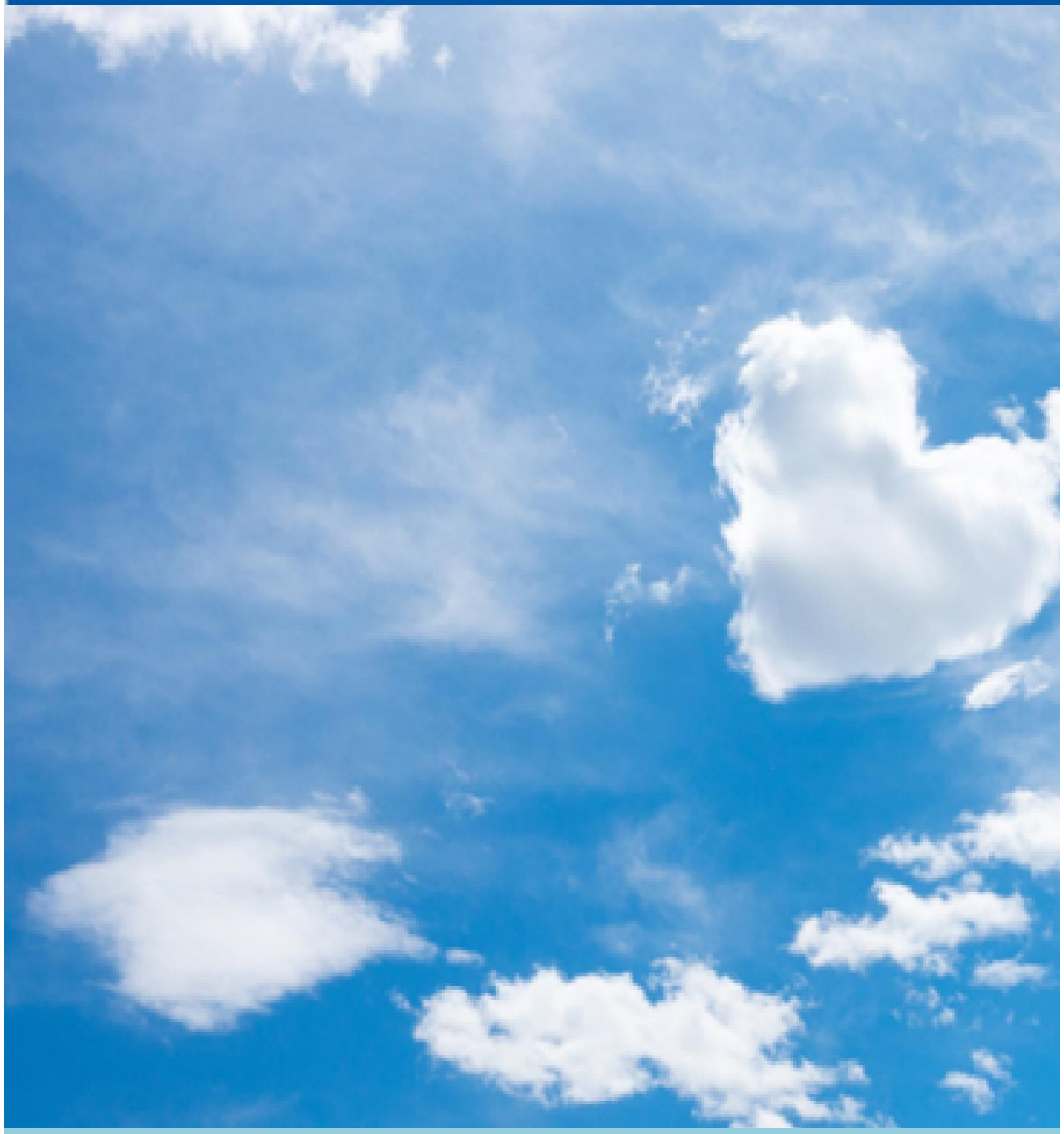
InformGloucestershire



Air Quality in Gloucestershire

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Contents

1. Executive Summary

- Air quality in Gloucestershire is relatively good, most of parts of the county are below current UK targets for PM 2.5, PM 10 and nitrogen dioxide, however there are several areas of the county which exceed levels recommended by the WHO.
- The effects of air pollution are distributed unequally across the population. The most deprived 20% of neighbourhoods in England have higher air pollution levels than the least deprived neighbourhoods.
- Air pollution is considered a serious public health issue for the UK. One of the most important health impacts of air pollution is the increase in mortality risk associated with long-term exposure to particulate air pollution. In 2021 there were 355 deaths attributable to air pollution in Gloucestershire.
- Air pollution also affects daily quality of life as it can exacerbate lung conditions such as Chronic Obstructive Pulmonary Disease (COPD) and asthma, resulting in increased use of medications and hospital admissions.

2. What is air pollution?

The World Health Organisation defines air pollution as 'contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere'[1].

Pollutants of major public health concern include nitrogen dioxide (NO2), arising from NOX and particulate matter (PM10/2.5). All combustion processes produce nitrogen dioxide, a gas which is harmful to health in concentrations above recommended limits. Particulate matter is a complex mix of non-gaseous particles of varied physical and chemical composition. The number denotes the size of the particle, particular matter 10 are particles with a diameter of less than 10 microns (µm) and particulate matter 2.5 are less than 2.5µm. The smaller the particle the deeper into the lungs it can travel causing more severe health effects.

WHO data show that almost all of the global population (99%) breathe air that exceeds WHO guideline limits and contains high levels of pollutants[2].

[1] Air pollution, World Health Organisation Air pollution (who.int)
[2] *Ibid.*

3. What are the issues with air quality in Gloucestershire?

3.1 Modelled data

DEFRA assesses air quality in the UK through a combination of monitoring and modelling. DEFRA has no monitoring sites in Gloucestershire so relies on modelling. The modelling takes into account:

- Large point sources (e.g. power stations, steel works and oil refineries),
- Small point sources (e.g. boilers in town halls, schools or hospitals and crematoria),
- Distant sources (characterised by the rural background concentration),
- Local area sources (e.g. road traffic, domestic and commercial combustion and agriculture)
- Roadside concentrations determined by using a roadside increment model which attempts to estimate the contribution from road traffic sources and adds this on top of the modelled background concentrations discussed above
- Other contributions

3.1.1 Particulate Matter 2.5 (PM 2.5)

Particulate matter 2.5 (PM 2.5) is the term used to describe condensed phase (solid or liquid) particles suspended in the atmosphere which are 2.5 um or less in diameter.

Current WHO Air Quality Guidelines levels introduced in 2021, suggest the target level for PM2.5 should be 5 ugm-3[3], this is significantly lower than the previous target of 10 ugm-3. The UK's Environment Act (2021) has a lower target, it states that by 2040 levels of PM 2.5 should not exceed 10 ugm-3.

PM.25 at a 1km^2 level is visualised in Figure 1, it shows all areas in Gloucestershire are estimated to have exceeded the WHO target in 2021, however, most parts of the county have met the target set by the UK's Environment Act. Estimated levels of PM 2.5 in most areas are estimated to be between 6-8 ugm-3, the exceptions are parts of Gloucester and areas around our market towns, which have estimated levels between 11-13 ugm-3.

[3] WHO Air quality guidelines WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide

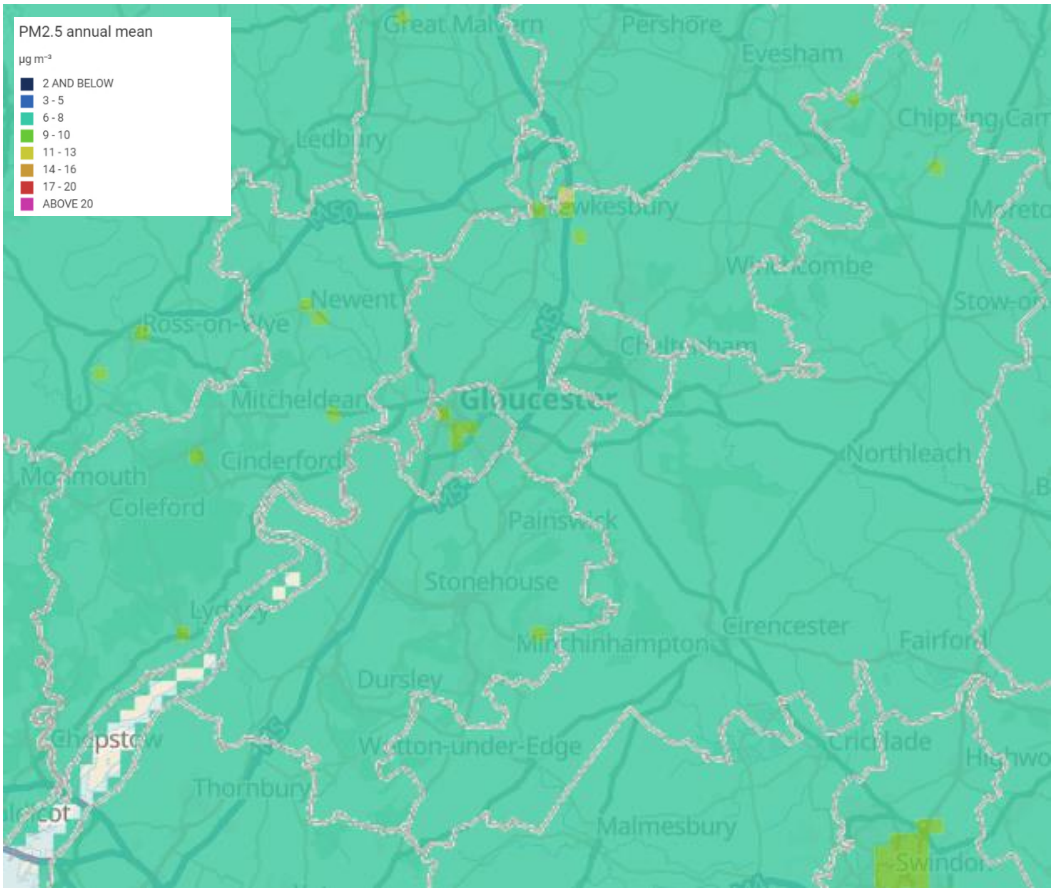

Figure 1: Ambient air quality map, PM 2.5 background concentration, 2021, Gloucestershire[4]

Population weighted data is available at a local authority level, this estimated that in 2021 the total annual mean PM2.5 concentration in Gloucestershire was 7.1 ugm-3, above WHO guidelines but below the target set in the UK's Environment Act. Figure 2 shows that all of Gloucestershire's statistical neighbours also had PM 2.5 levels which exceeded the WHO Guidelines. When compared to its statistical neighbours, Gloucestershire is ranked 6th out of 16 areas, putting it in the top half of similar authorities. Gloucestershire has higher PM 2.5 levels than the South West (6.8 ugm-3) but was below the national average of 7.4 ugm-3.

[4] UK ambient air quality map, UK Ambient Air Quality Interactive Map (defra.gov.uk)

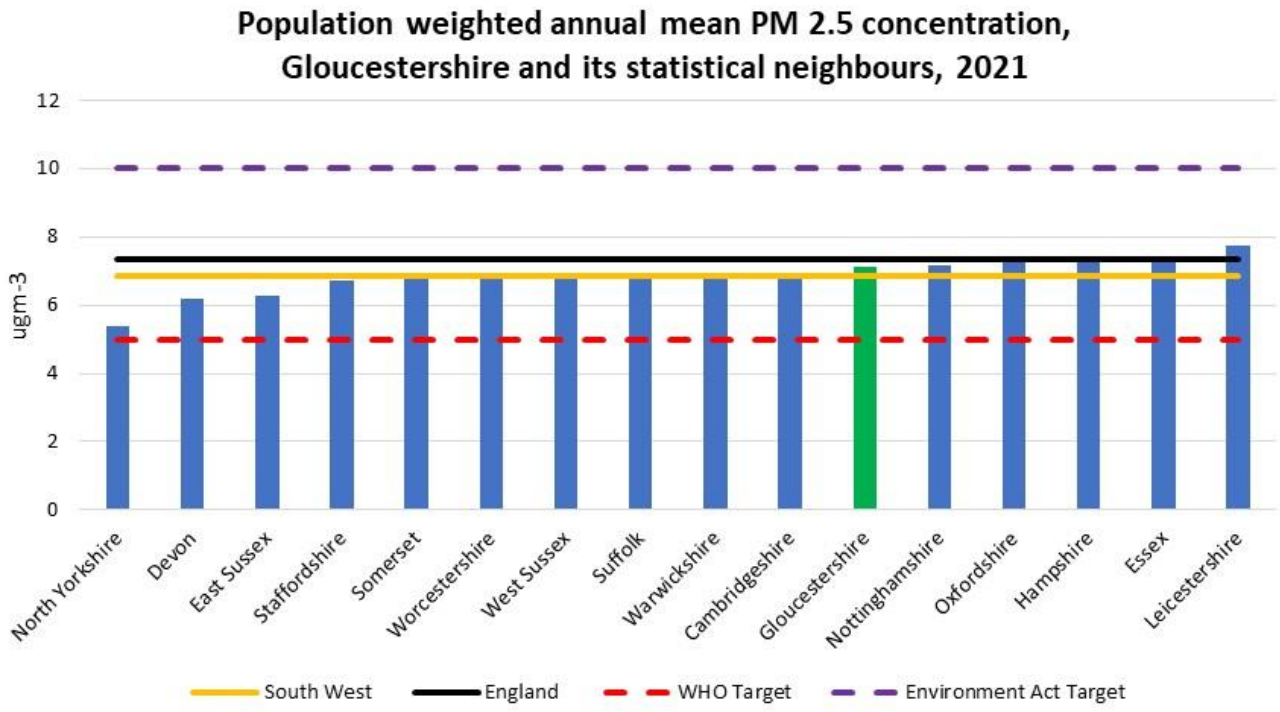

Figure 2: Population weighted annual mean PM 2.5 concentration, Gloucestershire and its statistical neighbours, 2021[5]

Data at a district level shows all of Gloucestershire exceed WHO guidelines but met the targets set out by the UK Environment Act, which is unsurprising given the small area data. Levels of PM 2.5 are highest in Gloucester where they exceed the national average, followed by Cheltenham where they are in line with the national average.

[5] Modelled Background Pollution Data, Defra https://uk-air.defra.gov.uk/data/pcm-data

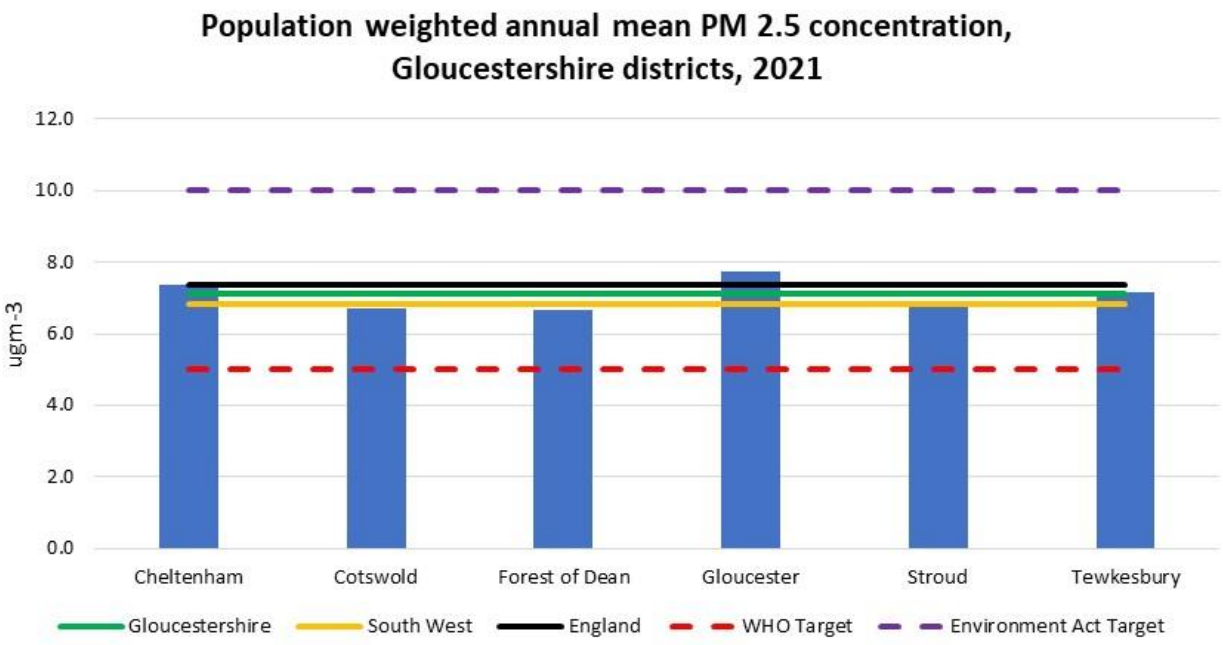

Figure 3: Population weighted annual mean PM2.5 concentration, Gloucestershire and its districts[6]

Figure 4 and Figure 5 show the trend in PM 2.5 concentration between 2017 and 2021 at a local authority level. All areas follow a similar pattern, with levels of PM 2.5 falling sharply in 2020 and remaining low in 2021. Much of this decline is likely to be a result of changes to travel and transport caused by lockdown restrictions introduced during the COVID-19 pandemic. While these restrictions were temporary, they have brought about longer-term changes to society in particular the move towards hybrid working, meaning it is unclear whether PM 2.5 levels will return to pre-covid levels.

