

# **Recommended areas of England in need of hospital resources to cope with COPD hospital admissions**

## **Introduction**

Chronic obstructive pulmonary disease (COPD) describes a group of lung conditions that can cause breathing difficulties (NHS UK, 2019). “115,000 people are diagnosed with COPD each year – equivalent to a new diagnosis every 5 minutes” (BLF, 2019). Additionally, the UK is among the top 20 countries for COPD mortality worldwide (BLF, 2019). Therefore, it is vital to equip hospitals with the necessary resources to cope with COPD hospital admissions.

To aid in this, disease mapping was done through estimating standardised mortality ratios (SMRs) utilising data on hospital admission rates for COPD. Specifically, this data was collected on the number of hospital admissions due to COPD for each year between 2001 and 2010 in 324 local authority administrative areas in England.

Corresponding expected number of cases (calculated using indirect standardisation by applying the age-sex specific rates for England to the age-sex population profile of each of the local authorities) were also used.

This analysis helps to identify key areas and boroughs in England where resources should be allocated to local hospitals to cope with COPD hospital admissions.

## **Analysis and Discussion of Findings**

*Code and files used to complete report can be found at <https://github.com/jhfran/copd-disease-mapping>*

### Mean Observed Hospital Admissions

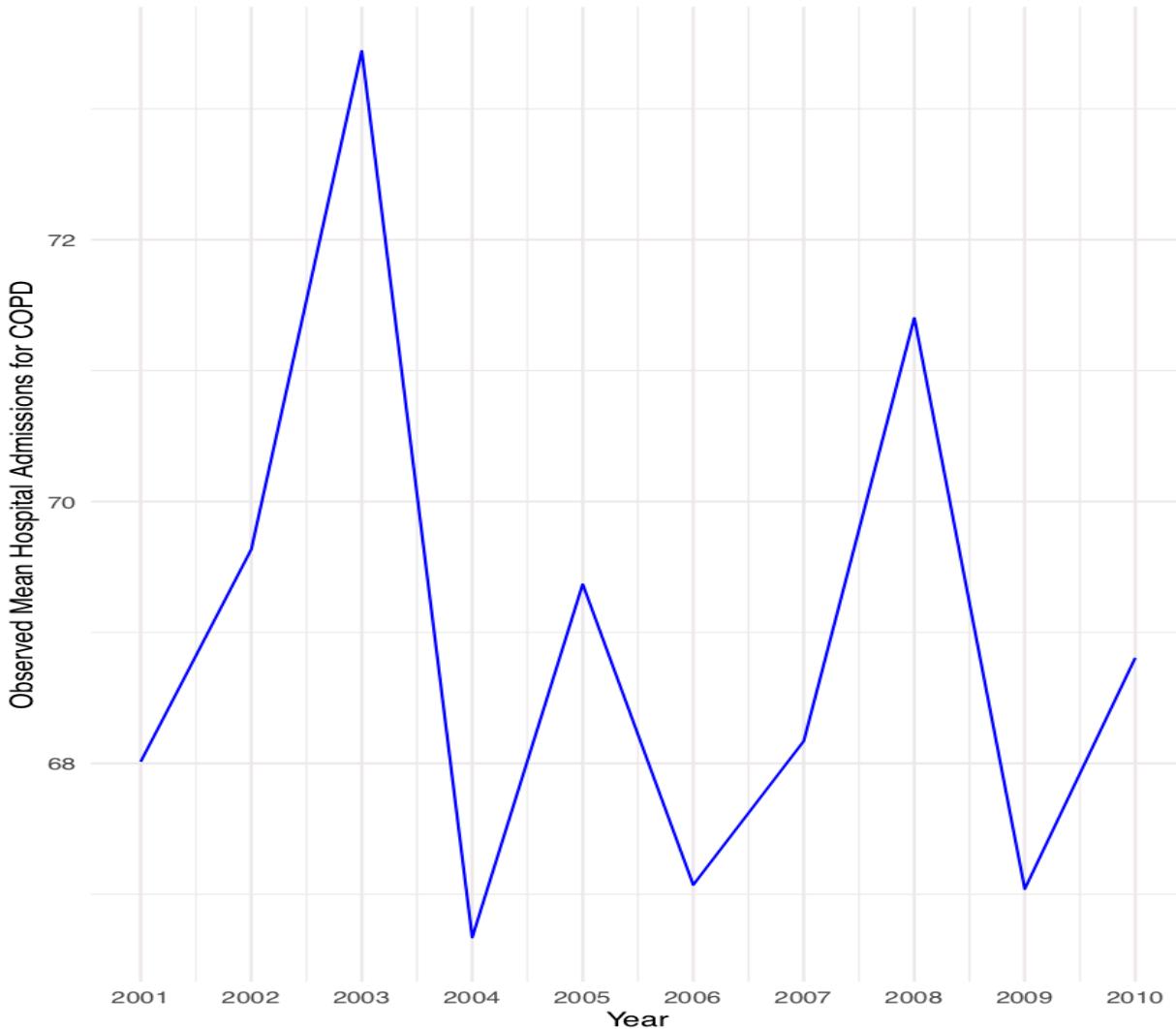
Firstly, the mean observed hospital admissions for COPD in England for the years 2001 -2010 were calculated. As shown in Table 1 below, mean hospital admissions ranged between 66.67 and 73.44. To help us visualise this, a line graph with this information was also plotted (Figure 1). As shown in table 1 and Figure 1, we can see that 2003 and 2008 had the highest observed mean hospital admissions of 73.44 and 71.40 respectively.

