obesity cases by sex, as for the remaining subpopulations, which may result in disproportionately high costs for women.³¹

Table 13 below presents our breakdown of obesity costs split by sex:

Table 13 Incremental annual NHS and social care costs by sex

	Male	Female
Obesity prevalence	26.3%	27.7%

³¹ Note that, as for the remaining subpopulation, the total number of cases of obesity considered in our costs calculations is adjusted based on the Fingertips obesity prevalence estimate for GM (i.e. 27.1%). GMCR is only used to proportionally allocate these cases across groups – in this case, to find the split of obesity cases across men and women.

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	Male	Female
NHS total cost	£139 million	£205 million
<i>Proportion</i>	40.6%	59.4%
Social care total cost	£6.5 million	£7.6 million
NHS and social care total cost	£145 million	£213 million
Average cost per 1000 inhabitants	£133,690	£185,092

Source: Frontier Economics

Note: As for the remaining subpopulation, the total number of cases of obesity considered in our costs calculations is based on the Fingertips obesity prevalence estimate for GM (i.e. 27.1%). GMCR is only used to proportionally allocate these cases across groups – in this case, to find the split of obesity cases across men and women. This is why the implied obesity prevalence across genders is higher than the prevalence in Figure 3 which, for illustrative purposes, was measured based on the number of GMCR records.

While we estimate obesity prevalence to be *slightly* higher for women (27.7%) than for men (26.3%), we find obesity costs to be *significantly* higher for women than for men both in terms of total costs (£224 million for women, £154 million for men) and average costs per thousand inhabitants (£185,092 for women, £133,690 for men). This is driven by a combination of factors, including (i) a slightly higher share of women in the population, (ii) a significantly higher number of obesity records amongst women, and (iii) a higher rate of cases of severe obesity amongst women.

As mentioned above, to the extent women living with obesity are over-represented in GMCR, the true differences in cost across sex might be smaller.

3.2.6 Breakdown of NHS and social care costs by ethnicity

Table 14 below presents our breakdown of obesity costs by ethnicity.

Table 14 Incremental annual NHS and social care costs by ethnicity

	Other Ethnic Groups	Black or Black British	Asian or Asian British	Mixed	White
Obesity prevalence	48.4%	36.2%	32.6%	31.8%	21.7%
NHS cost	£10.1 million	£19.1 million	£53.6 million	£8.6 million	£252.7 million
<i>Proportion</i>	3%	6%	16%	2%	73%
Social care cost	£.9 million	£1.2 million	£3.9 million	£.5 million	£20.5 million
NHS and social care cost	£11.0 million	£20.3 million	£57.5 million	£9.1 million	£273.2 million

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	Other Ethnic Groups	Black or Black British	Asian or Asian British	Mixed	White
Average cost per 1000 inhabitants	£238,181	£227,639	£213,150	£203,068	£152,888

Source: Frontier Economics

Note: Due to data limitation issues, the estimates for "Other Ethnic Groups" should be interpreted with caution.

Individuals with White ethnicity account for the majority of the NHS costs derived from obesity (73.3%), while individuals from Mixed ethnicity account for the smallest proportion (2.5%). However, obesity prevalence is lowest for White individuals (21.7%), which have the lowest average cost per thousand inhabitants (£152,888). Obesity prevalence is highest amongst minorities, which have the highest average costs per thousand inhabitants (e.g. £238,181 for individuals of Other Ethnic Groups).

We note that individuals from Other Ethnic Groups are over-represented in the GMCR data (which includes a larger number of records of individuals allocated to this ethnicity than the total population size of this group, as per Census data). For this reason, we have applied a downwards adjustments which forces the share of obesity cases in this ethnic group to be in line those of the remaining non-White groups. The cost estimates for Other Ethnic Groups are therefore less reliable and should be interpreted with caution.