[6] *Ibid.*

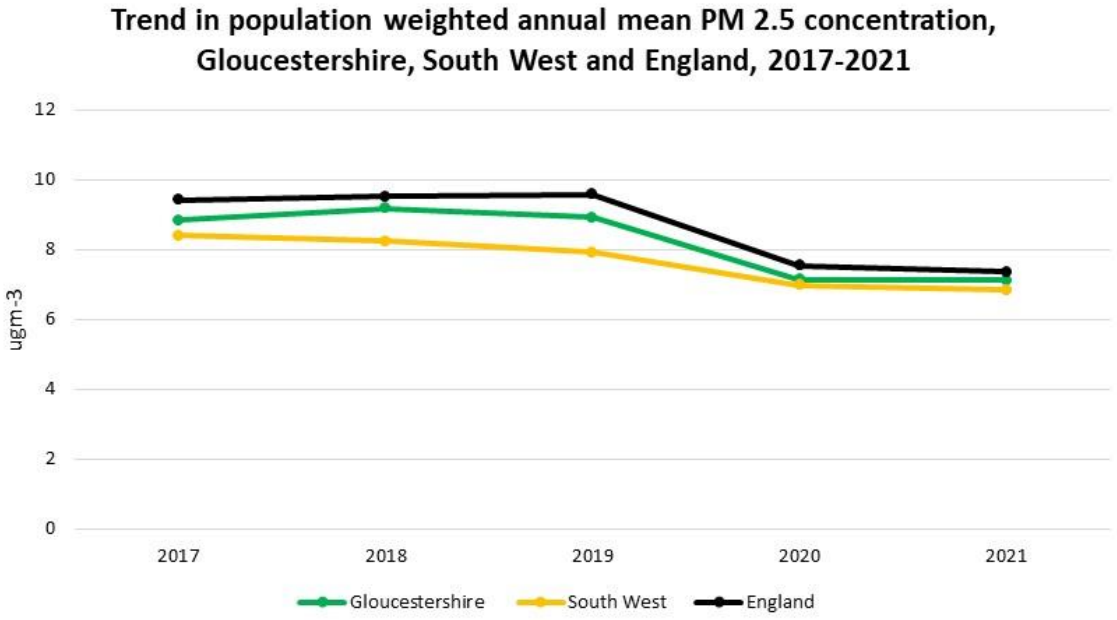

Figure 4: Trend in population weighted annual mean PM 2.5 concentration, Gloucestershire, South West and England 2017-2021[7]

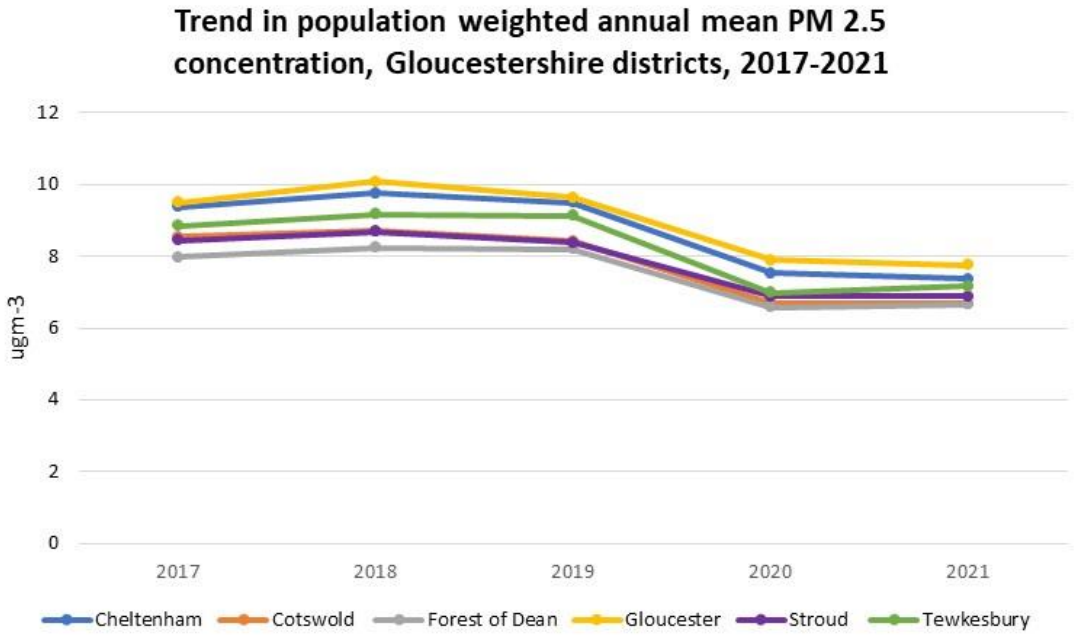

Figure 5: Trend in population weighted annual mean PM 2.5 concentration, Gloucestershire districts, 2017-2021[8]

[7] *Ibid.*

[8] *Ibid.*

DEFRA also produces estimates of anthropogenic PM 2.5, this is because estimates based on total PM 2.5 might give a misleading impression of the scale of the potential influence of policy interventions. The estimates of anthropogenic PM2.5 present a similar picture with Gloucestershire faring better than the national average and worse than the South West.

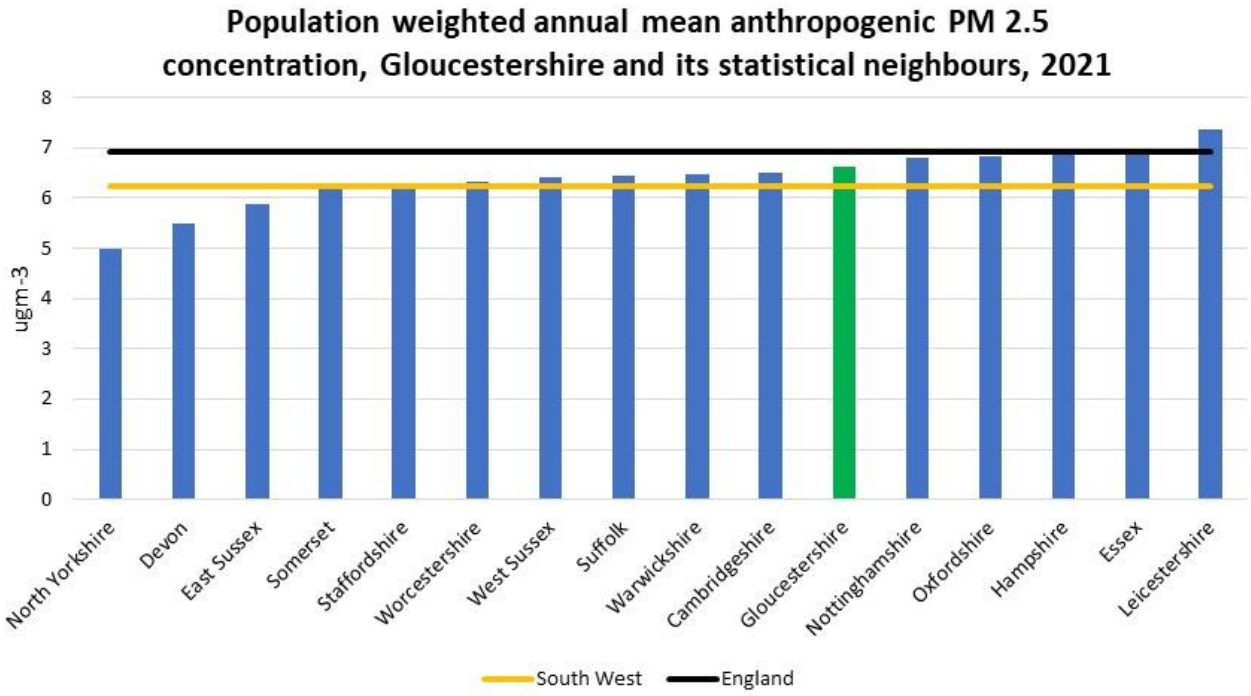

Figure 6: Population weighted annual mean anthropogenic PM 2.5 concentration, Gloucestershire and its statistical neighbours[9]

At district level Cheltenham and Cheltenham had the highest levels of anthropogenic PM 2.5.

[9] *Ibid.*

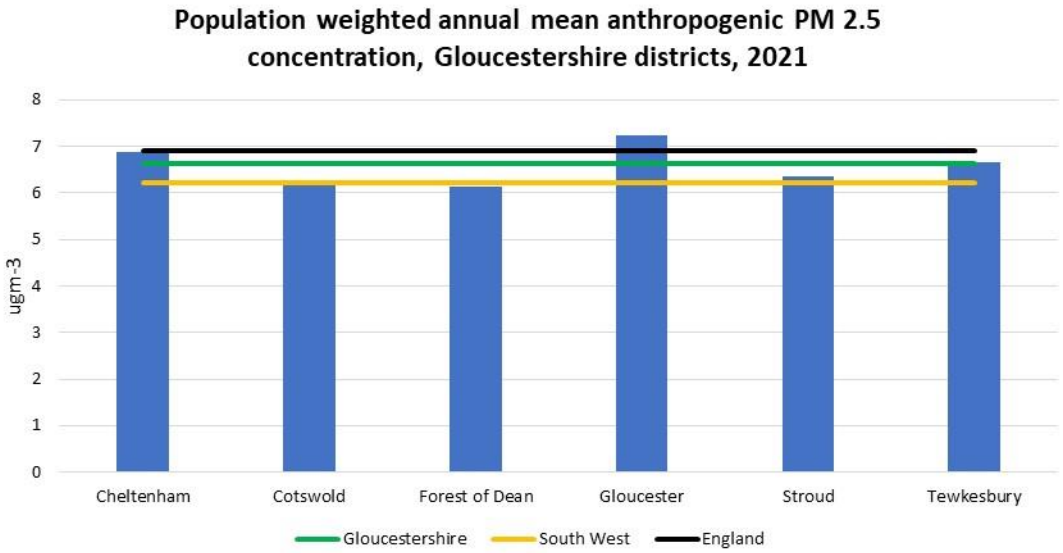

Figure 7: Population weighted annual anthropogenic mean PM2.5 concentration, Gloucestershire and its districts[10]

Figure 8 and Figure 9 show the trend in the anthropogenic PM 2.5 the picture reflects that seen in overall PM 2.5, with all areas seeing a sharp decline in levels of PM 2.5 between 2019 and 2020.

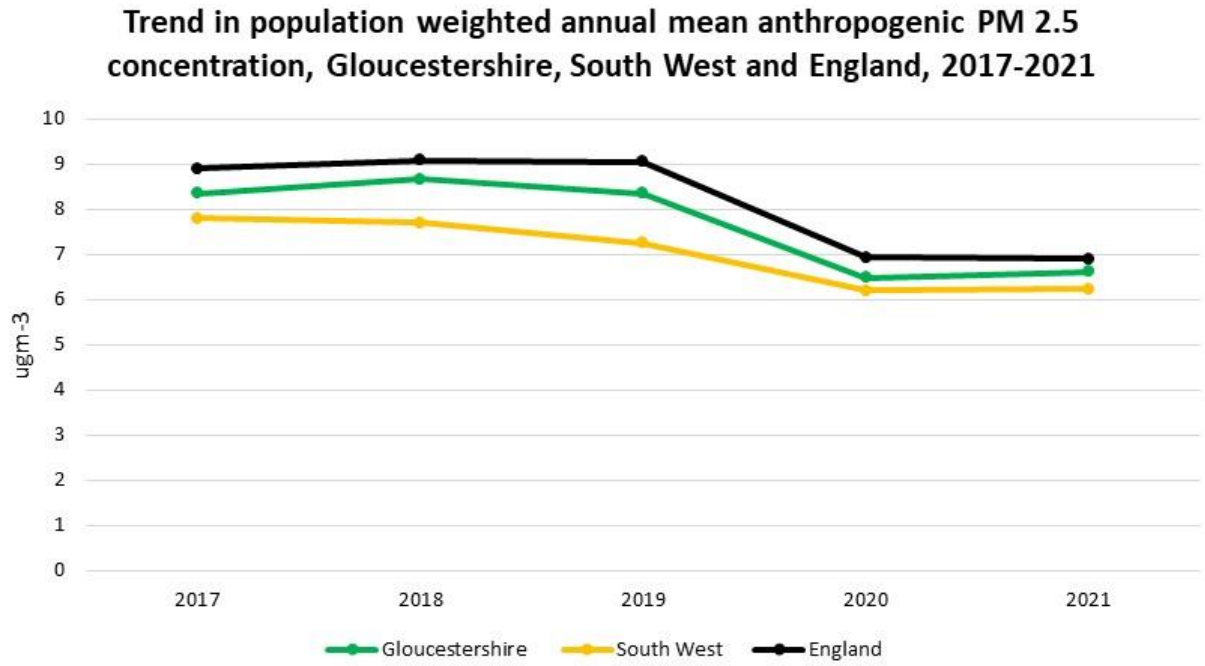

Figure 8: Trend in population weighted annual mean anthropogenic PM 2.5 concentration, Gloucestershire, South West and England, 2017-2021[11]

[10] *Ibid.*

[11] *Ibid.*

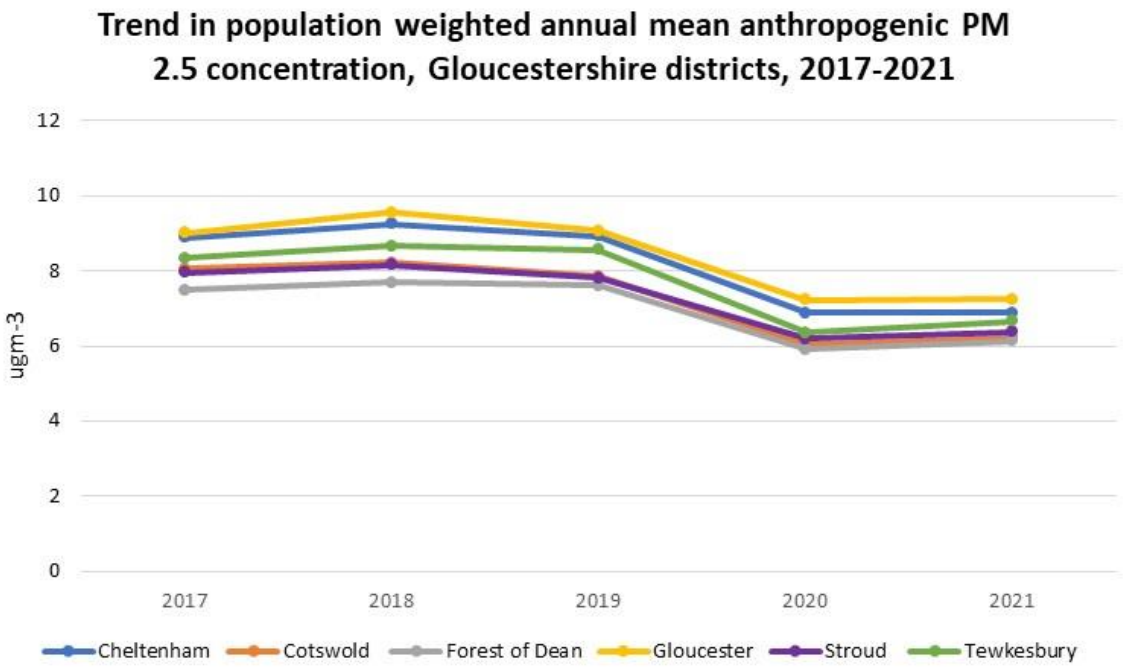

Figure 9: Trend in population weighted annual mean anthropogenic PM 2.5 concentration, Gloucestershire districts, 2017-2021

3.1.2 Particulate Matter 10 (PM 10)

Particulate matter 10 (PM 10) is the term used to describe condensed phase (solid or liquid) particles suspended in the atmosphere which are 10 um or less in diameter.

Current WHO Air Quality Guidelines levels for PM10 are set at 10 ugm-3[12], this is significantly lower than the previous target of 20 ugm-3. Across the UK the current guidelines are set at 40 ugm-3. Data at a 1km^2 level is visualised in Figure 10 and gives a granular view of PM 10, it shows most areas in Gloucestershire are estimated to have levels of PM10 below 13 ugm-3 in 2021. Levels exceed this in the areas surrounding the M5 motorway as well as around our market towns where they reach 14-17 ugm-3. Part of the A40 in the Forest of Dean stands out as having the highest level of PM10 in the county with an estimate of 18-20 ugm-3.

[12] WHO Air quality guidelines WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide

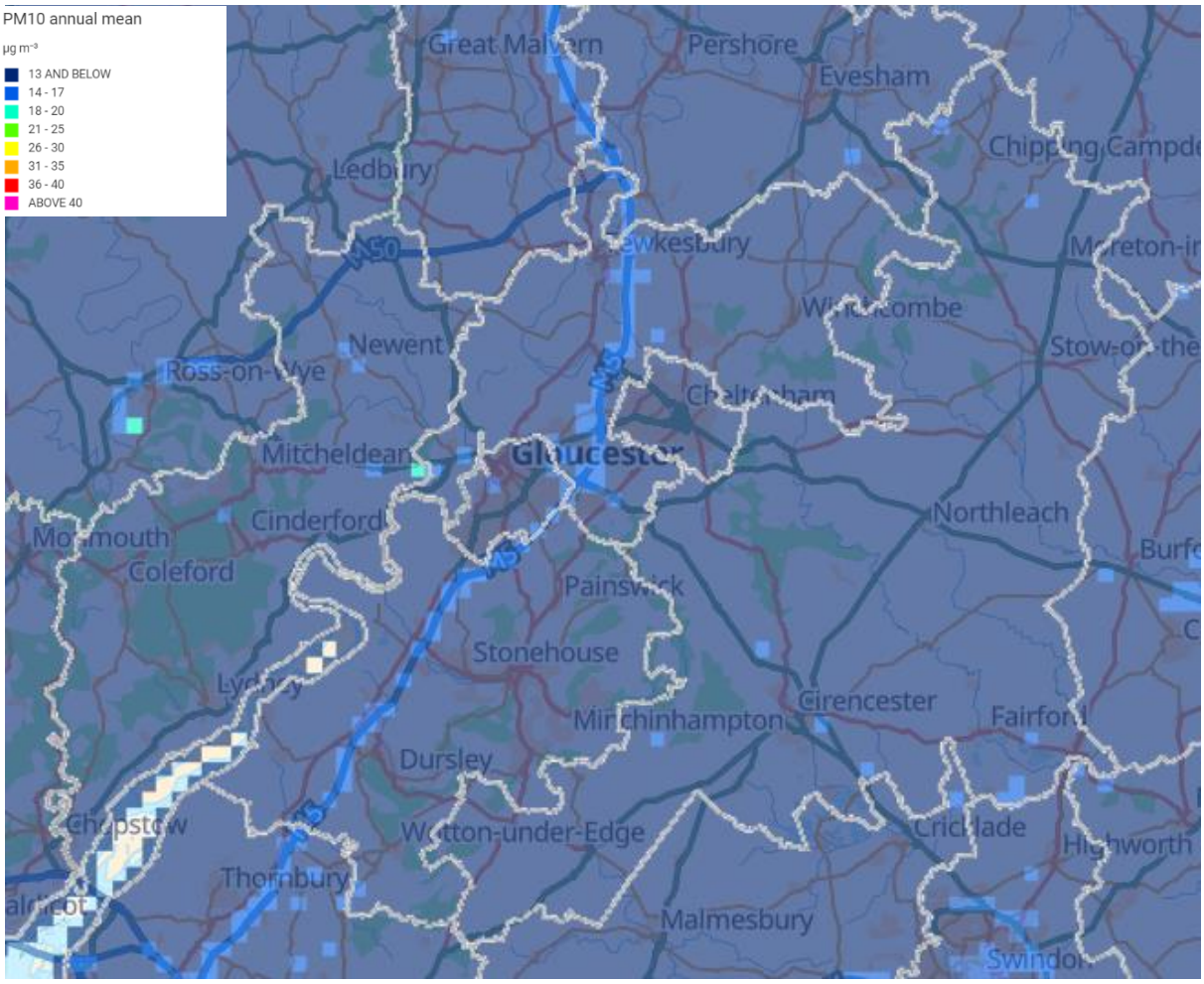

Figure 10: Ambient air quality map, PM 10 background concentration, 2021, Gloucestershire[13]

Aggregate data is not available for upper tier local authorities however, a breakdown is available at district level, this data differs slightly from that reported elsewhere in that it uses the maximum recorded value rather than the average. It shows that all districts within Gloucestershire had a maximum value which exceeded WHO guidelines in 2021 but were considerably lower than the current UK targets. Maximum levels of PM 10 were highest in Tewkesbury where they were estimated to be reach 18 ugm-3.