**TABLE 1: Mean of Observed Hospital Admissions for COPD in England between 2001 - 2010**

Year	Observed Mean Hospital Admissions
2001	68.01
2002	69.63
2003	73.44
2004	66.67
2005	69.37
2006	67.07
2007	68.17
2008	71.40
2009	67.04
2010	68.81

**FIGURE 1**

**Mean Observed Hospital Admissions for COPD in England  
Years 2001 – 2010**



**SMR**

Standardised morbidity ratios (SMRs) is calculated as the observed number of deaths (O)/ the expected number (indirect standardisation) (E):

$$SMR = \frac{O}{E}$$

An SMR of 1 means that the rate of COPD in the area is the same as in reference population. If it is greater than 1, we have more COPD cases than expected; if it is less than 1 we have less COPD cases than expected.

Raw SMRs do not adjust for extreme values based on small/large expected numbers therefore smooth SMRs were preferred to provide stability to the estimates (using data from surrounding areas).

Therefore, raw and smooth SMRs were then calculated for years 2001 – 2010. However, I focused on the first and last years of the study (2001 and 2010 respectively) and the years with highest 2 mean observed hospital admissions for COPD (2003 and 2008).

Tables with the raw and smooth SMR summary statistics for years 2001, 2003, 2008 and 2010 were produced below along with maps and plots of both raw and smooth SMRs for comparison.