3.3 Potential avoided costs if rates of obesity were lower

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

- **Scenario 1:** If obesity prevalence in Greater Manchester equalled the national average;
- **Scenario 2:** If obesity prevalence in Greater Manchester was at the level observed in the borough with lowest prevalence (Bolton).³²

Table 15 Costs in Greater Manchester if obesity levels were decreased

Cost area	GM obesity prevalence scenario		
	Current	England average	Bolton average
NHS	£344.0m	£328.8m	£296.7m
Social care	£27.2m	£26.0m	£23.5m
Individuals	£491.7m	£469.9m	£424.0m

³² Bolton has the lowest obesity prevalence based on the source data used in this analysis (GMCR), as explained in more detail throughout the report. We note that prevalence by borough varies by source.

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GM obesity prevalence scenario			
Cost area	Current	England average	Bolton average
Family / carers	£568.1m	£543.0m	£490.0m
Economic activity	£1780.5m	£1701.7m	£1535.5m
Total	£3.21bn	£3.07bn	£2.77bn

Source: *Frontier Economics*

We estimate that if prevalence in Greater Manchester was similar to the national average, the overall costs would be **£142 million** per year, or 4.4%, lower than the current costs of obesity.

If prevalence in Greater Manchester was instead at the level currently observed in Bolton, we estimate that the overall costs would be **£442 million** per year, or 13.8%, lower than the current costs of obesity.

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 obesity is reduced. To estimate any such savings would require an intervention study to observe the impact of reducing rates of obesity, accounting for interactions between obesity 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

We used 2023 population estimates for Greater Manchester from Varbes which are based on mid-2021 population estimates published by the Office of National Statistics (ONS) in combination with recent growth rates (see [here](#)). To this figure, we have applied the shares of adults (18+) and elder (65+) population in Greater Manchester based on ONS population estimates (see [here](#)), and the NHS estimate of obesity prevalence in Greater Manchester (see [here](#)) to obtain the number of adult and elder individuals living with obesity.

The analysis was carried out in May 2023 prices. The inputs used in the analysis are based on the most recent evidence available. Where inputs refer to years prior to May 2023, the analysis used the CPI index (from the [ONS](#)) to bring inputs to May 2023 prices using the following formula:

$$\text{Adjusted input} = \text{Original input} * (\text{CPI May 2023}/\text{CPI reference date})$$

A.2 Costs of related illnesses

The 2021 Global Burden of Disease Study has been used to identify a preliminary set of illnesses associated with obesity. In discussion with Lilly and Health Innovation Manchester, illnesses have been included in the model if there is strong evidence that they are associated with obesity, and data available on underlying costs, population attributable fractions (PAFs), and prevalence figures. Some illnesses from the preliminary list have been excluded due to lack of data (e.g. gallbladder diseases). Co-morbidities between the illnesses we have modelled have also been factored into our calculations in cases where there are economies of scale identified, and a reduction in cost per case has been applied.

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

Table 16 Cost per case for related illnesses

Illness	Cost per case per year – men (2023)	Cost per case per year – women (2023)	Source and notes
Diabetes	£1,226	£1,040	PHE – The health and social care costs of a selection of health conditions and multi-morbidities. Tables 3 and 4 ³³ Available here (2015 prices)
Hypertension	£1,320	£973	see above
CHD	£1,734	£1,394	see above
CHD and Diabetes ³⁴	£2,322	£1,891	see above
Breast cancer	n/a ³⁵	£2,936	see above
Stroke	£2,949	£2,358	see above
Stroke and Hypertension	£3,674	£2,867	see above
Liver disease	£4,391	£3,706	see above
Depression	£945	£1,031	see above
Sleep apnoea	£1,071	£1,071	Cost-effectiveness of using continuous positive airway pressure in the treatment of severe obstructive sleep apnoea/hypopnoea syndrome in the UK (see here , 2008 prices)

³³ 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.

³⁴ For multi-morbidities, we have calculated the cost savings by dividing the cost per patient with multi-morbidities by the sum of the cost of the individual illnesses. We have then used this rate on the sum of the cost of illnesses we have constructed (i.e. costs with baseline subtracted).