[13] UK ambient air quality map, UK Ambient Air Quality Interactive Map (defra.gov.uk)

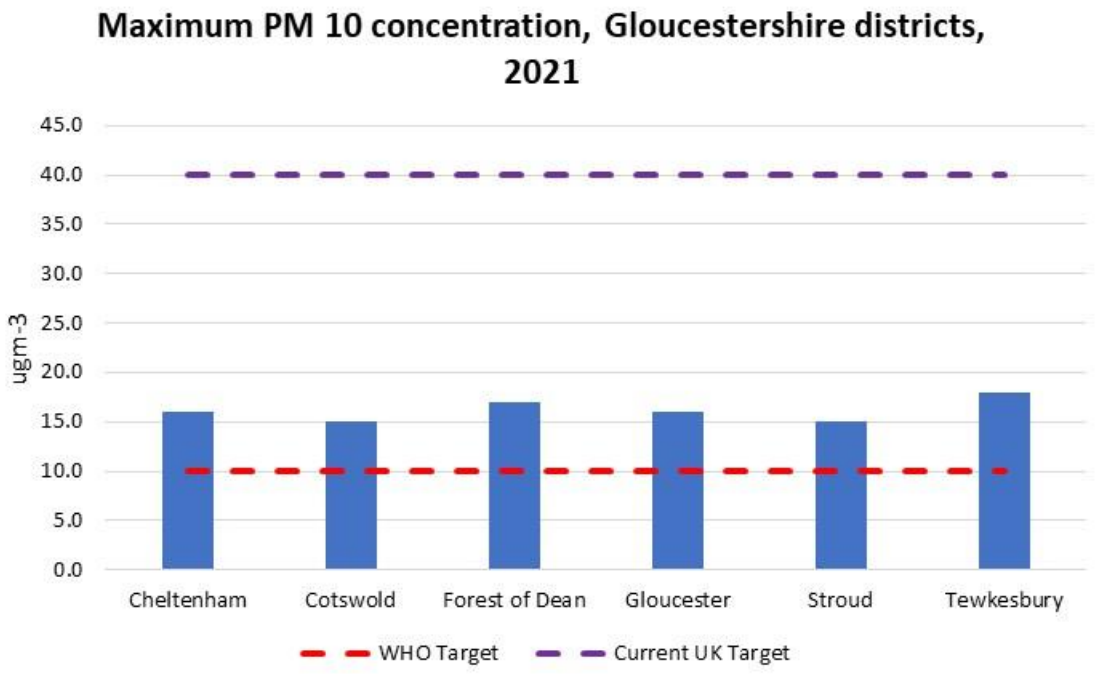

Figure 11: Maximum PM 10 concentration, Gloucestershire districts, 2021[14]

Estimates of PM10 are also available for small areas known as Lower Super Output Areas[15]. This data is not as timely as district level data or data at a 1km^2 level as it relates to 2019, however it does present an interesting picture. Figure 12 shows that all Lower Super Output Areas in the county had average values which exceed the current WHO guidelines of 10 ugm-3 but are lower than the current UK targets. Levels of PM10 are estimated to be at their highest around Northway and Churchdown in Tewkesbury, the east of Cheltenham and north of Gloucester, many of which border the M5 corridor.

[14] PM10 annual mean Local Authority 2021, UK Air, DEFRA

[15] These are small areas based on Census 2011 and contain an average of 1,600 people.

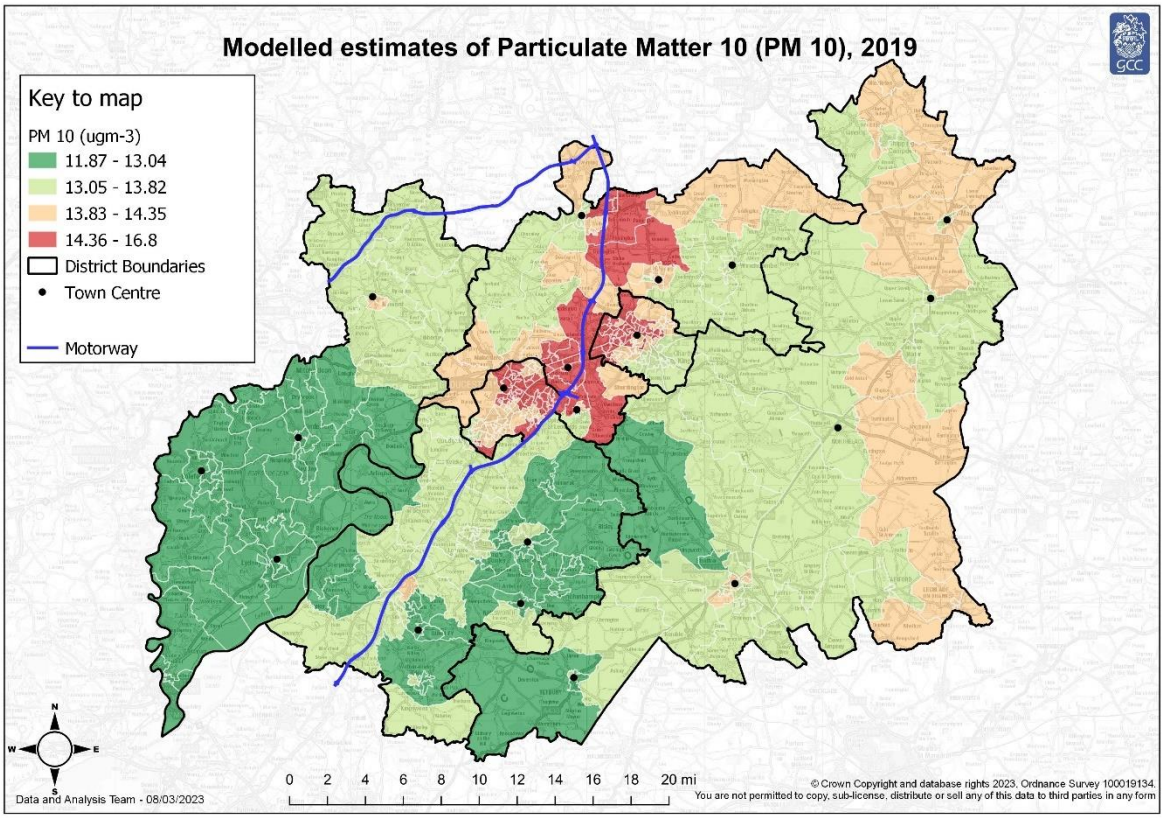

Figure 12: Modelled estimates of particulate matter (PM10) at Lower Super Output Area Level, 2019[16]

3.1.3 Nitrogen Dioxide

Nitrogen dioxide, or NO2, is a gaseous air pollutant composed of nitrogen and oxygen. Current WHO Air Quality Guidelines levels for nitrogen dioxide are set at 10 ugm-3[17], this is significantly lower than the previous target of 40 ugm-3, the current UK target is set at 40 ugm-3. Data at a 1km^2 level is visualised in Figure 13 and gives a granular view of nitrogen dioxide, it shows most areas in Gloucestershire are estimated to have levels of nitrogen dioxide below 10 ugm-3 in 2021, meaning most of the county meets the guidelines set by the WHO. Levels exceed this in the areas surrounding M5 junctions 12, 11, 11A and 9 as well as parts of Gloucester and Cheltenham where they reach 11-20 ugm-3.

[16] CDRC https://data.cdrc.ac.uk/dataset/access-to-healthy-assets-and-hazards-ahah

[17] WHO Air quality guidelines WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide

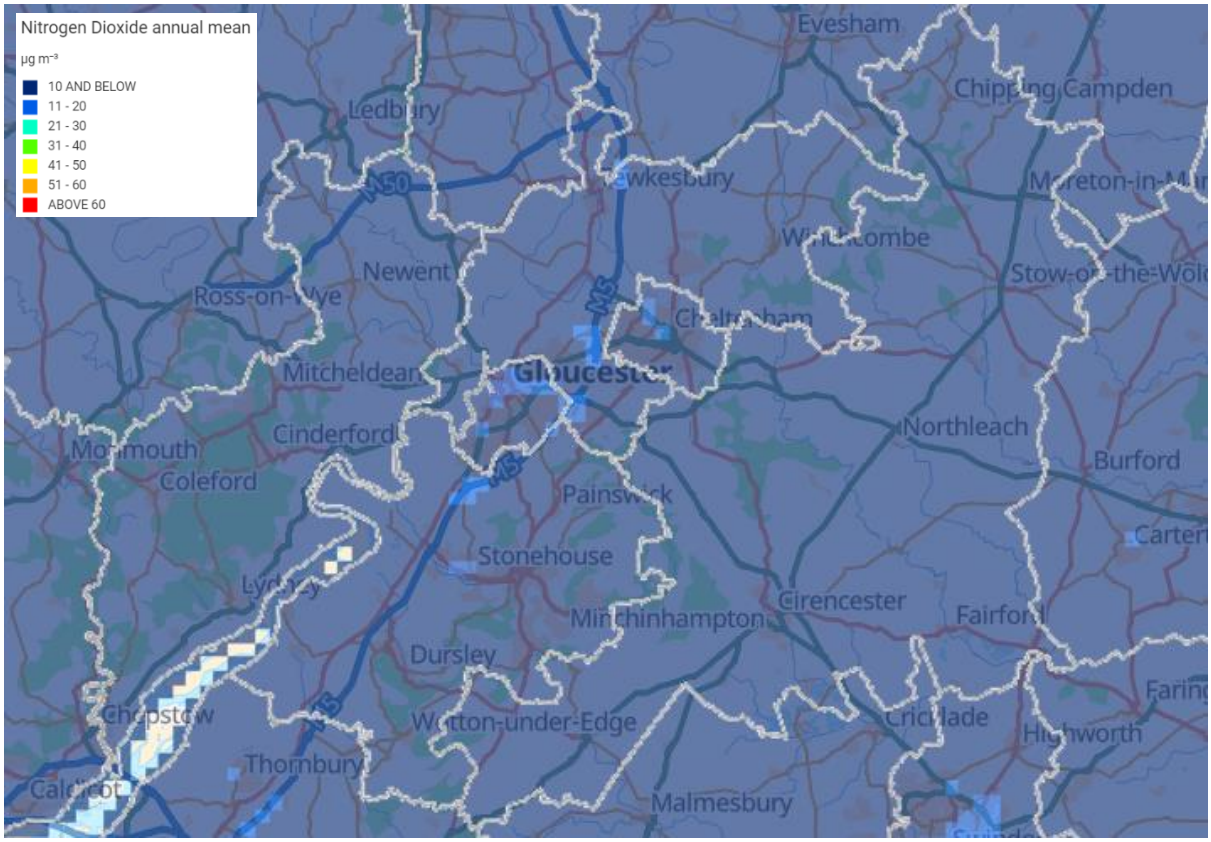

Figure 13: Ambient air quality map, nitrogen dioxide background concentration, 2021, Gloucestershire[18]

Aggregate data is not available for upper tier local authorities however, a breakdown is available at district level, this data differs slightly from that reported elsewhere in that it uses the maximum recorded value rather than the average. It shows that all districts within Gloucestershire had maximum levels which exceeded WHO guidelines in 2021 but were considerably lower than the current UK targets. Maximum levels of nitrogen dioxide were highest in Cheltenham where they were estimated to be reach 28 ugm-3.

[18] UK ambient air quality map, UK Ambient Air Quality Interactive Map (defra.gov.uk)

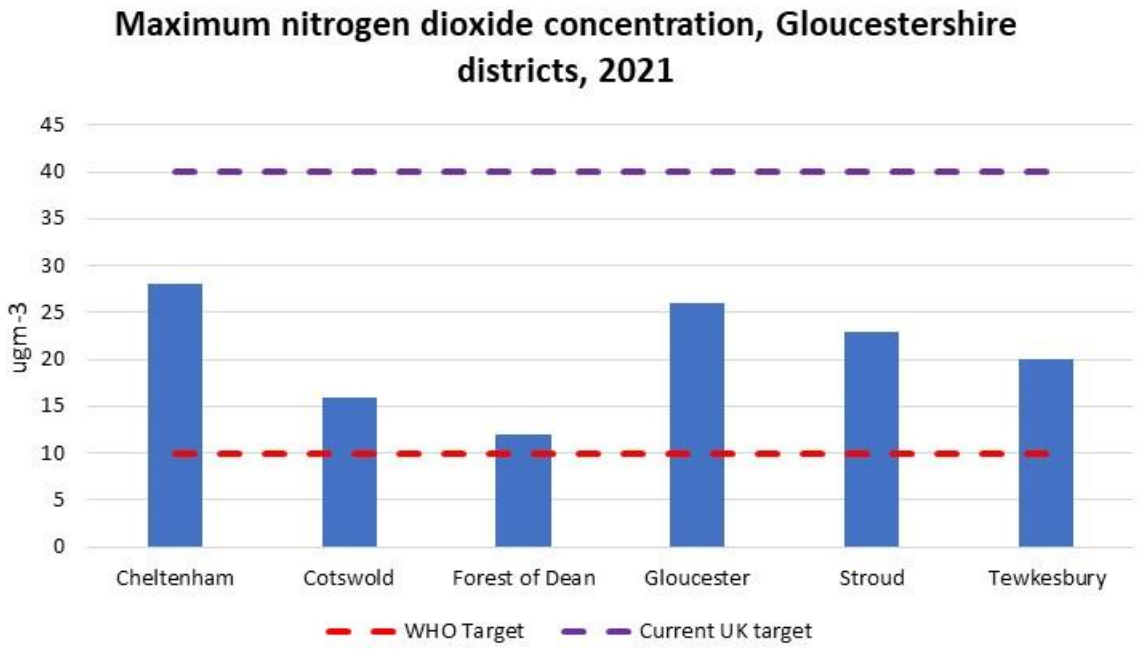

Figure 14: Maximum nitrogen dioxide concentration, Gloucestershire districts, 2021[19]

Estimates of nitrogen dioxide are also available for small areas known as Lower Super Output Areas[20]. This data is not as timely as district level data or data at a 1km^2 level as it relates to 2019, however it does present an interesting picture. Figure 15 shows that large areas of the Forest of Dean, Cotswold, Stroud and Tewkesbury currently have average nitrogen dioxide levels below WHO guidelines and all LSOAs in the county are below the current UK targets. Levels of nitrogen dioxide are estimated to be at their highest around Northway and Churchdown in Tewkesbury, central Gloucester and Cheltenham

[19] Nitrogen Dioxide annual mean Local Authority 2021, UK Air, DEFRA

[20] These are small areas based on Census 2011 and contain an average of 1,600 people.

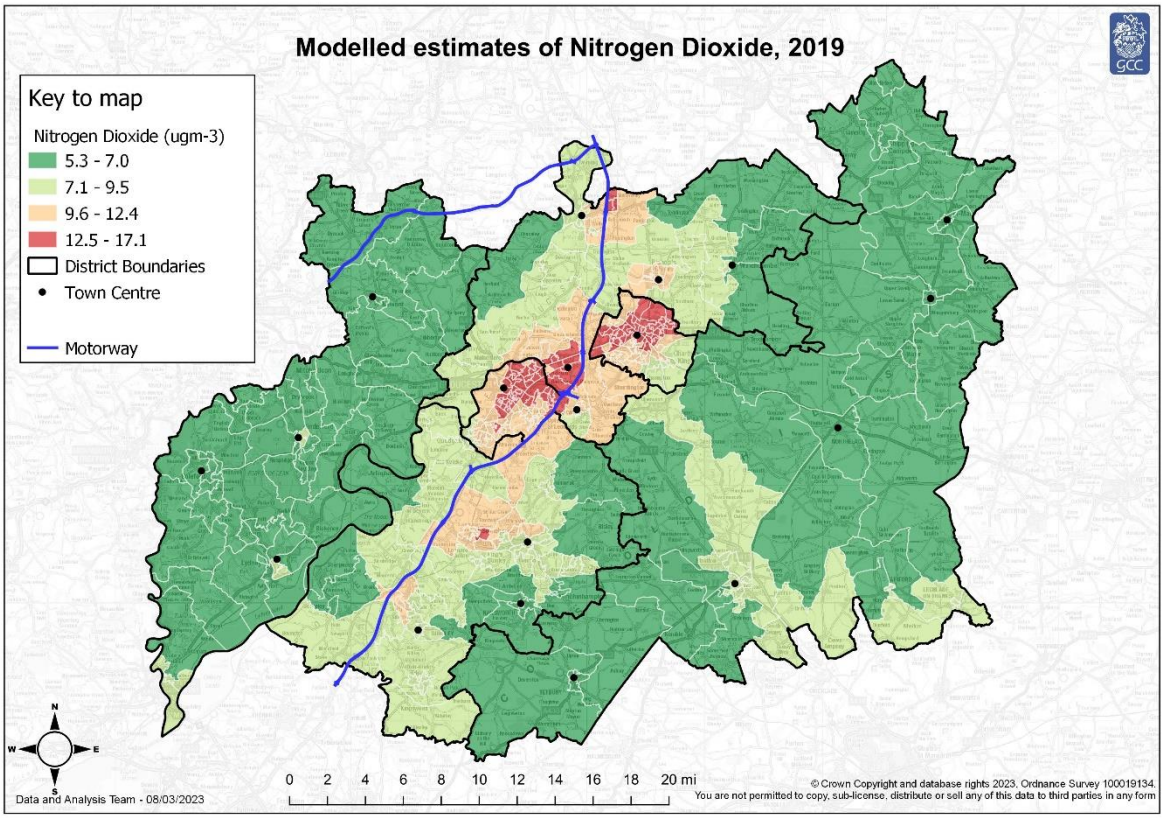

Figure 15: Modelled estimates of nitrogen dioxide at Lower Super Output Area Level, 2019[21]

3.2 Monitoring

All Districts and Borough councils measure local air quality using passive diffusion tubes. These tubes monitor background nitrogen dioxide levels that provide a general indicator of pollution levels at particular sites. In 2020[22] there were around 150 monitoring sites across the county (in some cases there are multiple monitoring sites in one location). Figure 16 shows their location and average reading, there were no sites across the county that exceeded the current UK recommendations, however there were over 100 sites that exceeded the WHO current recommendations. The areas with the greatest levels of nitrogen dioxide were mainly in Cheltenham and Gloucester or around key road networks such as the Air Balloon roundabout in Cotswold district, which recorded the highest levels in the county.

[21] CDRC https://data.cdrc.ac.uk/dataset/access-to-healthy-assets-and-hazards-ahah

[22] The last year data was available for all districts, some districts have published more recent data for 2021 and 2022.