### Summary Statistics 2001

**Table 2:** Raw SMR summary statistics for the year 2001

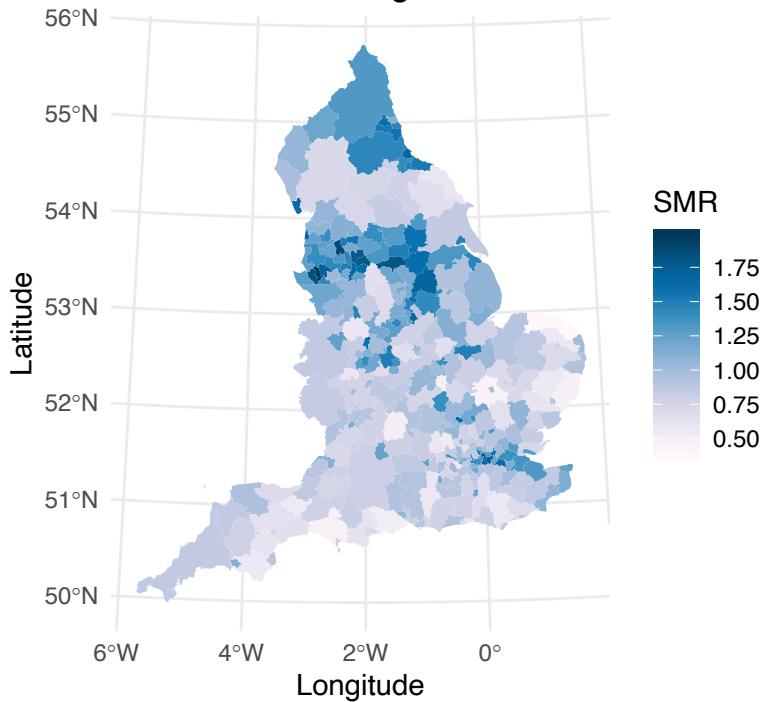
Minimum Raw SMR	1 <sup>st</sup> Quartile	Median	Mean	3 <sup>rd</sup> Quartile	Maximum Raw SMR
0.3883	0.7900	0.9496	1.0349	1.2526	1.9861

**Table 3:** Smooth SMR summary statistics for the year 2001

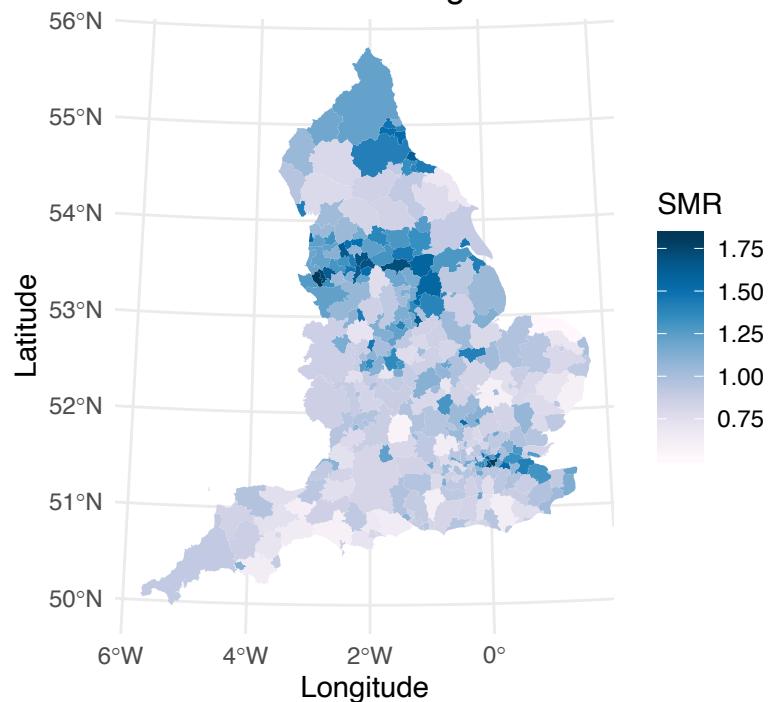
Minimum Smooth SMR	1 <sup>st</sup> Quartile	Median	Mean	3 <sup>rd</sup> Quartile	Maximum Smooth SMR
0.5302	0.8478	0.9692	1.0414	1.2103	1.7465