³⁵ The Population Attributable Fraction for breast cancer for men is estimated to be zero. For this reason we have not sourced cost data for breast cancer for men.

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Illness	Cost per case per year – men (2023)	Cost per case per year – women (2023)	Source and notes
Musculoskeletal disorders	£697	£697	HEE: A retrospective review of the influences, milestones, policies and practice developments in the First contact MSK model ³⁶ Available here (2011 prices)
Colorectal cancer	£7,319	£6,991	see above
Ovarian cancer	n/a	£1,837	Bariatric surgery, lifestyle interventions and orlistat for severe obesity: the REBALANCE mixed-methods systematic review and economic evaluation, Table 50 Available here (2016 prices)
Kidney cancer	£541	£541	see above
Oesophageal cancer	£12,476	£12,476	see above

Source: Frontier Economics

Note: Costs reported in this table are *incremental costs* derived from the listed conditions; for this, we have subtracted the 'baseline' costs included in the PHE report, which account for care and treatment received by individuals without these conditions.

Due to data limitations, we don't consider cost savings derived from treating depression or liver disease simultaneously with other obesity-related conditions. The impact of this is likely to be minor.

Table 17 Population Attributable Fractions (PAFs) for related illnesses

Illness	PAF – men	PAF – women	Source
Type 2 diabetes	48%	75.3%	National Audit Office: Tackling Obesity in England (2001)
Hypertension	26%	45.4%	see above
CHD ³⁷	14.8%	18.1%	see above
Osteoarthritis	16.5%	9.4%	see above
Stroke	6.2%	7.2%	see above

³⁶ Source reports the number of adults affected by MSK and NHS spending on MSK. A cost per case is derived from these statistics.

³⁷ The PAF for CHD is constructed using the PAFs for myocardial infarction and angina, weighted by the prevalence of angina and incidence of myocardial infarction.

Colorectal cancer	30.6%	30.7%	see above
Ovarian cancer	n/a	15.4%	see above
Kidney cancer	22.2%	29.6%	Brown et al. (2015). The fraction of cancer attributable to modifiable risk factors in England, Wales, Scotland, Northern Ireland, and the United Kingdom in 2015. British Journal of Cancer. Available here
Liver cancer	25%	24.8%	see above
Breast cancer	-	9%	see above
Oesophageal cancer	31.3%	16.2%	see above

Source : Frontier Economics

For most conditions we used data on Population Attributable Fractions (PAFs), which directly estimates the proportion of cases which are *due* to obesity. This was our preferred approach. For some conditions (depression, liver disease and sleep apnoea) data on PAFs was not available. In these cases we instead used Odds Ratios (ORs) or Hazard Ratios (HRs) to estimate the increased incidence of these conditions among individuals living with obesity compared with individuals without obesity. We note that this approach does not account for other confounding factors.

For **depression, sleep apnoea and liver diseases**, we base our analysis on odds ratios for obese individuals relative to healthy individuals. These are 1.33³⁸, 4.1³⁹ and 2.22⁴⁰, respectively.

Table 18 Prevalence of diagnosed related illnesses

Illness	Prevalence – men	Prevalence – women	Source
Hypertension	15.3%	12.9%	Frontier Economics based on Fingertips (available here)

³⁸ Floriana S. Luppino, MD; Leonore M. de Wit, MS; Paul F. Bouvy, MD, PhD; et al (2010), *Overweight, Obesity, and Depression – A Systematic Review and Meta-analysis of Longitudinal Studies* (available [here](#)).