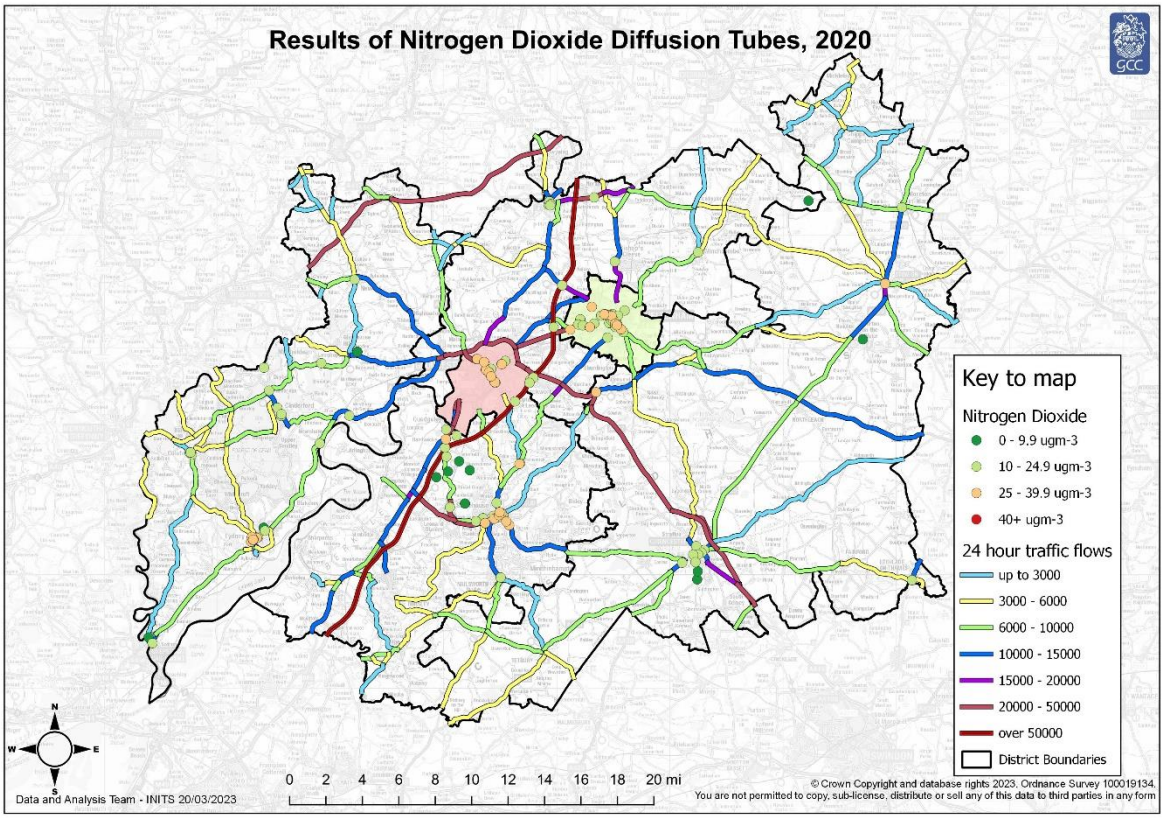

Figure 16: Results of nitrogen dioxide Diffusion Tubes, 2020[23]

It is worth noting that the 2020 figures will be influenced by changes to travel and transport caused by lockdown restrictions introduced during the COVID-19 pandemic. While these restrictions were temporary, they have brought about longer-term changes to society, in particular the move towards hybrid working, meaning it is unclear whether nitrogen dioxide levels will return to pre-covid levels, however it is unlikely they will remain as low as they were in 2020, for this reason.

Figure 17 provides a picture of recorded nitrogen dioxide levels in 2019, pre-pandemic. It shows that there in 2019 there were 9 areas that exceeded current UK guidelines around nitrogen dioxide, these areas were mainly located in Cheltenham and Gloucester, as well as Lydney High Street and the Air Balloon roundabout in Cotswold which recorded the highest levels of nitrogen dioxide.

[23] Sourced from district councils

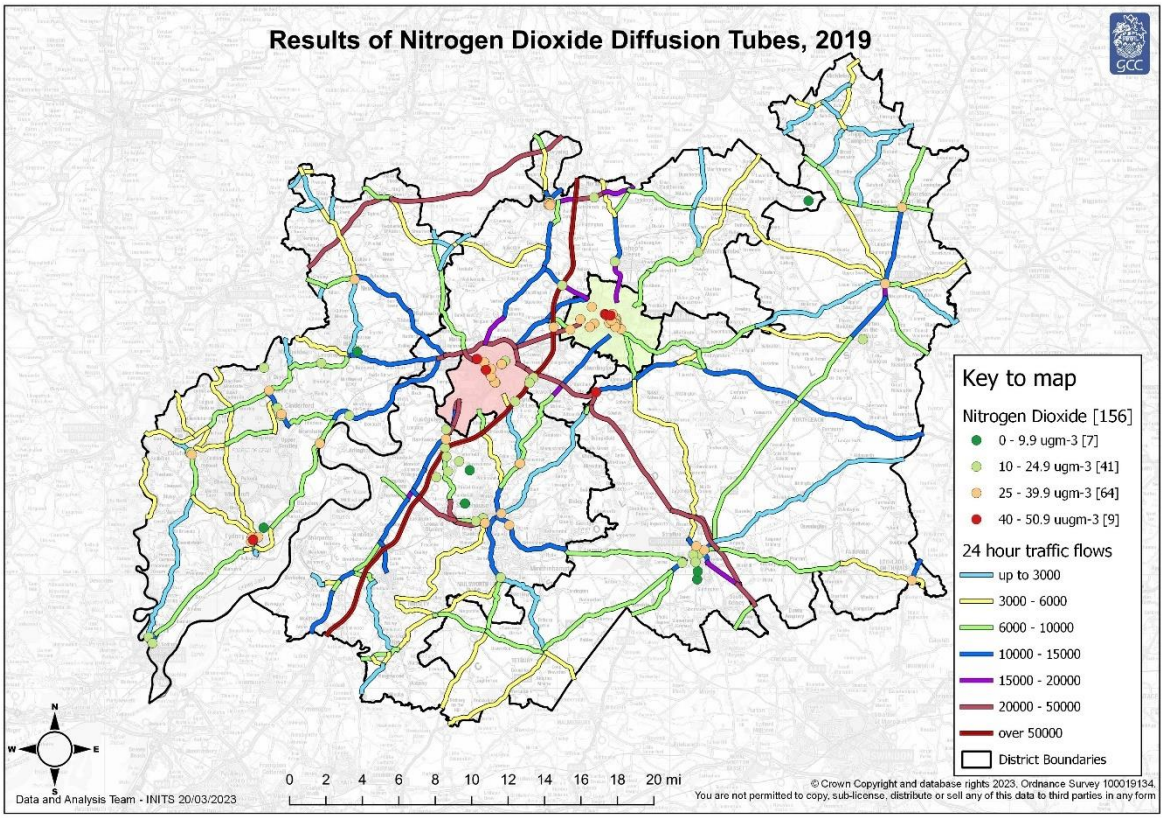

Figure 17: Results of nitrogen dioxide Diffusion Tubes, 2019[24]

3.3 Air Quality Management Areas

The aim of air quality monitoring is to make sure that the national air quality objectives will be achieved throughout the UK by the relevant deadlines. If a local authority finds any places where the objectives are not likely to be achieved, it must declare an Air Quality Management Area there. This area could be just one or two streets, or it could be much bigger.

There are currently 7 AQMAs across Gloucestershire, they have all been declared because monitoring shows the sites do not meet the EU air quality objective for nitrogen dioxide. Table 1 shows the details of these sites, Stroud and Tewkesbury are the only districts not to currently have an AQMA. The majority of AQMAs are located in major urban areas or in the case of Cotswold at a major road junction (the Air Balloon junction, Birdlip) due to high vehicle emissions.

[24] *Ibid.*

Table 1: AQMAs in Gloucestershire[25]

Local Authority	AQMA Name	Description	Pollutants	Data Declared
Cheltenham	Cheltenham Borough Council AQMA 2020	• High Street from junction of Gloucester Road and Tewkesbury Road to junction of Burton Street • Poole Way • Swindon Road from junction of Poole Way to St George's Street	Nitrogen dioxide	15/09/2020
Cotswold	Birdlip AQMA	An area encompassing the junction of the A417 and A436 at the Birdlip Roundabout including nearby properties	Nitrogen dioxide	08/04/2008
Cotswold	Thames Street, Lechlade AQMA	A section of road on Thames Street in Lechlade near the junction of Thames Street (A361) with the High Street (A417). The road is used by a mix of vehicle types (including HGV's) controlled by traffic lights at the busy junction. The traffic controls cause queuing in peak periods alongside the front of cottages.	Nitrogen dioxide	02/04/2014
Forest of Dean	Lydney AQMA	An area in Lydney along parts of the B4231 (High Street, Hill Street and Newerne Street) and parts of Bream Road and Forest Road	Nitrogen dioxide	01/07/2010

[25] AQMAs, DEFRA

Gloucester	Barton Street AQMA	An area encompassing Barton Street, Gloucester from its junction with Trier Way/Bruton Way to the north west and Upton Street to the south east	Nitrogen dioxide	08/08/2005
Gloucester	Priory Road AQMA	An area encompassing the junction of St Oswalds Road and Priory Road	Nitrogen dioxide	08/08/2005
Gloucester	Painswick Road AQMA	An area encompassing a number of properties on either side of Painswick Road, Gloucester	Nitrogen dioxide	05/10/2007

In recent years the AQMA in Tewkesbury has been revoked following improvements in air quality, the AQMA in Cheltenham was also revoked and replaced with one covering a smaller area.

Table 2: Revoked AQMAs in Gloucestershire [26]

Local Authority	AQMA Name	Description	Pollutants	Date Declared	Date Revoked
Cheltenham	Cheltenham Whole Borough AQMA	The whole borough of Cheltenham	Nitrogen dioxide	18/11/2011	15/09/2020
Tewkesbury	Tewkesbury Town Centre AQMA	An area encompassing parts of Tewkesbury town centre, including parts of High Street, Barton Street Church Street and the Eastern Relief Road.	Nitrogen dioxide	05/12/2008	01/08/2022

[26] AQMAs, DEFRA

4. What does this mean for health?

Air pollution is considered a serious public health issue for the UK27. Figure 18 shows exposure to air pollution has various different health effects, which come about at every stage of life, from a foetus' first weeks in the womb all the way through to old age. The health effects of air pollution are complex, and range in severity of impact. In some cases, damage can be gradual and may not become apparent for many years. There is strong evidence that air pollution causes the development of coronary heart disease, stroke, respiratory disease, and lung cancer, exacerbates asthma and has a contributory role in mortality. The annual burden of air pollution in the UK has been estimated to be equivalent to approximately 28,000-36,000 deaths at typical ages and an associated loss of population life of 328,000-416,000 life years lost[28].

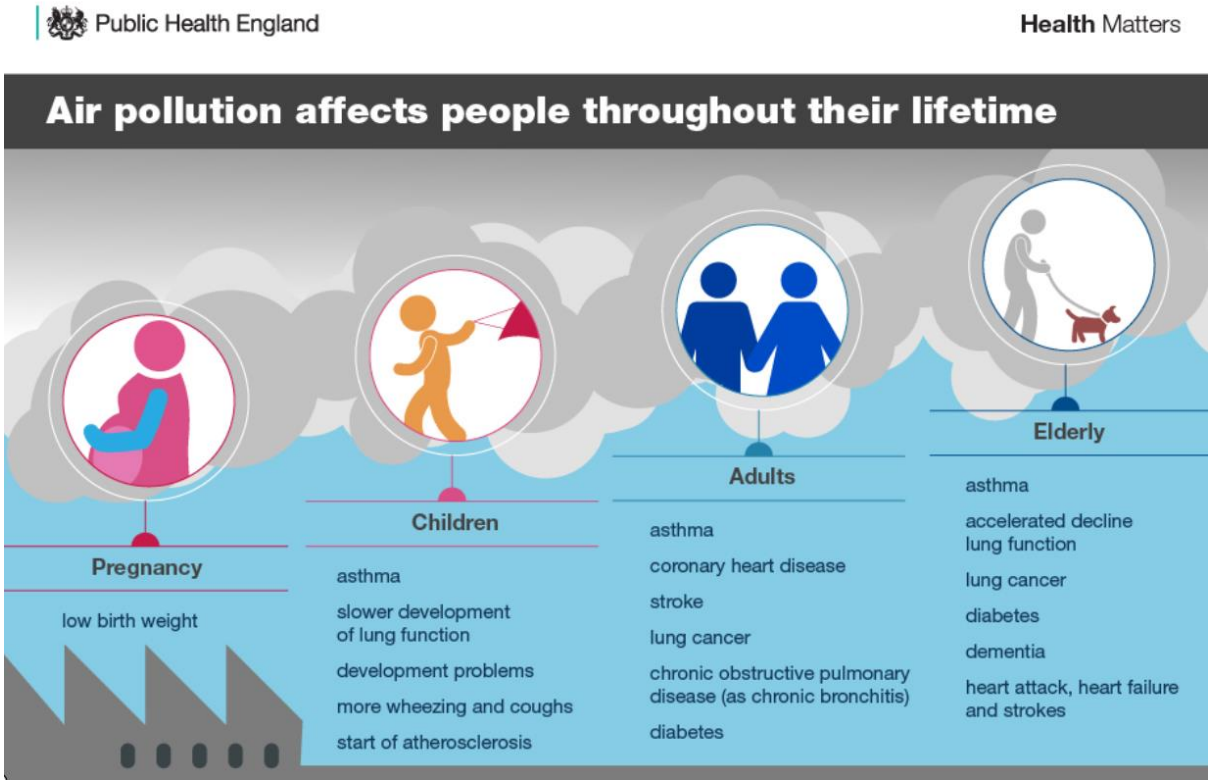

Figure 18: Lifetime effects of air pollution[29]

[27] Air Pollution Evidence Review – PHE, 2019 https://www.gov.uk/government/publications/improving-outdoor-air-quality-and-health-review-of-interventions

[28] COMEAP, 2018 Nitrogen dioxide: effects on mortality - GOV.UK (www.gov.uk)

[29] Health Matters, PHE

4.1 Mortality

In order to quantify the impact of exposure to PM 2.5 OHID provide estimates of the fraction of mortality attributable[30] to particulate air pollution, these estimates are based on the research evidence of mortality risk, combined with modelled levels of the background air pollution to which populations are exposed at local authority level. In Gloucestershire around 5.3% of deaths of people aged 30+ are thought to be attributable to air pollution. Figure 19 shows this was lower than the national average (5.5%) but higher than the regional average (5.1%). When compared to its statistical neighbours, Gloucestershire is ranked 6th out of 16 areas, putting it in the top half of similar local authorities, reflecting its position in terms of overall levels of PM 2.5.

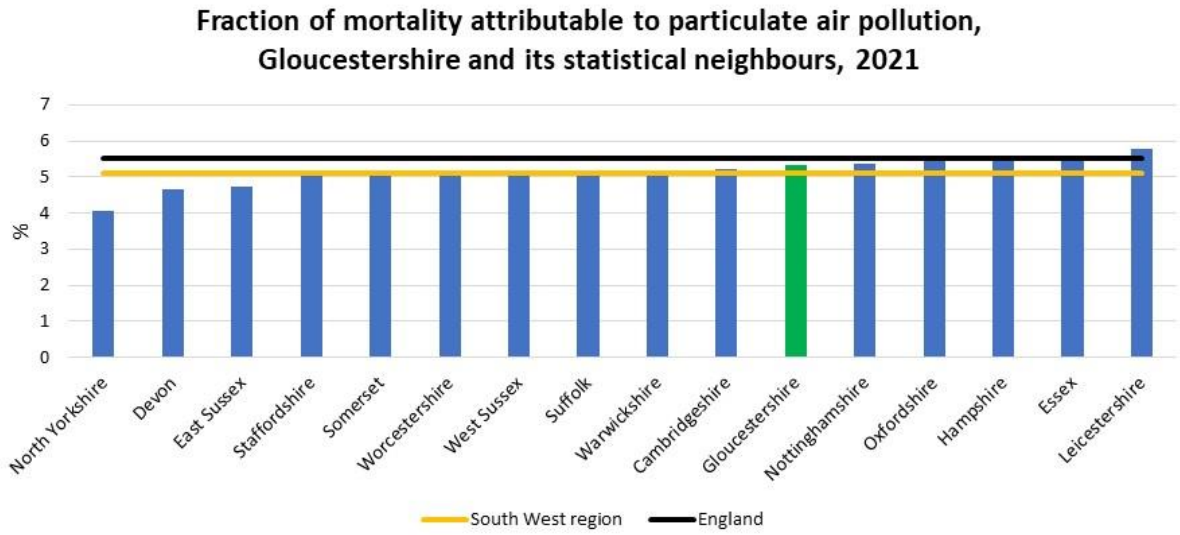

Figure 19:Fraction of mortality attributable to particulate air pollution, Gloucestershire and its statistical neighbours, 2021[31]

At district level Gloucester and Cheltenham have the highest fractions of mortality attributable to particulate air pollution, with Gloucester exceeding the national average. Conversely Cotswold and the Forest of Dean have the lowest fractions of mortality attributable to particulate air pollution, reflecting the picture seen in overall levels of PM 2.5.

[30] Attributable - Deaths are not individually attributed to air pollution, but rather it can be thought of as a contributory factor in many deaths from other causes such as respiratory disease and Cardiovascular disease

[31] PHOF, OHID

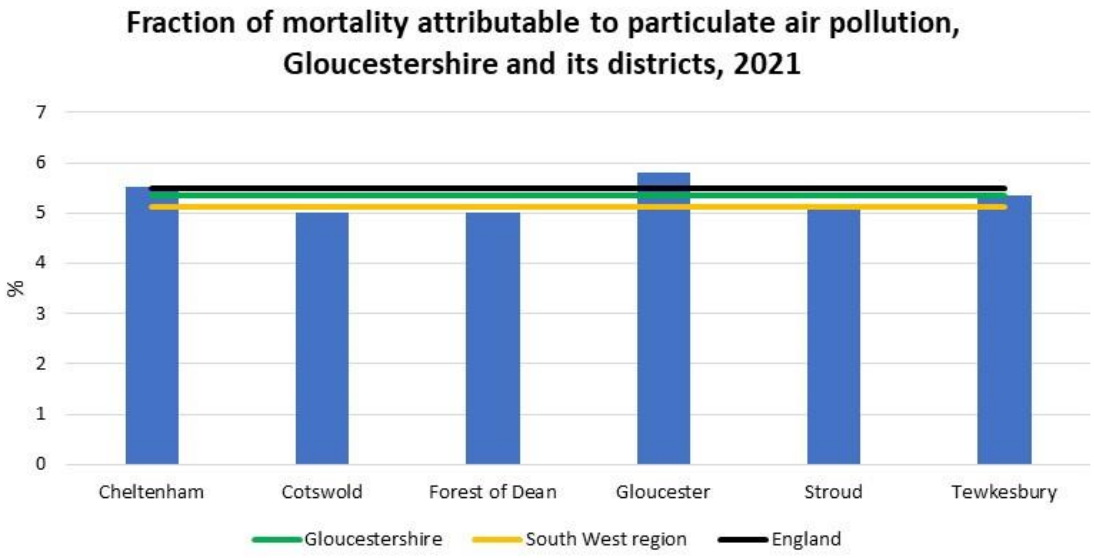

Figure 20: Fraction of mortality attributable to particulate air pollution, Gloucestershire and its districts, 2021[32]

Figure 21 and Figure 22 show the trend in the fraction of mortality attributable to particulate air pollution at a county and district level, all areas follow a similar pattern with the fraction of mortality attributable to particulate air pollution declining sharply between 2019 and 2020 reflecting the impact of COVID-19 on pollution levels.