Figure 2

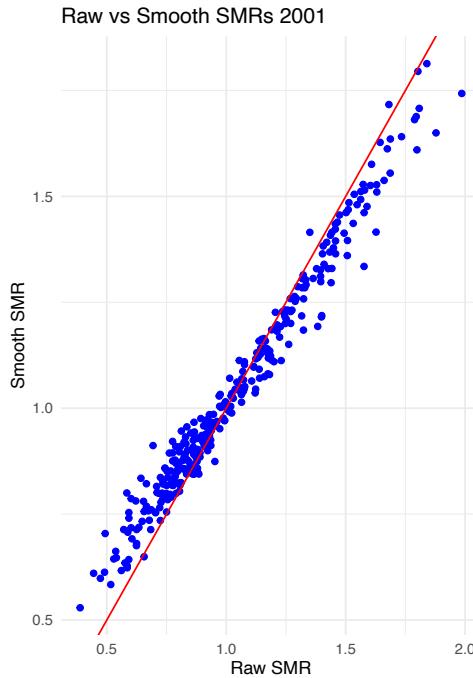
Raw SMRS for England in 2001



Smooth SMRS for England in 2001



**Figure 3**



For the year 2001. From a visual perspective, by comparing the maps in Figure 2 we cannot see noticeable differences in the prevalence of COPD in the different areas. However, we can already see that there are certain key areas with smooth SMRs over 1 (Figure 2).

**Table 4: Areas with highest smooth SMR values**

Region	County
North East	Northumberland
	County Durham
	North Yorkshire (north)
	Kingston upon Hull
Metropolitan	Merseyside
	Tyne & Wear
	Greater Manchester
	South Yorkshire
	West Yorkshire
South East	Greater London (and surrounding areas)

In Tables 2 & 3, the smooth SMRs minimised the range of values with a minimum SMR raised from 0.3883 to 0.5302 and a maximum SMR lowered from 1.9861 to 1.7465. Figure 3 also shows that there isn't a lot of variation between raw and smooth SMRs but the smooth SMRs clearly raise values below 1 and lower values above 1.

### Summary Statistics 2003

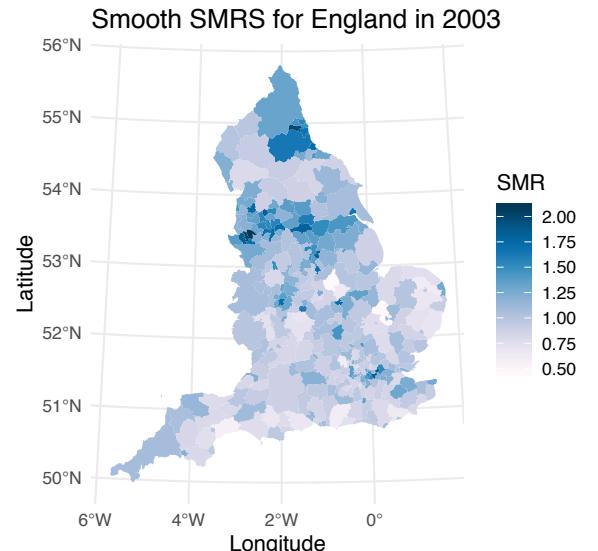
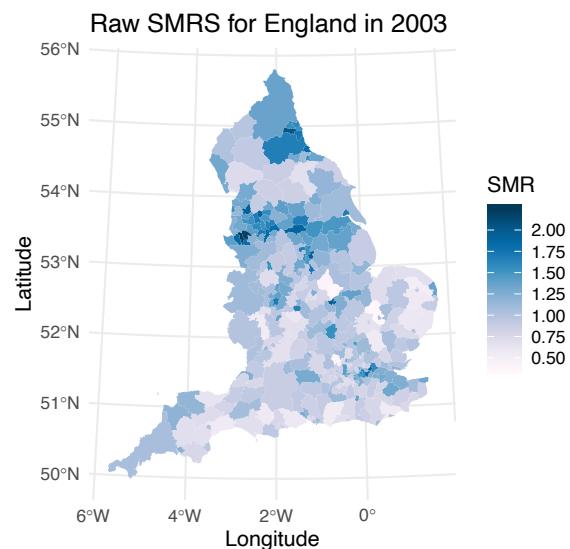
**Table 5: Raw SMR summary statistics for the year 2003**

Minimum Raw SMR	1 <sup>st</sup> Quartile	Median	Mean	3 <sup>rd</sup> Quartile	Maximum Raw SMR
0.3616	0.8519	1.0209	1.0895	1.3071	2.2483