³⁹ Kivimake et al (2022), *Body-mass index and risk of obesity-related complex multimorbidity: an observational multicohort study* (available [here](#))

⁴⁰ Kivimake et al (2022), *Body-mass index and risk of obesity-related complex multimorbidity: an observational multicohort study* (available [here](#))

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Illness	Prevalence – men	Prevalence – women	Source
Type 2 diabetes	6.5%	5.0%	Frontier Economics based on Diabetes.org (available here)
Musculoskeletal disorders	14.6%	19.3%	Office for Health Improvement and Disparities (available here)
Depression	6.0%	6.0%	Frontier Economics based on ONS and NHS (available here , and here)
Sleep apnoea	2.35%	2.40%	Frontier Economics estimate of prevalence for all population based on prevalence amongst obese from <i>Obstructive Sleep Apnea in Obese Patients: a UK Population Analysis</i> (see here)
Liver disease (diagnosed NASH)	0.83%	0.83%	Frontier Economics based on <i>Disease burden and economic impact of diagnosed nonalcoholic steatohepatitis (NASH) in the United Kingdom (UK) in 2018</i> (see here)
CHD (w/o diabetes)	2.4%	2.4%	Frontier Economics based on Fingertips and Heron et al. (2019). Direct Healthcare Costs of Sedentary Behaviour in the UK. <i>Journal of Epidemiology & Community Health</i> , 73(7), 625-629.
CHD and Diabetes	1.0%	1.0%	Heron et al. (2019). Direct Healthcare Costs of Sedentary Behaviour in the UK. <i>Journal of Epidemiology & Community Health</i> , 73(7), 625-629.
Stroke (w/o hypertension)	0.8%	0.8%	Stroke.org (available here)
Stroke and Hypertension	1.0%	1.0%	Wu et al. (2015). High Blood Pressure and All-Cause and

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Illness	Prevalence – men	Prevalence – women	Source
			Cardiovascular Disease Mortalities in Community-Dwelling Older Adults. Medicine (Baltimore). 2005, 94(47)
Colorectal cancer	0.07%	0.05%	House of Commons Library (available here)
Ovarian Cancer	-	0.02%	House of Commons Library (available here)
Kidney cancer	0.02%	0.01%	House of Commons Library (available here)
Liver cancer	0.01%	0.01%	Cancer research UK (available here)
Oesophageal cancer	0.02%	0.01%	Cancer research UK (available here)
Breast cancer	-	0.14%	House of Commons Library (available here)

Source: Frontier Economics

Note: Where data is available, we consider prevalence based on **diagnosed** disease (rather than estimates including both diagnosed and undiagnosed cases). This approach is conservative, as undiagnosed individuals are likely to incur lesser costs to the NHS

The combination of the data sources above allows us to calculate the average care and treatment cost to the NHS per person living with obesity, due to obesity. The table below exemplifies how this was calculated.

Table 19 Estimating average cost to the NHS derived from Type 2 diabetes per (male) person living with obesity

Metric	Value	Source
Prevalence of diagnosed type 2 cases, male (A)	6.5%	see Table 18
PAF (B)	48%	National Audit Office, ScotPHO
Prevalence of diagnosed type 2 cases due to obesity, Male (C = A * B)	3.1%	calculated

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Prevalence of male obesity in England (D)	25.4%	Health Survey for England
Cost of treating type 2 diabetes case (additional to baseline)- Male (F)	£1,226	PHE report
Average incremental cost per individual living with obesity for the treatment of Type 2 diabetes cases caused by obesity (G = F * C / D)	£150.7	<i>calculated</i>

Source: *Frontier Economics*

As indicated in the sources in Table 18, our calculations rely on illness prevalence figures from published sources, and not GMCR. This is for two reasons. First, we have only received GMCR data relative to individuals living with obesity, which doesn't allow us to calculate disease prevalence at the wider population level (which is an essential metric in our methodology). Second, an analysis of the data indicates that illnesses are under recorded in GMCR. This can be observed in Table 20 below.