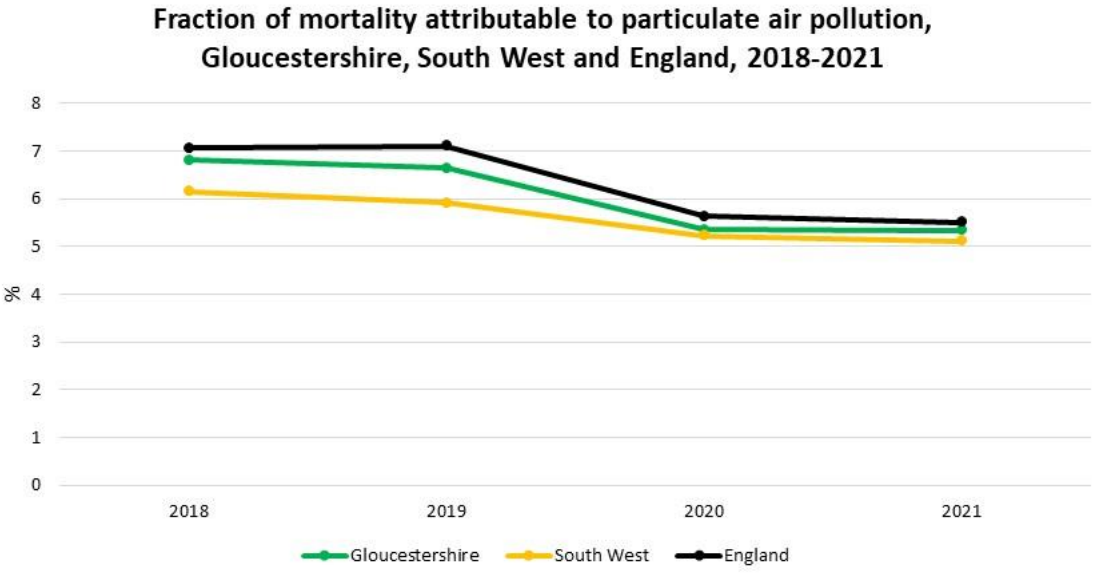

Figure 21: Fraction of mortality attributable to particulate air pollution, Gloucestershire, South West and England, 2018-2021[33]

[32] *Ibid.*

[33] *Ibid.*

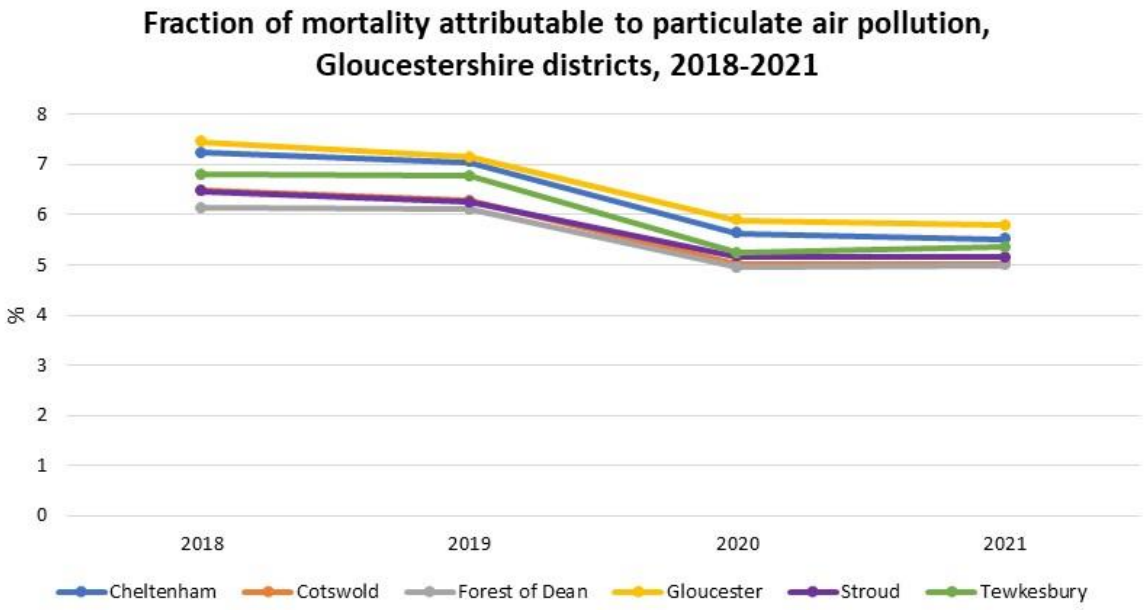

Figure 22: Fraction of mortality attributable to particulate air pollution, Gloucestershire districts, 2018-2021[34]

The concept of the fraction of mortality attributable to particulate air pollution can seem abstract, so to provide context Table 3 shows it expressed it as the number of all deaths of people over 30+ reported to the Office for National Statistics. In Gloucestershire 5.3% of deaths would equate to around 355 of the deaths of people aged 30+ recorded in 2021.

Table 3: Estimated Deaths Attributable to Particulate Air Pollution, 2021[35]

	Estimated Deaths Attributable to Particulate Air Pollution, 2021
Cheltenham	65
Cotswold	51
Forest of Dean	49
Gloucester	73
Stroud	65
Tewkesbury	51
Gloucestershire	**355**
South West	3,107
England	29,848

[34] *Ibid.*

[35] PHOF, OHID and Mortality Statistics, ONS

Table 4 presents a comparison of deaths attributable to some other key risk factors in Gloucestershire. It is important to note that unlike the other indicators that are based on recorded mortality data for specific causes of death, the figures for air pollution are estimates of mortality attributable to a risk factor. Deaths are not individually attributed to air pollution, rather, air pollution is considered to be a contributory factor in many deaths. The table illustrates that, in Gloucestershire, exposure to PM2.5 is calculated to be responsible for a higher rate of premature mortality than preventable respiratory disease, suicide, or communicable diseases.

Table 4: Ranking of PHOF mortality indicator for Gloucestershire, 2021 and 2019-2021 for suicide rate[36]

Indicator	Mortality rate per 100,000 population
Preventable mortality <75	147.1
Preventable cancer <75	45.2
Preventable CVD <75	27
Preventable liver disease <75	22.4
Deaths due to COVID-19 <75	17
Mortality attributable to $PM_{2.5}$ > 30+	16.4
Preventable respiratory disease <75	14.5
Suicide rate > 10+	11.3
Communicable diseases (all persons)	7.1

4.2 Long-term conditions

Air pollution is associated with acute and long-term health problems, especially asthma, chronic obstructive pulmonary disease (COPD), coronary heart disease (CHD), heart failure, stroke, diabetes and dementia. Figure 23 shows the number of Gloucestershire GP patients with conditions associated with poor air quality.

[36] PHOF and http://www.adph.org.uk/2017/03/air-quality-a-briefing-for-directors-of-public-health/

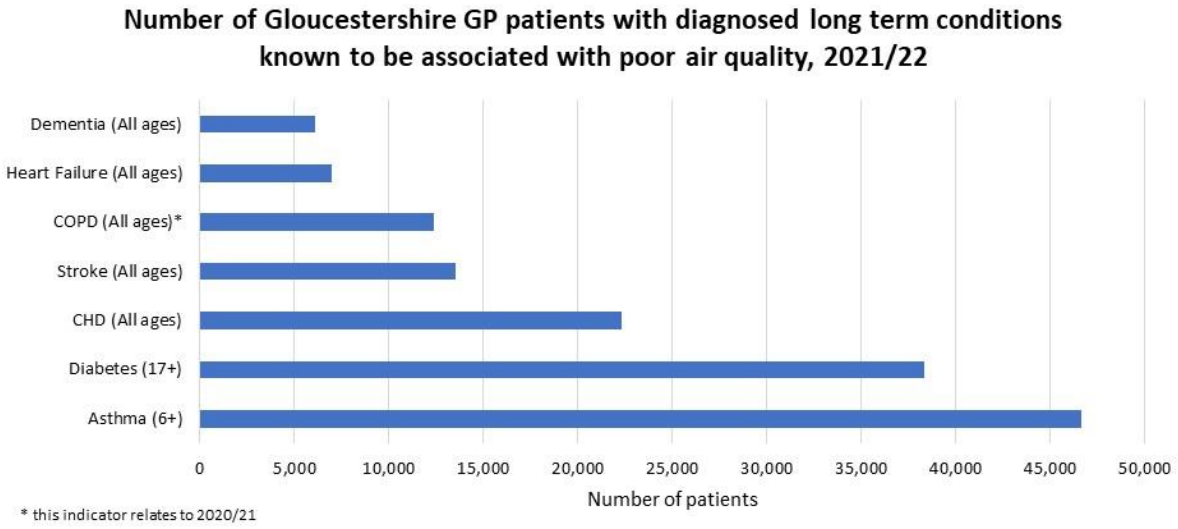

Figure 23: Number of Gloucestershire GP patients with diagnosed long term conditions known to be associated with poor air quality, 2021/22[37]

4.2.1 Asthma

Asthma is the most common condition affecting around 46,649 patients or 7.3% of patients aged 6+, this was significantly higher than the national average of 6.5%.Figure 24 shows Asthma prevalence by GP practice alongside the 7 Air Quality Management Areas in the county. The GP practices with the highest prevalence's of asthma are mainly located in the rural districts and are not in the immediate vicinity of the Air Quality Management Areas. It is worth noting that patients will travel to a GP practice so this does not definitively mean they do not live in an Air Quality Management Area but maybe less likely to than those patients registered at practices in and around Air Quality Management Areas.

[37] GP Practice Profiles, OHID

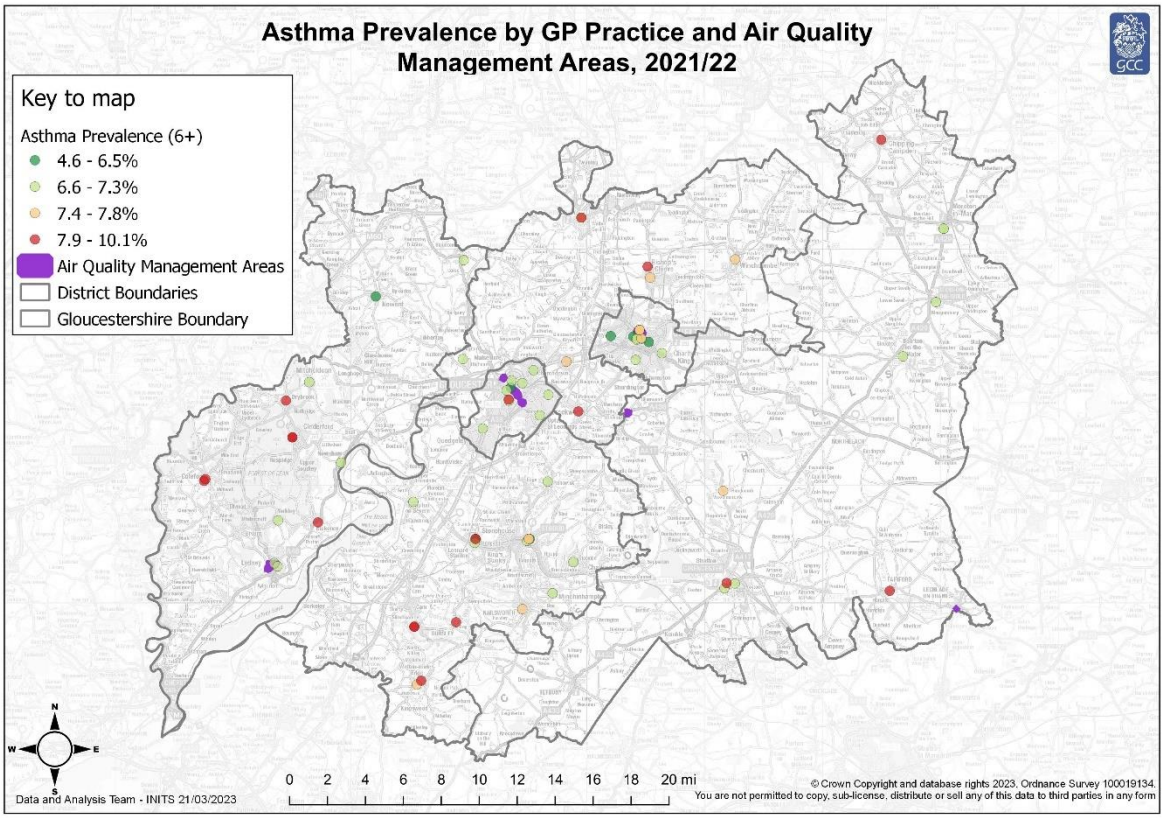

Figure 24: Asthma prevalence by GP Practice and Air Quality Management Areas, 2020/21[38]

4.2.2 COPD

In 20120/21 there were around 12,366 people in Gloucestershire with COPD, this equates to a prevalence of 1.9% which was in line with the national average of 1.9%[39]. Figure 25 shows COPD prevalence by GP practice, the majority of GP practices with the highest prevalence of COPD are located in the rural districts of the Forest of Dean, Stroud and Tewkesbury and are not in the vicinity of AQMA's. However, Kingsholm Surgery in Gloucester and St Catherine's Surgery in Cheltenham both have high prevalence of COPD and are in the vicinity of AQMA's.

[38] GP Practice Profiles, OHID and AQMA's, DEFFRA

[39] GP Practice Profiles, OHID

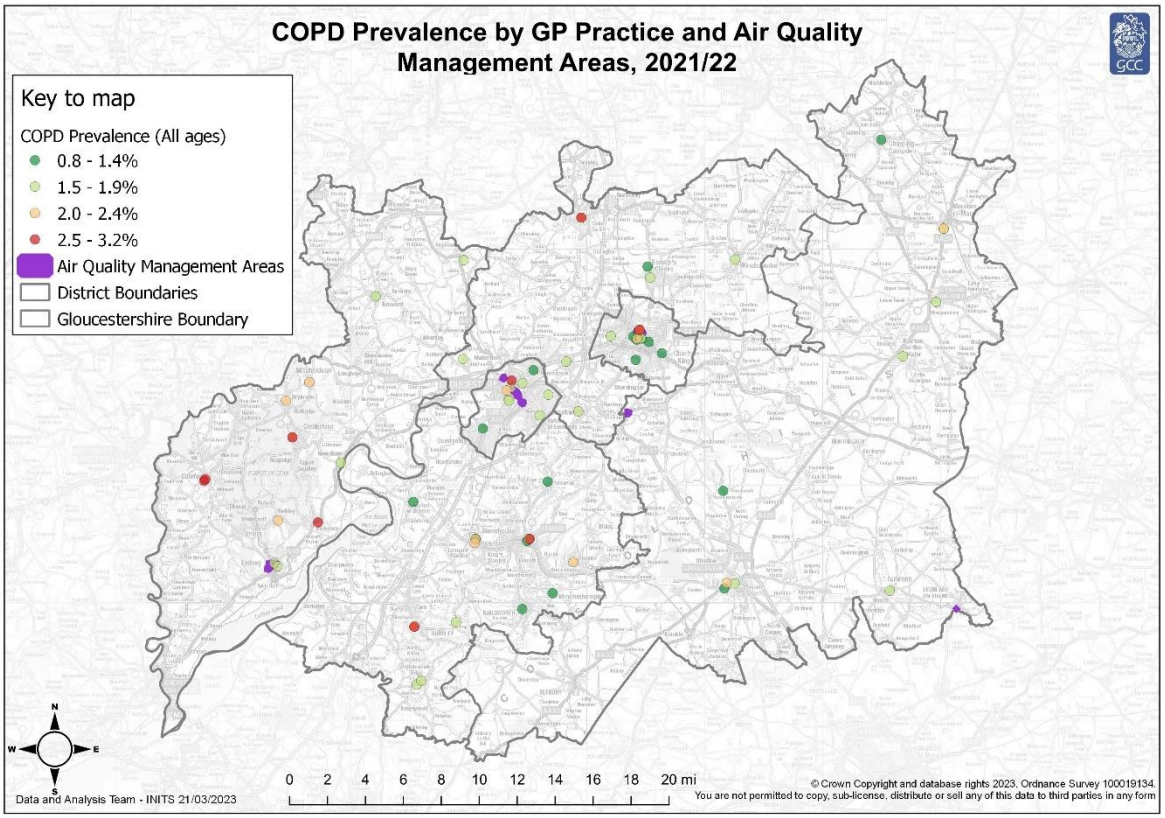

Figure 25: Prevalence of COPD by GP Practice and Air Quality Management Areas, 2020/21[40]

Gloucestershire had a significantly lower rate of emergency hospital admissions for COPD (276 per 100,000) than the England average (415 per 100,000) in 2019/20, this equates to 1,155 admissions. At district level, Gloucester has a similar rate of emergency hospital admissions for COPD to England (435 per 100,000) while all other districts have significantly lower rates of hospital admissions[41].

4.2.3 CHD

In 2020/21 there were around 22,289 people in Gloucestershire with CHD, this equates to a prevalence of 3.3% which was significantly higher than the national average of 3.0%. Figure 26 shows CHD prevalence by GP practice, the majority of GP practices with the highest prevalence of CHD are not in the vicinity of AQMA's.

[40] GP Practice Profiles, OHID and AQMA's, DEFFRA

[41] Public Health Profiles, OHID

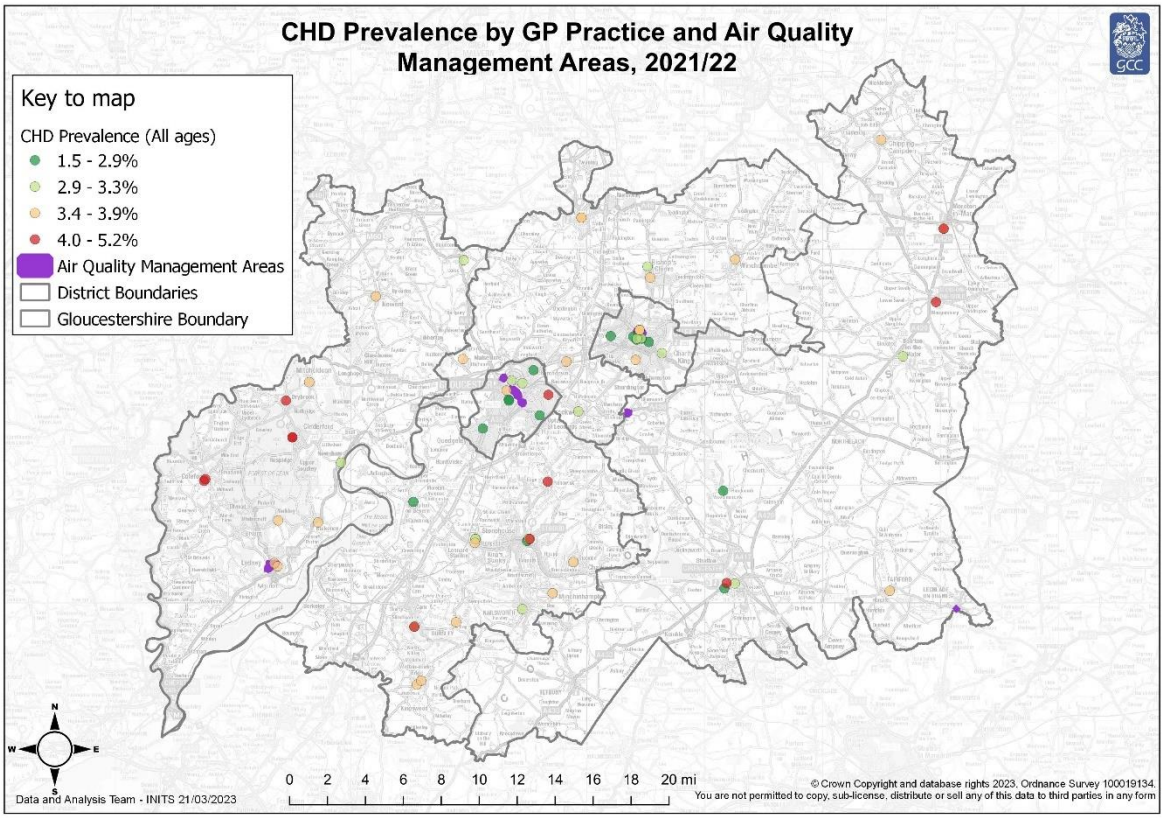

Figure 26: Prevalence of CHD by GP Practice and Air Quality Management Areas, 2020/21[42]

4.2.4 Heart Failure

In 2021/22 there were around 6,984 people in Gloucestershire with heart failure, this equates to a prevalence of 1.0% which was in line with the national average of 1.0%. Figure 27 shows heart failure prevalence by GP practice, a number of GP practices with the highest prevalence of heart failure are in the vicinity of AQMA's, namely Lydney practice which is near the Lydney AQMA and St Catherine's Surgery, St George's Surgery and Royal Well Surgery in Cheltenham.