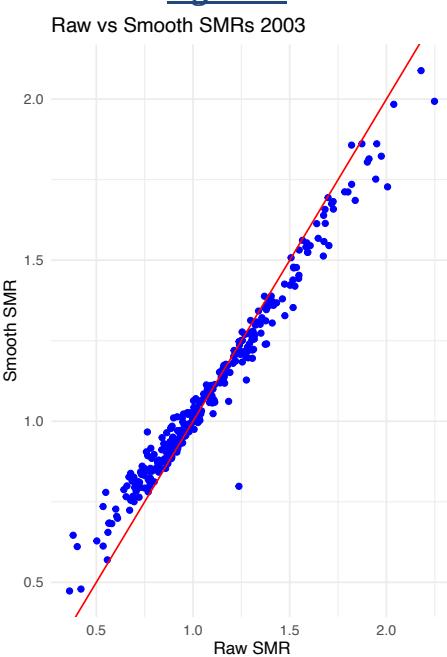
**Table 6: Smooth SMR summary statistics for the year 2003**

Minimum Smooth SMR	1 <sup>st</sup> Quartile	Median	Mean	3 <sup>rd</sup> Quartile	Maximum Smooth SMR
0.4740	0.8918	1.0267	1.0965	1.2558	2.0240

**Figure 4**



**Figure 5**



Similar to 2001, there were, visually, no significant changes between the raw and smooth SMR values.

In Tables 5 & 6 the smooth SMRs minimised the range of values with a minimum SMR raised from 0.3616 to 0.4740 and a maximum SMR lowered from 2.2483 to 2.0240. Figure 5 also shows that there isn't a lot of variation between raw and smooth SMRs but the smooth SMRs clearly raise values below 1 and lower values above 1. It also shows three values above 2.0.

From our summary statistics in tables 5 and 6 we can see this increase in both the maximum and minimum values which reflects Figure 1 which had 2003 as the year with the highest observed mean hospital admissions for COPD. Instead of seeing an increase in COPD hospital admissions across England, we see increases in the same areas identified in 2001.

### Summary Statistics 2008

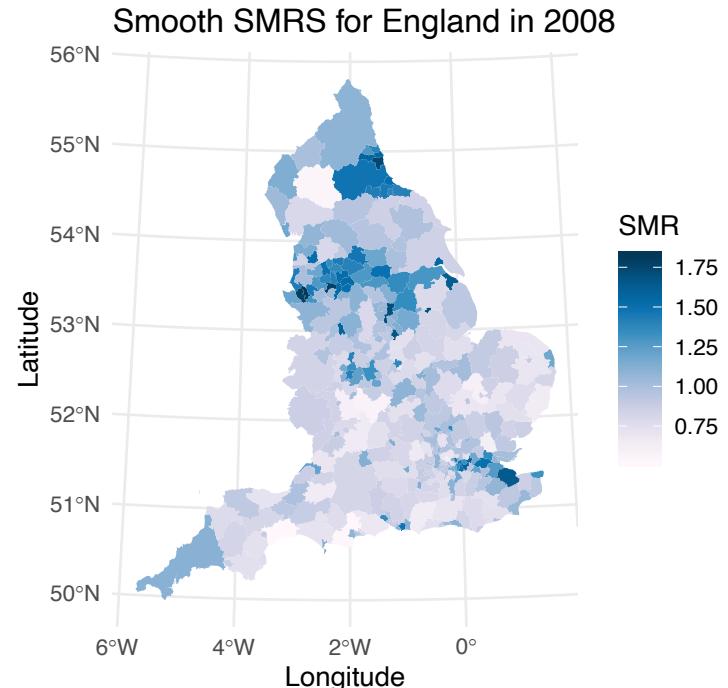
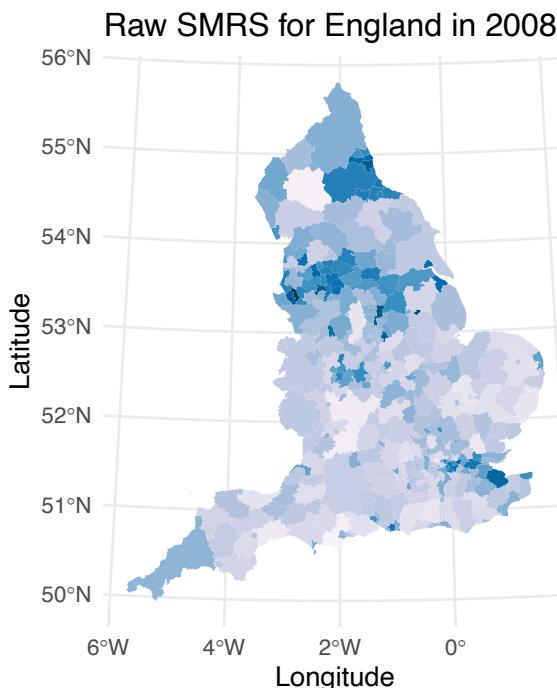
**Table 7: Raw SMR summary statistics for the year 2008**