Table 20 Comparison of illness prevalence in GMCR against alternative sources

Condition	Prevalence as per GMCR (within obese population)	Frontier estimates from other sources (across whole population)
Hypertension	3.1%	14.1%
Diabetes	1.5%	5.7%
Stroke	0.1%	1.8%
CHD	1.1%	3.4%
Musculoskeletal disorders	3.2%	17.0%

Source: *Frontier Economics*

Note: "Frontier estimates from other sources" includes across men and women as per Table 18

A.3 Costs of formal social care

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

Table 21 Costs of formal social care – inputs and assumptions

Inputs and assumptions	Estimate	Source
Hourly cost of a social care worker (2023 prices)	£24.8	Community based social care unit costs (2022): (available here), page 80
Proportion of those requiring social care that receive social care (65+)	38.6%	The King's Fund (available here)
Additional social care hours per individual with BMI 30-40 per year (relative to healthy weight)	4.55	Copley et al. (2017). Estimating the variation in need for community-based social care by body mass index in England and associated cost: population-based cross-sectional study. BMC Public Health. Table 4, values from Model 3 (available here)

Source: *Frontier Economics*

A.4 NHS and formal social care costs by subpopulation

Number of people living with obesity in each subpopulation

The total number of people living with obesity in Greater Manchester was calculated based on obesity prevalence estimates from the Office for Health Improvement and Disparities, and ONS estimates on the adult population in Greater Manchester. In 2023, we estimate that 606,292 adults are living with obesity in Greater Manchester.

We have then calculated the shares of individuals living with obesity across each subpopulation using GMCR data. For example, we find that 30% of the adults living with obesity recorded in GMCR live in a LSOA in the first decile of the Index of Multiple Deprivation.

The number of people in each subpopulation was reached through the application of GMCR proportions to the ONS estimates of population living with obesity. Note that we have not directly used the total numbers of records of individuals living with obesity per subpopulation in GMCR. This is because the GMCR dataset is not fully comprehensive for obesity⁴¹, and this approach would understate the true number of individuals living with obesity.

⁴¹ Our analysis indicates that GMCR covers around 71% of the adult population with obesity in Greater Manchester.

Average cost-per-person in each subpopulation

We have calculated the average cost-per-person to the NHS for each subpopulation by balancing the cost figures for Greater Manchester (described in section 2.2) to reflect the different average levels of obesity in each subpopulation.

To do this, we first estimated the average cost-per-person to the NHS for individuals with different classes of obesity (split in three groups: BMI 30-34, 35-39 and 40+). This was based on a combination of:

1. The average number of outpatient visits, elective admissions and emergency admissions in the last 12 months for individuals with different classes of obesity (based on GMCR), and
2. The average cost to the NHS from outpatient visits, elective admissions and emergency admissions (sourced from NHS England).

Table 22 Average number of secondary care visits per person by BMI group

NHS activity	30-34*	35-39	40+
Outpatient visit	3.75	4.28	4.64
Elective admission	0.35	0.38	0.37
Emergency admission	0.37	0.42	0.54

Source: Frontier economics based on GMCR

Note: The BMI group 30-34 includes BAME individuals with BMI between 27.5 to 34.

Table 23 Cost to the NHS from secondary care visits by type

NHS activity	Average cost (2023 prices)
Outpatient visit	£190.71
Elective admission	£2,177.55
Emergency admission	£2,726.56

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

Note: All cost figures have been inflated to 2023 prices, as done in the remaining parts of the work.

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 calculated as the total weighted average unit cost of "non-elective inpatient – short stay" and "non-elective inpatient – long stay"

The above allows us to calculate average secondary care costs per person in each BMI group. This includes costs not related to obesity (i.e. derived from visits unrelated to obesity). In

combination with information on the number of individuals in each BMI group (based on GMCR) and our estimate of total costs to the NHS due to obesity (as per section 2.2), we derive NHS costs due to obesity per BMI group. For data availability reasons, note that the differences in costs across BMI groups in our analysis derive from secondary care usage.