[42] GP Practice Profiles, OHID and AQMA's, DEFFRA

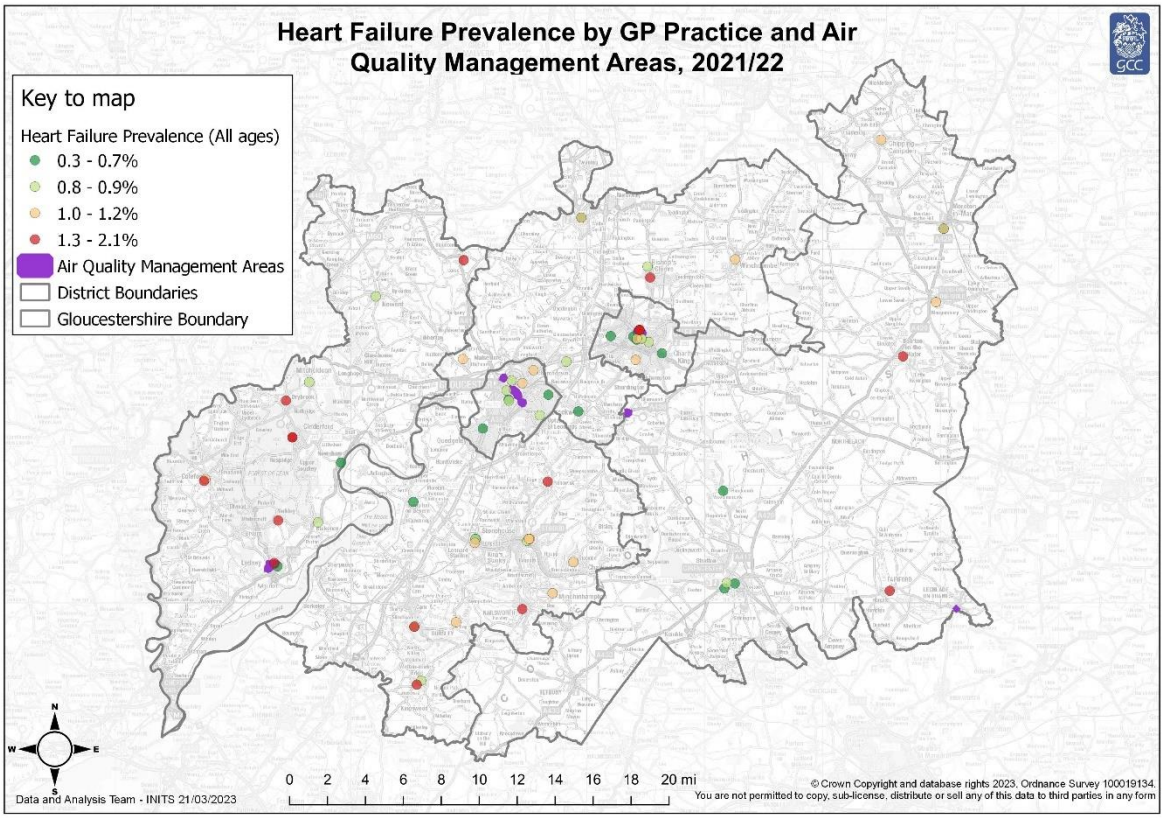

Figure 27: Prevalence of Heart Failure by GP Practice and Air Quality Management Areas, 2020/21[43]

4.2.5 Stroke

In 2021/22 there were around 13,534 people in Gloucestershire who were recorded as having had a stroke, this equates to a prevalence of 2.0% which was significantly higher than the national average of 1.8%. Figure 28 shows stroke prevalence by GP Practice the majority of GP practices with the highest prevalence of strokes are located in the rural districts of the Forest of Dean and Cotswold and are not in the vicinity of AQMA's. However, Kingsholm Surgery in Gloucester and Severnbank Surgery in Lydney both have high prevalence of strokes and are in the vicinity of AQMA's.

[43] GP Practice Profiles, OHID and AQMA's, DEFFRA

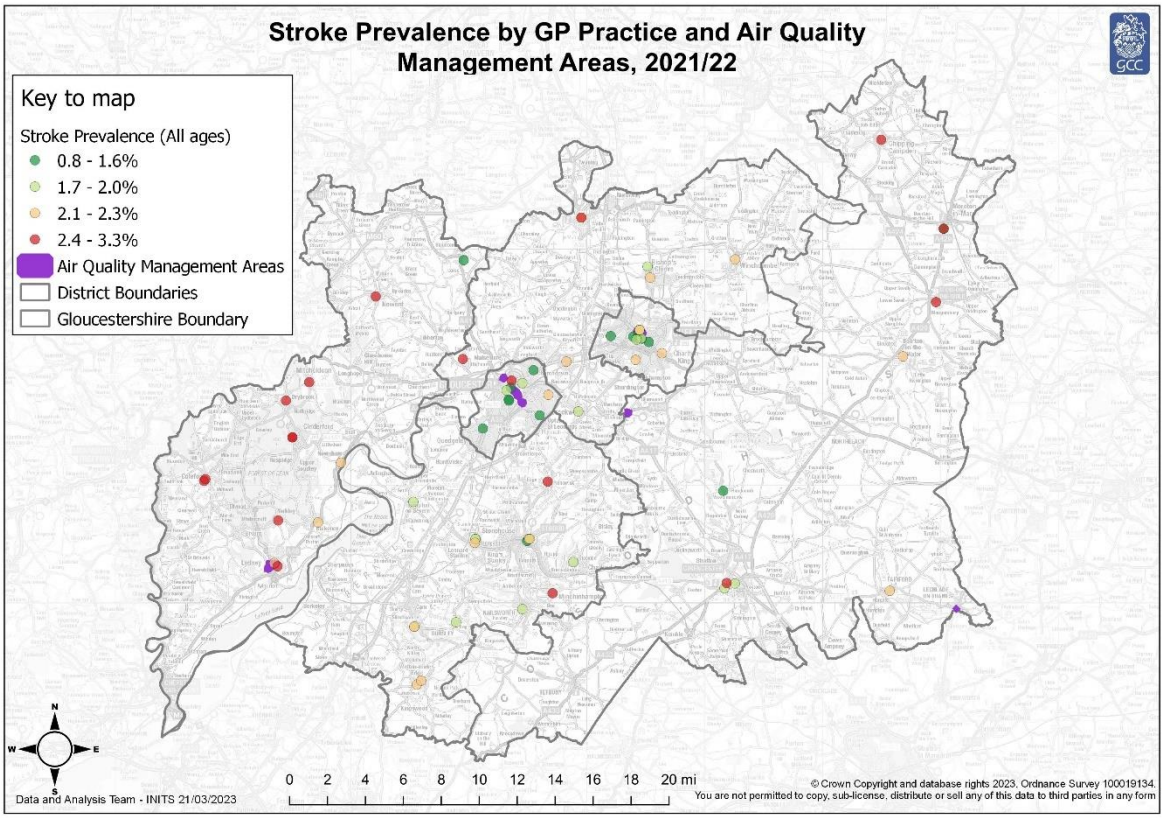

Figure 28: Stroke Prevalence by GP Practice and Air Quality Management Areas, 2021/22[44]

4.2.6 Dementia

In 2021/22 there were around 6,082 people in Gloucestershire who were recorded as having dementia, this equates to a prevalence of 0.9% which was significantly higher than the national average of 0.7%. Figure 29 shows dementia prevalence by GP practice, the majority of GP practices with the highest prevalence of dementia are not in the vicinity of AQMA's.

[44] GP Practice Profiles, OHID and AQMA's, DEFFRA

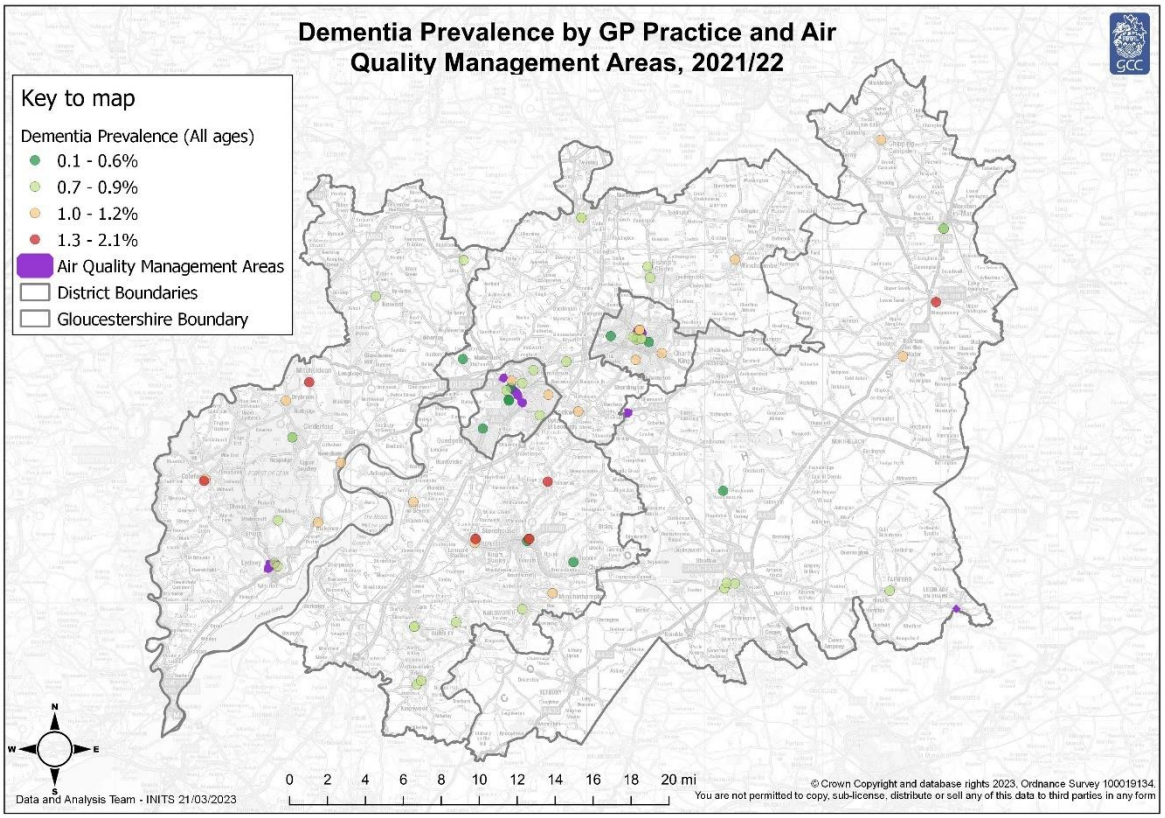

Figure 29: Dementia Prevalence by GP Practice and Air Quality Management Areas, 2021/22[45]

4.2.7 Diabetes

In 2021/22 there were around 38,340 people in Gloucestershire who were recorded as having diabetes, this equates to a prevalence of 7.0% which was significantly lower than the national average of 7.3%. Figure 30Figure 29 shows diabetes prevalence by GP practice, several GP practices with the highest prevalence of diabetes are within the vicinity of AQMA's, namely Lydney Practice and Severnbank Surgery in Lydney and Kingsholm Surgery, Aspen Medical Practice and Gloucester City Health Centre in Gloucester.

[45] GP Practice Profiles, OHID and AQMA's, DEFFRA

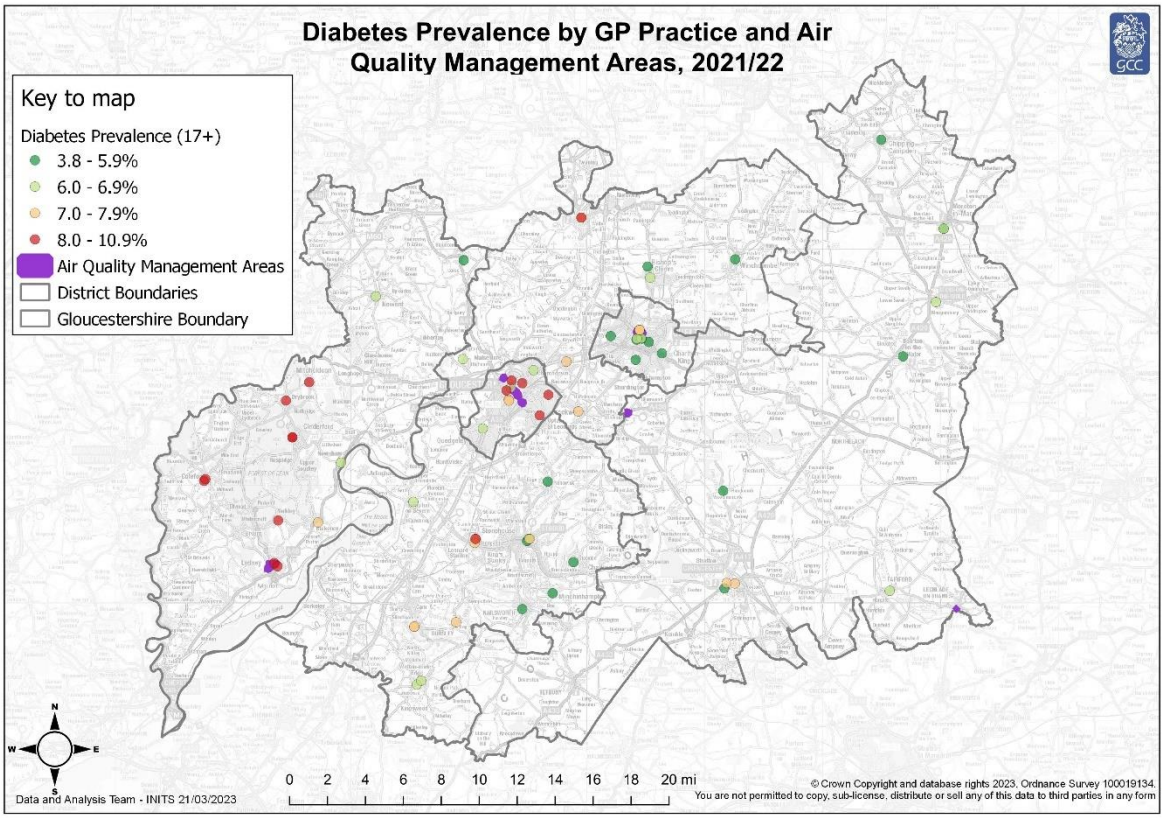

Figure 30: Diabetes Prevalence by GP Practice and Air Quality Management Areas, 2021/22[46]

5. Who is vulnerable?

The effects of air pollution are distributed unequally across the population. The more urban and congested areas have higher levels of pollution, as do areas near arterial and trunk roads. This, therefore, impacts on the health of those that live and work next to these areas.

5.1 Deprivation

Studies have suggested that the most deprived areas bear a disproportionate share of poor air quality. Research has found that, in England, the most deprived 20% of neighbourhoods had higher air pollution levels than the least deprived neighbourhoods, 1.5 µg/m3 higher PM10 and 4.4 µg/m3 NO2, after adjusting for other factors[47]. Furthermore, the risk of experiencing poorer health outcomes as

[46] GP Practice Profiles, OHID and AQMA's, DEFFRA

[47] Fecht, D. et al Associations between air pollution and socioeconomic characteristics, ethnicity and age profile of neighbourhoods in England and the Netherlands. Environmental Pollution, 2015; 198: 201. A summary of the article is available at: http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/newssummary/news_26-1-2015-12-17-52

a result of air pollution may be heightened for those living in areas of deprivation due to poor housing, indoor air quality, stress of living on low income, limited access to healthy food and/or green space and the fact that moving away from that area may be unaffordable[48].

Within Gloucestershire there are 6 Lower Super Output Areas that contain monitoring sites that exceeded the UK's current recommended levels for nitrogen dioxide in 2019[49], of these 3 are in the most deprived 20% of the country in terms of Multiple Deprivation. Table 5 shows that Lower Super Output Areas in the most deprived 20% of the country account for 42.9% of LSOA's that have monitoring sites that exceed recommended levels and only 8.3% of the total LSOAs, suggesting Gloucestershire follows the national trend with deprived areas bearing a disproportionate effect of air pollution.

Table 5: Deprivation and monitoring sites that exceed the recommended level for nitrogen dioxide[50]

	LSOAs that have monitoring sites that exceed the recommended levels for nitrogen dioxide in 2019	**Total LSOAs**
Quintile 1 (most deprived 20% of the country)	42.9%	8.3%
Quintile 2	14.3%	11.5%
Quintile 3	28.6%	21.7%
Quintile 4	14.3%	26.0%
Quintile 5 (least deprived 20% of the country)	0.00%	32.4%

The modelled data supports the idea that the most deprived areas bear a disproportionate effect of air pollution. Figure 31 and Figure 32 shows the most deprived 20% of LSOAs had significantly higher levels of nitrogen dioxide and PM10 than the least deprived neighbourhoods, with a difference of 3.0 ugm-3 in terms of nitrogen dioxide and 0.7 ugm-3 for PM10.

[48] Royal College of Physicians. Every Breath We Take: The Lifelong Impact of Air Pollution.; 2016.
[49] Data for 2020 was not used as this is likely to be skewed by the impact of the COVID19 pandemic
[50] Index of Multiple Deprivation 2019, MHCLG and data sourced from districts

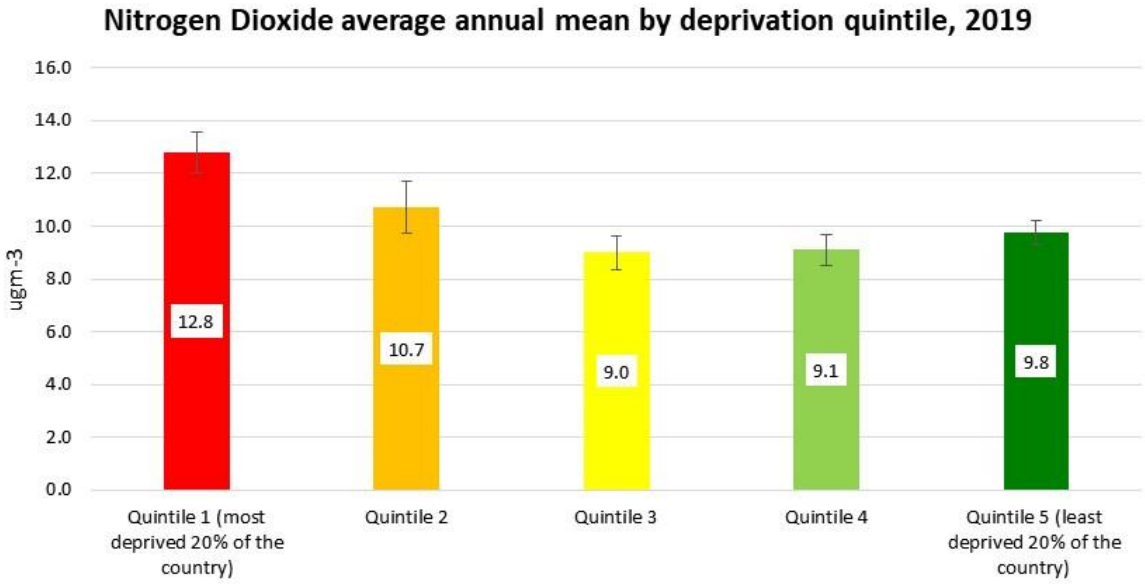

Figure 31: Modelled estimates of nitrogen dioxide by deprivation quintile, 2019[51]

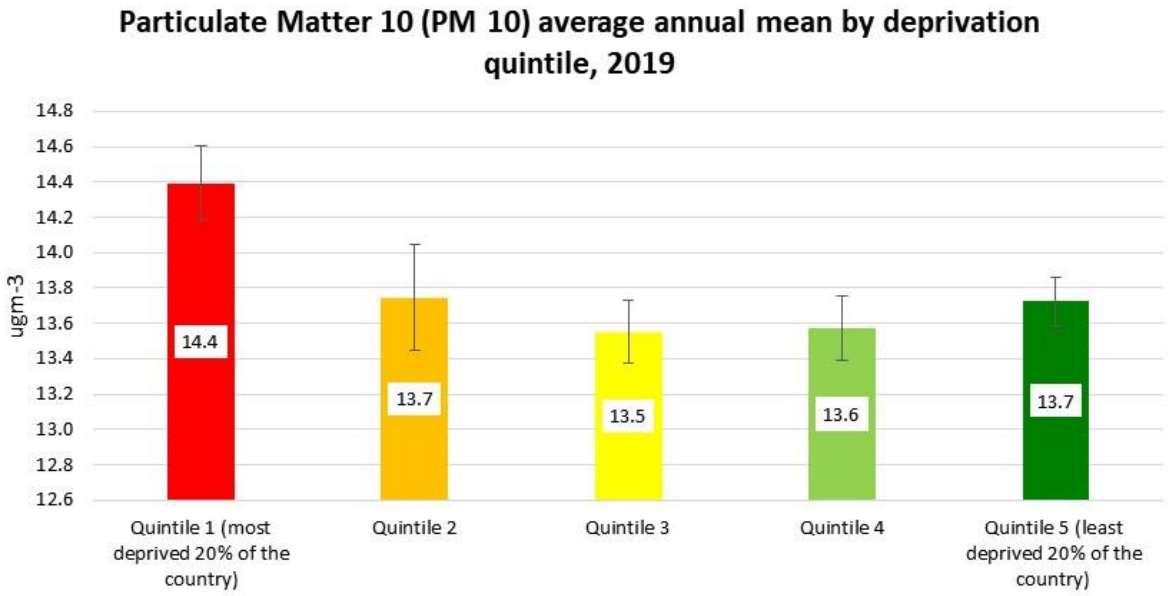

Figure 32: Modelled estimates of particulate matter 10 (PM 10) by deprivation quintile, 2019[52]

[51] CDRC https://data.cdrc.ac.uk/dataset/access-to-healthy-assets-and-hazards-ahah and Index of Multiple Deprivation 2019, MHCLG

[52] CDRC https://data.cdrc.ac.uk/dataset/access-to-healthy-assets-and-hazards-ahah and Index of Multiple Deprivation 2019, MHCLG

5.2 Car ownership

In addition, evidence suggests “communities that have access to fewest cars tend to suffer from the highest levels of air pollution, whereas those in which car ownership is greatest enjoy the cleanest air” and “Those communities that are most polluted and which also emit the least pollution tend to be amongst the poorest in Britain”[53]. This is linked to the fact that in many places poor housing stock is located close to busy road networks and occupied by more deprived communities.

Within Gloucestershire there are 57 (15.3%) Lower Super Output Areas that have lower levels of car ownership than nationally, of these 4 contain monitoring sites that exceeded the UK’s current recommended levels of nitrogen dioxide in 2019[54] (66.6% of all LSOAs with monitoring sites that exceeded recommended levels)[55].

The modelled data supports the idea that areas with lower than average levels of car ownership bear a disproportionate effect of air pollution. Figure 33 and Figure 34 shows the LSOA’s with lower levels of car ownership than nationally had significantly higher levels of nitrogen dioxide and PM10 than those with higher levels of car ownership, with a difference of 2.8 ugm-3 in terms of nitrogen dioxide and 0.6 ugm-3 for PM10.

[53] Mitchell, G. and Dorling, D. An environmental justice analysis of British air quality, Environment and Planning A 2003, volume 35, pages 909 – 929 http://www.dannydorling.org/wp-content/files/dannydorling_publication_id1827.pdf

[54] Data for 2020 was not used as this is likely to be skewed by the impact of the COVID19 pandemic

[55] 2021 Census and monitoring data sourced from districts.

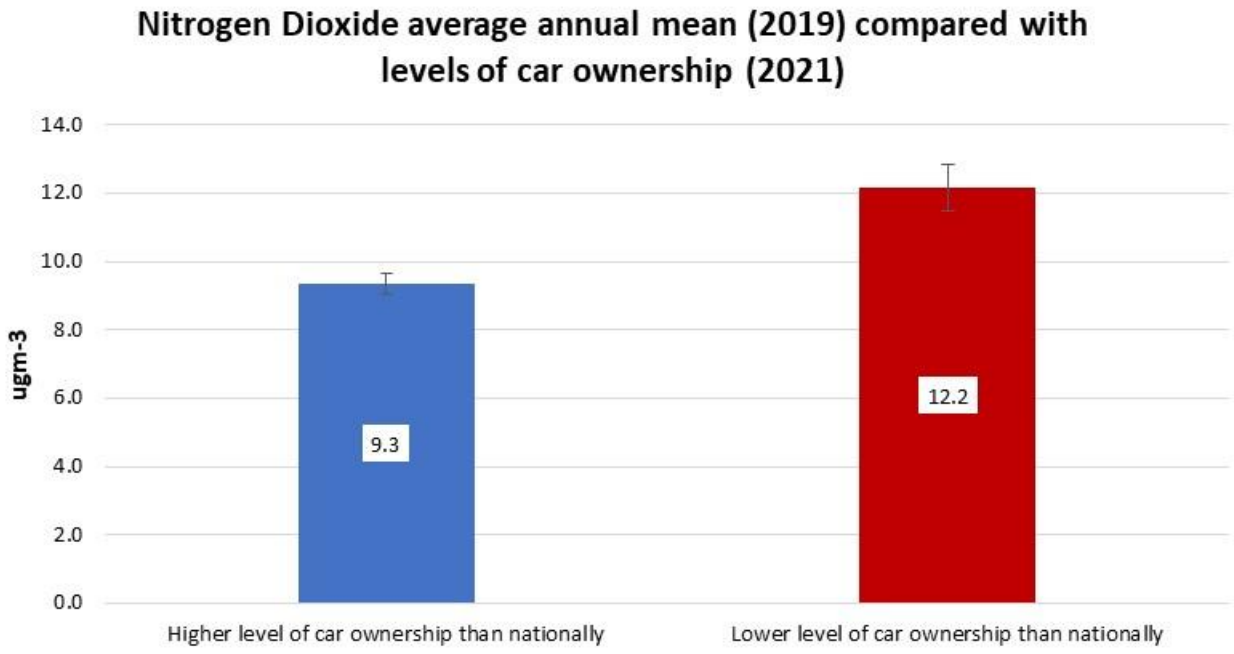

Figure 33: Nitrogen dioxide average annual mean (2019) compared with levels of car ownership (2021)[56]

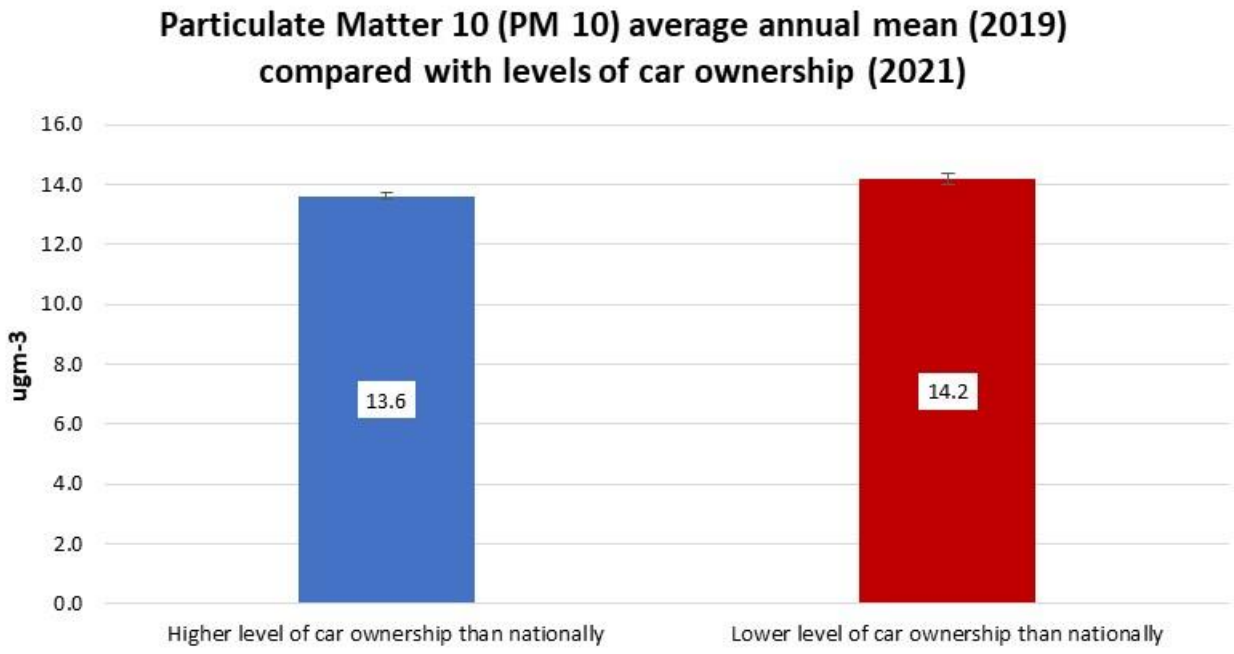

Figure 34: Particulate matter 10 (PM 10) average annual mean (2019) compared with levels of car ownership (2021)[57]

[56] 2021 Census and CDRC https://data.cdrc.ac.uk/dataset/access-to-healthy-assets-and-hazards-ahah

[57] *Ibid.*

5.3 Ethnicity

National studies have also found that the worst air pollution levels were seen in ethnically diverse neighbourhoods, defined as those where more than 20% of the population are non-white[58]. Within Gloucestershire there are 15 (4.0%) Lower Super Output Areas that fulfil this criteria, of these 1 is home to a monitoring site that exceeded the UK's current recommended levels of nitrogen dioxide in 2019[59] (16.6% of LSOAs which contain monitoring sites which exceed the recommended levels)[60].

The modelled estimates presented in Figure 35 and Figure 36 show that in areas where more than 20% of the population was non-white levels of nitrogen dioxide and PM 10 are likely to be higher than those where less than 20% of the population was non-white, with a difference of 4.2 ugm-3 for nitrogen dioxide and 0.9 ugm-3 for PM 10.

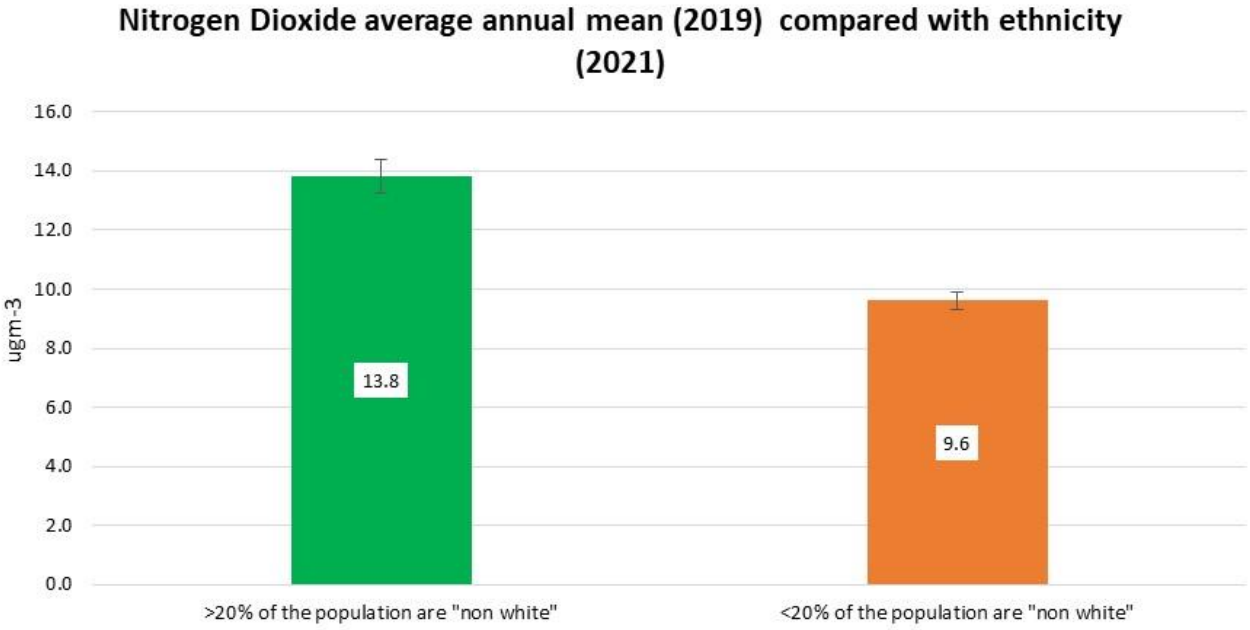

Figure 35: Nitrogen dioxide average annual mean (2019) compared with ethnicity (2021)[61]

[58] Fecht, D. et al Associations between air pollution and socioeconomic characteristics, ethnicity and age profile of neighbourhoods in England and the Netherlands. Environmental Pollution, 2015; 198: 201. A summary of the article is available at: http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/newssummary/news_26-1-2015-12-17-52

[59] Data for 2020 was not used as this is likely to be skewed by the impact of the COVID19 pandemic

[60] 2021 Census and monitoring data sourced from districts

[61] 2021 Census and CDRC https://data.cdrc.ac.uk/dataset/access-to-healthy-assets-and-hazards-ahah

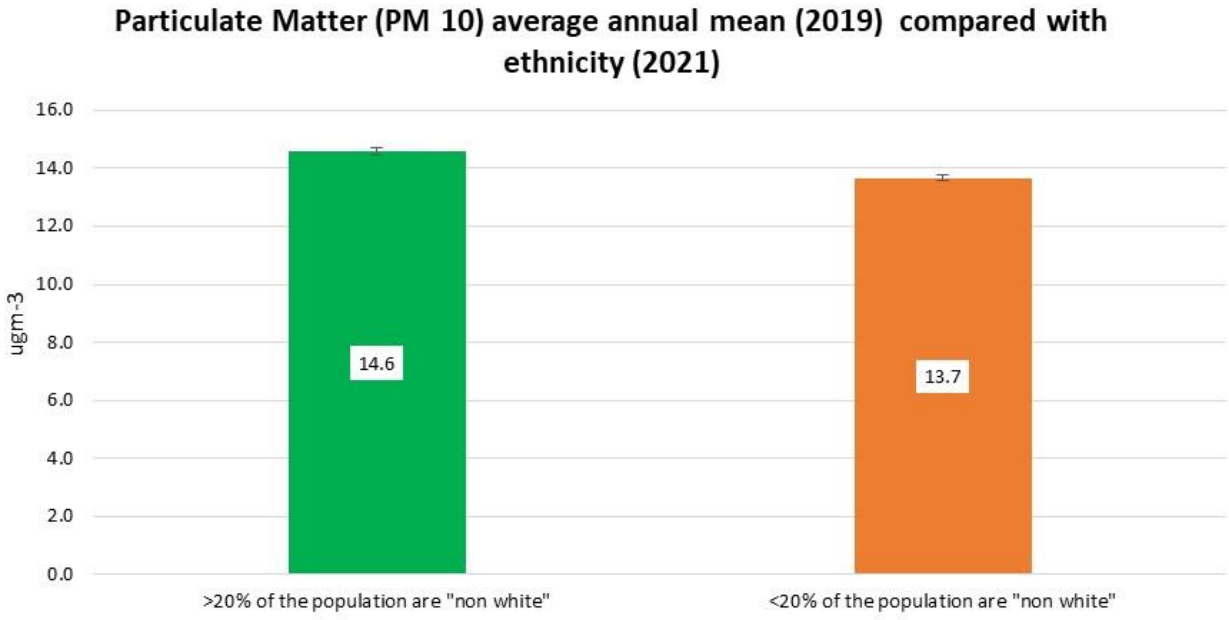

Figure 36: Particulate matter (PM 10) average annual mean (2019) compared with ethnicity (2021)[62]

5.4 Age

Children are also more likely to live in areas where air pollution is high[63]. This appears to be the case in Gloucestershire, with Figure 37 and Figure 38 showing levels of nitrogen dioxide and PM 10 are higher in areas that have a higher proportion of children than nationally than those with a lower proportion, conversely levels of nitrogen dioxide and PM 10 are lower in areas that have a higher proportion of people aged 65+ than nationally.