Table 24 Calculations of NHS costs due to obesity across BMI groups (differentiated based on differential usage of secondary care services)

	30-34*	35-39	40+
Secondary care cost in GMCR <u>per person</u>	£2,475	£2,811	£3,158
Increment relative to BMI 30-34	-	£336	£683
Costs due to obesity per BMI group <u>per person</u> (algebraic)	x	$x + 336$	$x + 683$
Population per BMI group	396,473	127,950	81,869
<u>Total</u> costs due to obesity per BMI group (algebraic)	$396,473 x$	$127,950 \cdot (x + 336)$	$81,869 \cdot (x + 683)$
<u>Total</u> NHS costs due to obesity	£344 million across all groups		
NHS costs due to obesity per BMI group <u>per person</u> (solving for x , considering that total expense is £344 million)	£404	£740	£1,087

Source: Frontier Economics

Note: The BMI group 30-34 includes BAME individuals with BMI between 27.5 to 34.

Finally, we consider the share of people living with different classes of obesity (BMI 30-34, 35-39 and 40+) in each subpopulation to calculate an average cost to the NHS per person which is specific to each subpopulation.

Due to data limitations, the average cost per person to social care organisations was not differentiated by subpopulation based on average levels of BMI. Instead, we consider a unique average cost measure as described in section 2.3

A.5 Costs of informal social care

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

Table 25 Costs of informal social care – inputs and assumptions

Inputs and assumptions	Estimate	Source
Median hourly wage in GM (2023)	£15	ASHE Table 8.6a (available here)
Additional informal social care hours per individual with BMI 30-40 per year (relative to healthy weight)	157.5	Copley et al. (2017). Estimating the variation in need for community-based social care by body mass index in England and associated cost: population-based cross-sectional study. BMC Public Health. Table 4, values from Model 3 (available here)

Source: *Frontier Economics*

A.6 Costs due to productivity losses

Costs of loss of productivity associated with obesity due to unemployment and economic inactivity are estimated for individuals with obesity between the ages of 50-64. The data sources informing our assumptions and calculations are summarised below.

Table 26 Data sources – losses from unemployment and inactivity

Inputs and assumptions	Estimate	Source
Unemployed share of adult population (note: not unemployment rate)	4.4%	ONS Nomisweb Available here
Inactive share of adult population	23%	ONS Nomisweb Available here
Retired Odds Ratio for individuals with obesity	1.43	Unemployment and retirement and ill-health: a cross-sectional analysis across European countries (Available here)
Unemployed Odds Ratio for individuals with obesity	1.31	see above

Inputs and assumptions	Estimate	Source
Homemaker Odds Ratio for individuals with obesity	1.34	see above
Median annual salary GM (2023)	£27,845	ASHE Table 8.7a (available here)

Source: *Frontier Economics*

Costs of loss of productivity associated with obesity due to sickness absence are estimated for individuals with obesity between the ages of 18-64. The data sources informing our assumptions and calculations are summarised below.

Table 27 Data sources – sickness absence losses

Inputs and assumptions	Estimate	Source
Difference between sick leave days taken by individuals with and without obesity	4	Harvey et al. Obesity and sickness absence: results from the CHAP study, <i>Occupational Medicine</i> , Volume 60, Issue 5, August 2010, Pages 362–368. Available here
Median daily wage in GM (2023), calculated as 7 times hourly wage	£105	ASHE Table 8.6a (available here)
Employment rate in GM	73%	ONS Nomisweb Available here
Employment rate for individuals with obesity	64%	Frontier Economics based on ONS Nomisweb and Table 26

Source: *Frontier Economics*

A.7 Costs due to loss of QALYs

The data sources informing our assumptions and calculations for QALY losses associated with obesity are summarised in Table 28.

Table 28 Data sources – QALY losses

Inputs and assumptions	Estimate	Source
QALYs lost due to obesity	0.031-0.032 (depending on age)	Managing Overweight and Obesity among Adults, page 30-31. Available here

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Inputs and assumptions	Estimate	Source
QALYs lost due to severe obesity	0.107	See above
Monetary value of one QALY	£70,000	Green Book (2022), page vii Available here
NICE's cost effectiveness threshold	£20,000	NICE Briefing (2013), page 3 Available here

Source: *Frontier Economics*

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