[62] *Ibid.*

[63] Fecht, D. et al Associations between air pollution and socioeconomic characteristics, ethnicity and age profile of neighbourhoods in England and the Netherlands. Environmental Pollution, 2015; 198: 201. A summary of the article is available at: http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/newssummary/news_26-1-2015-12-17-52

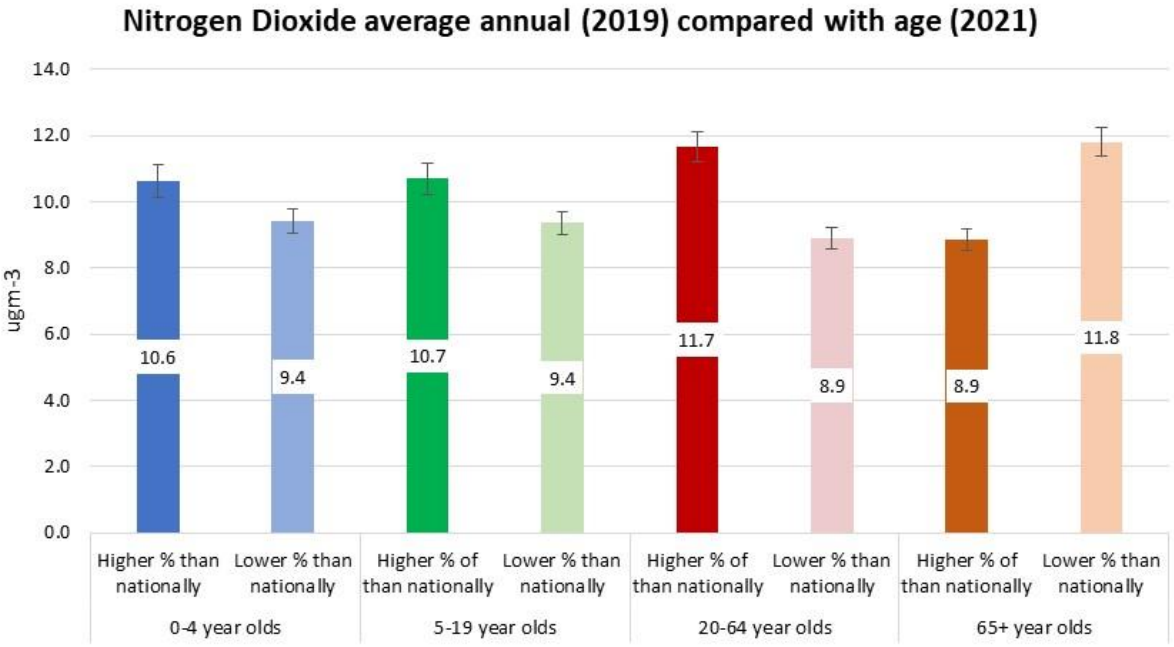

Figure 37: Nitrogen dioxide average annual mean (2019) compared with age (2021)[64]

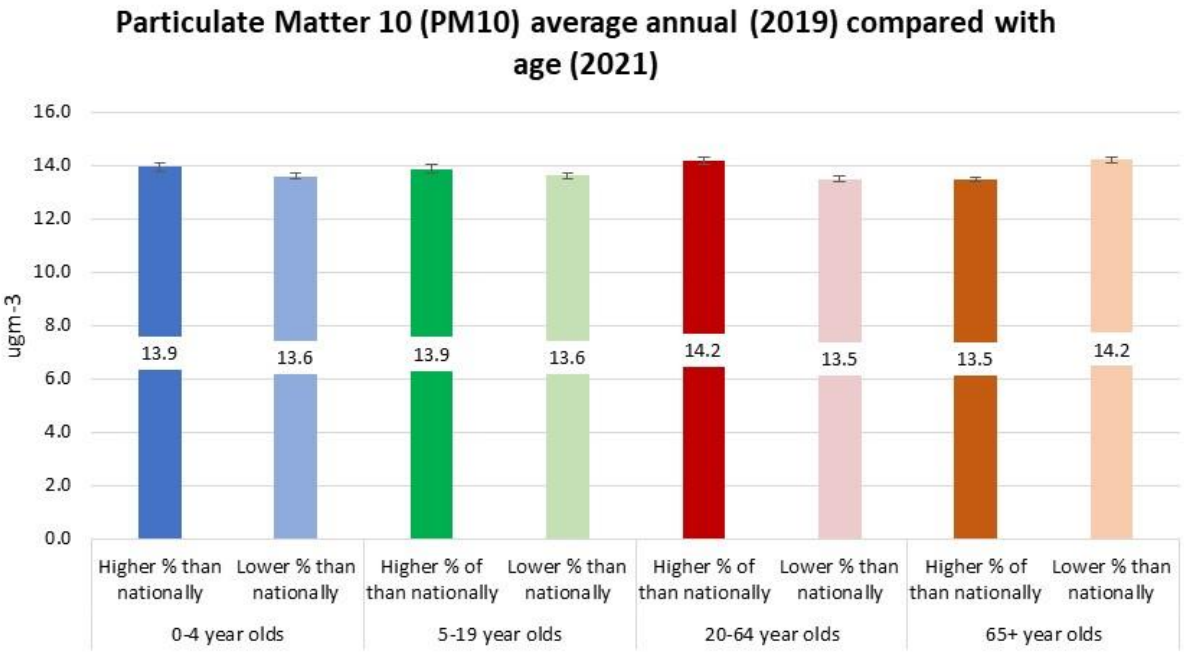

Figure 38: Particulate matter 10 (PM10) average annual (2019) compared with age (2021)[65]

[64] 2021 Census and CDRC https://data.cdrc.ac.uk/dataset/access-to-healthy-assets-and-hazards-ahah

[65] *Ibid.*

5.5 Existing conditions

There is evidence that people with pre-existing conditions are more susceptible to the health effects of air pollution. Figure 39 and Figure 40 shows the levels of nitrogen dioxide and PM 10 are slightly higher in areas where the rate of adult social care service users is higher than the county average, however this difference is not statistically significant. This may in part be due to the fact that Adult Social Care Service Users only include those who have care funded by the County Council, it does not capture those who require care but fund this care themselves.

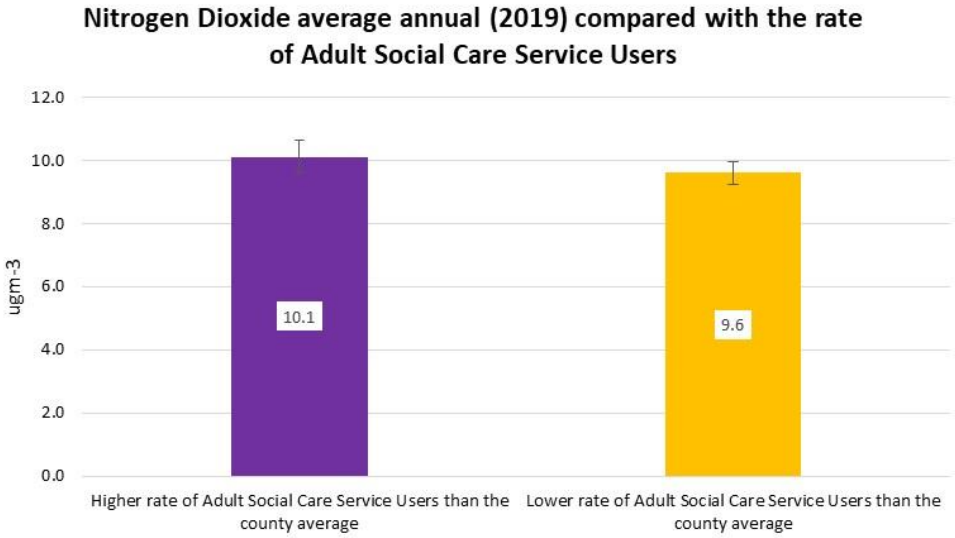

Figure 39: Nitrogen dioxide average annual (2019) compared with the rate of Adult Social Care Service Users[66]

[66] Data and Analysis Team, GCC and CDRC https://data.cdrc.ac.uk/dataset/access-to-healthy-assets-and-hazards-ahah

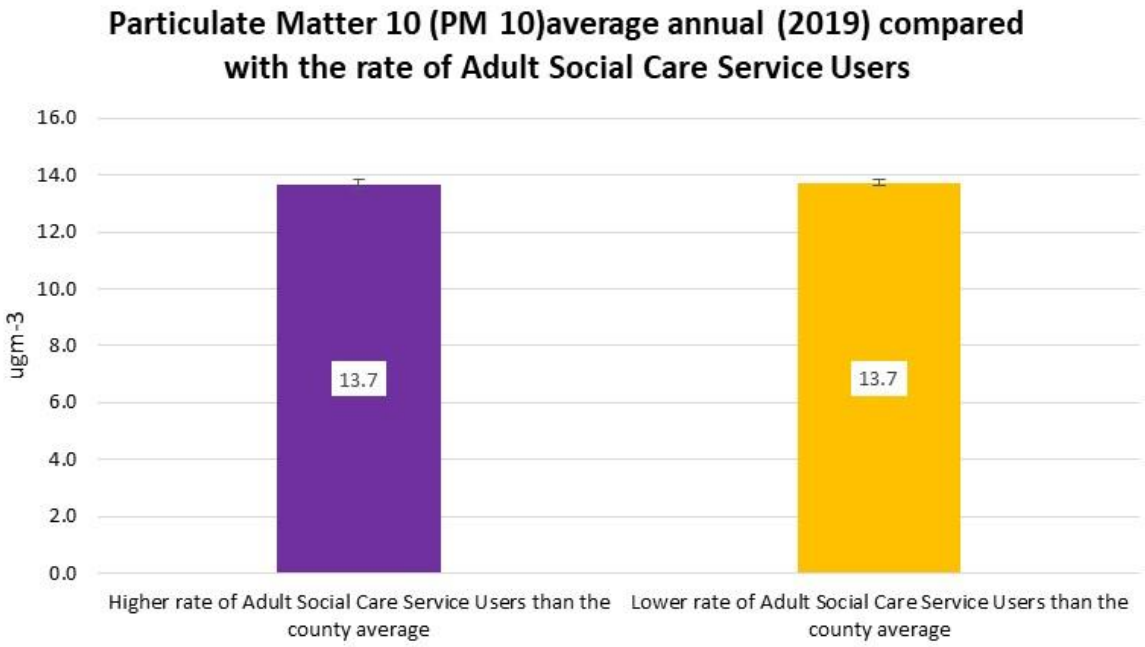

Figure 40: Particulate matter 10 (PM10) average annual (2019) compared with the rate of Adult Social Care Service Users[67]

6. What can be done to reduce this?

6.1 Walking and cycling

Switching journeys from cars to walking, cycling and public transport not only has a large beneficial impact on the individual's health, but a wider benefit to the population health as there are corresponding decreases in overall air pollution levels.

The 2021 Census was carried out during a time of national lockdown meaning the travel to work data collected was unreliable as more people were working at home than normal. This means the most robust data around travel to work comes from the 2011 census, which provided information on method of travel to work for residents aged 16 to 74. Figure 41 shows that in 2011 76% of people travelled to work by car, this was higher than the national average of 66%. At district level the Forest of Dean had the highest proportion of residents travelling to work by car at 84% closely followed by Stroud at 83%, conversely Cheltenham had the lowest proportion of residents travelling to work by car at 64%.

[67] *Ibid.*

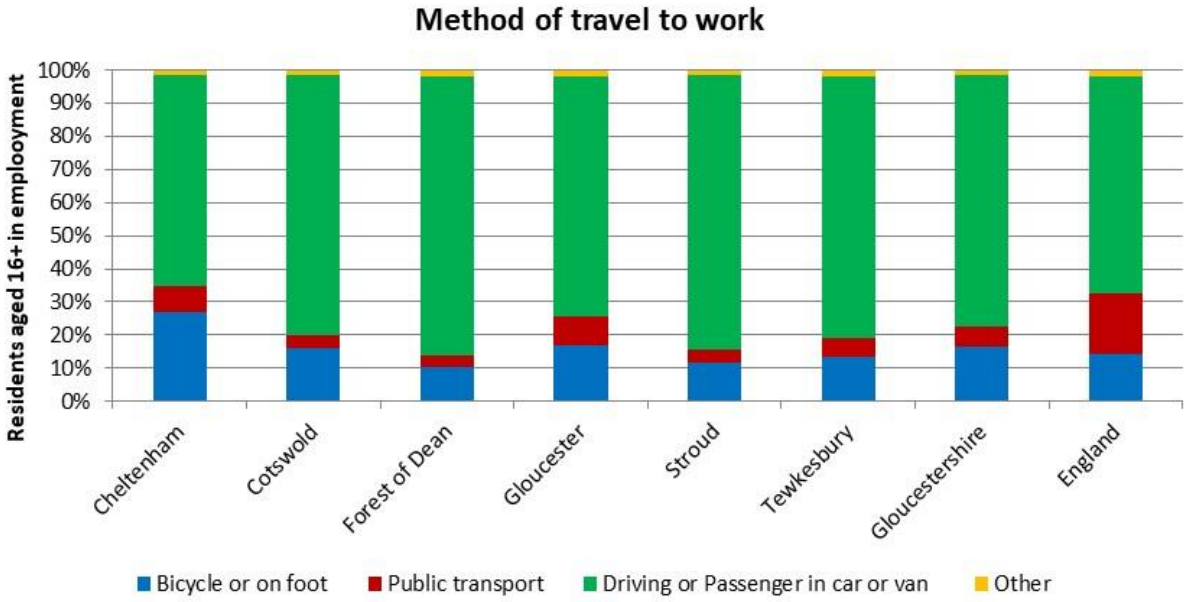

Figure 41: Method of travel to work, 2011[68]

Evidence suggests that those making short car trips are a prime target area for switching to active travel or public transport[69]. Figure 42 shows that of journeys to work that were less than 2km just over 50% were made by bicycle or foot, while 2.5% were made using public transport, both of these figures were lower than the national average. The Forest of Dean has the lowest proportion of short journeys to work made by bicycle or foot, while Cotswold had the lowest proportion of journeys made by public transport.

[68] 2011 Census, ONS

[69] www.sustrans.org.uk/sites/default/files/images/files/publications/Short%20journeys%20big%20savings%2023%20AUG.pdf

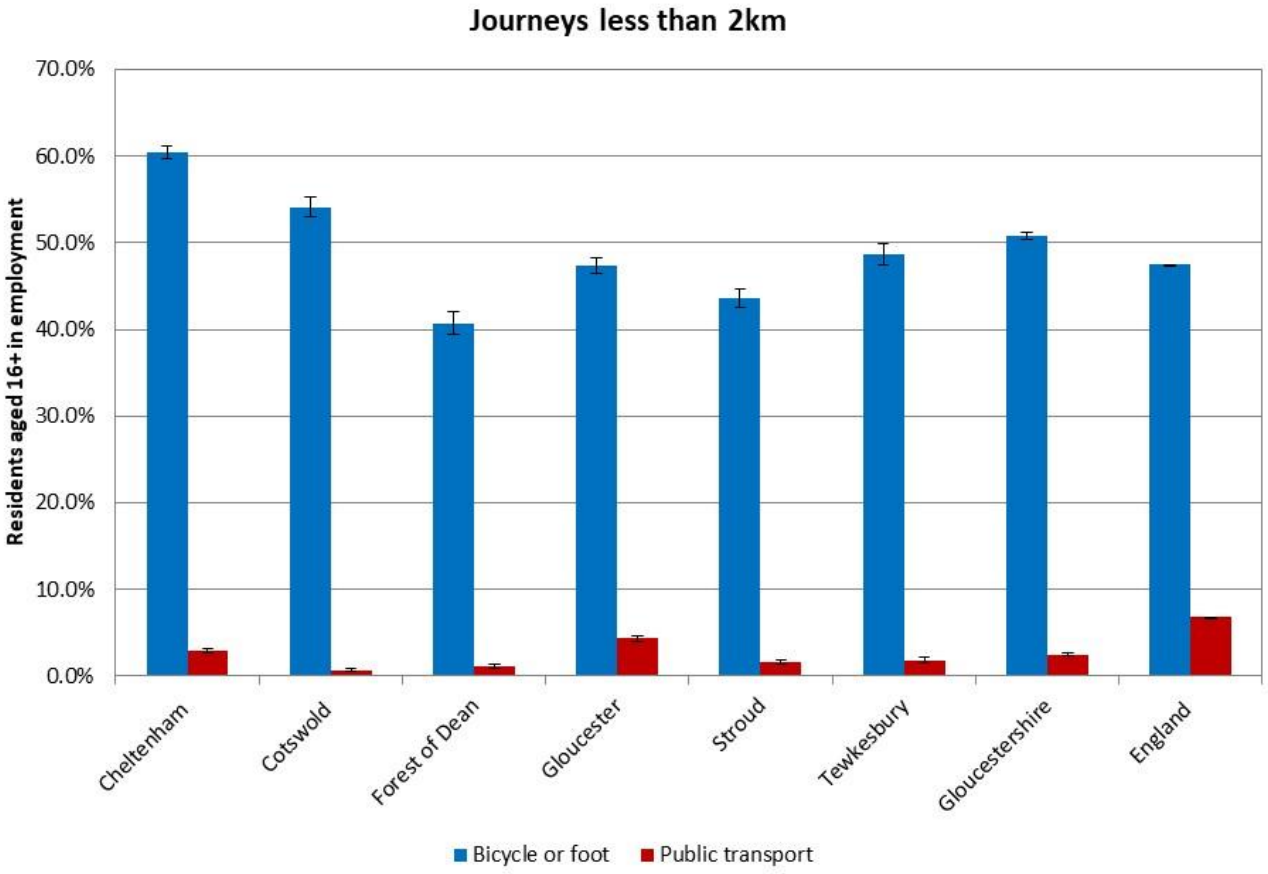

Figure 42: Travel to work method for journeys less than 2km[70]

The Pupil Wellbeing Survey (PWS) is conducted every two years and completed by students in years 4, 6, 8, 10 and 12. The survey aims to gain a better understanding of young people's experiences of life, the 2022 survey asked pupils "How do you normally (i.e. for most of the journey) travel to school?". The results showed the car was the most common method of travel for all pupils closely followed by walking. There are some differences between stages of education, walking is the most common method of transport for pupils at secondary school but is replaced by the car for pupils in primary school and post 16.

[70] *Ibid.*

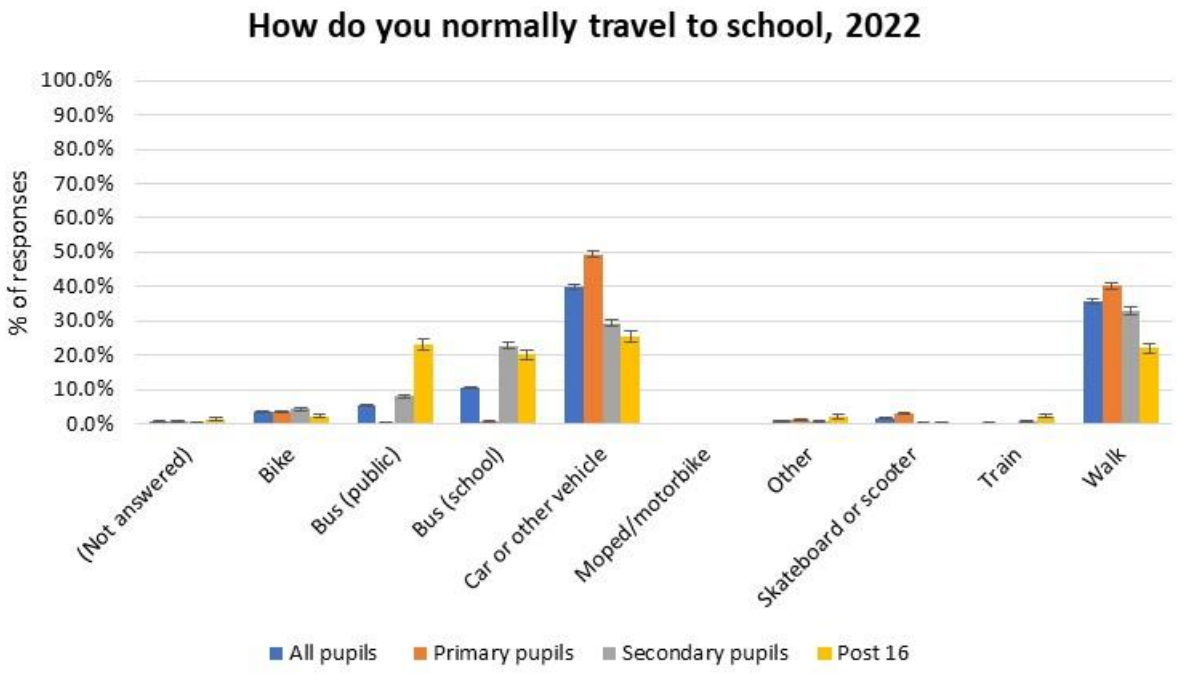

Figure 43: How do you normally travel to school[71]

[71] Pupil Wellbeing Survey, 2022