Minimum Raw SMR	1 <sup>st</sup> Quartile	Median	Mean	3 <sup>rd</sup> Quartile	Maximum Raw SMR
0.3211	0.7695	0.9404	1.0069	1.1979	2.0567

**Table 8: Smooth SMR summary statistics for the year 2008**

Minimum Smooth SMR	1 <sup>st</sup> Quartile	Median	Mean	3 <sup>rd</sup> Quartile	Maximum Smooth SMR
0.5197	0.8188	0.9524	1.0136	1.1581	1.8184

**Figure 6**



**Figure 7**

Raw vs Smooth SMRs 2008

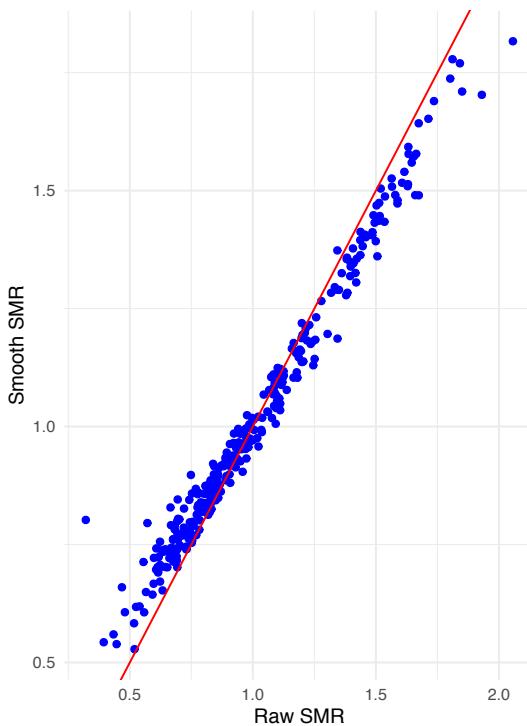


Figure 1 also showed 2008 as the year with the second highest observed mean hospital admissions for COPD. 2008 had the second highest maximum smooth SMR of 1.8184 (Table 8) but it had a higher minimum smooth SMR of 0.5200 than in 2003. There were also more outliers as shown in Figure 7.

In Figure 7, the SMRs increase in areas with SMRs above 1 when compared with previous years. The SMRs also increased in the smooth model when compared to the raw SMR model. It must be noted that it wasn't a country wide increase in smooth SMRs but in the areas previously identified (Table 4) and surrounding areas especially in Swale near Greater London and North Lincolnshire.

### Summary Statistics 2010

**Table 9: Raw SMR summary statistics for the year 2010**

Minimum Raw SMR	1 <sup>st</sup> Quartile	Median	Mean	3 <sup>rd</sup> Quartile	Maximum Raw SMR
0.3088	0.7682	0.9337	0.9639	1.1335	2.3856

**Table 10: Smooth SMR summary statistics for the year 2010**

Minimum Smooth SMR	1 <sup>st</sup> Quartile	Median	Mean	3 <sup>rd</sup> Quartile	Maximum Smooth SMR
0.5227	0.8069	0.9423	0.9704	1.0941	1.8710

Figure 8

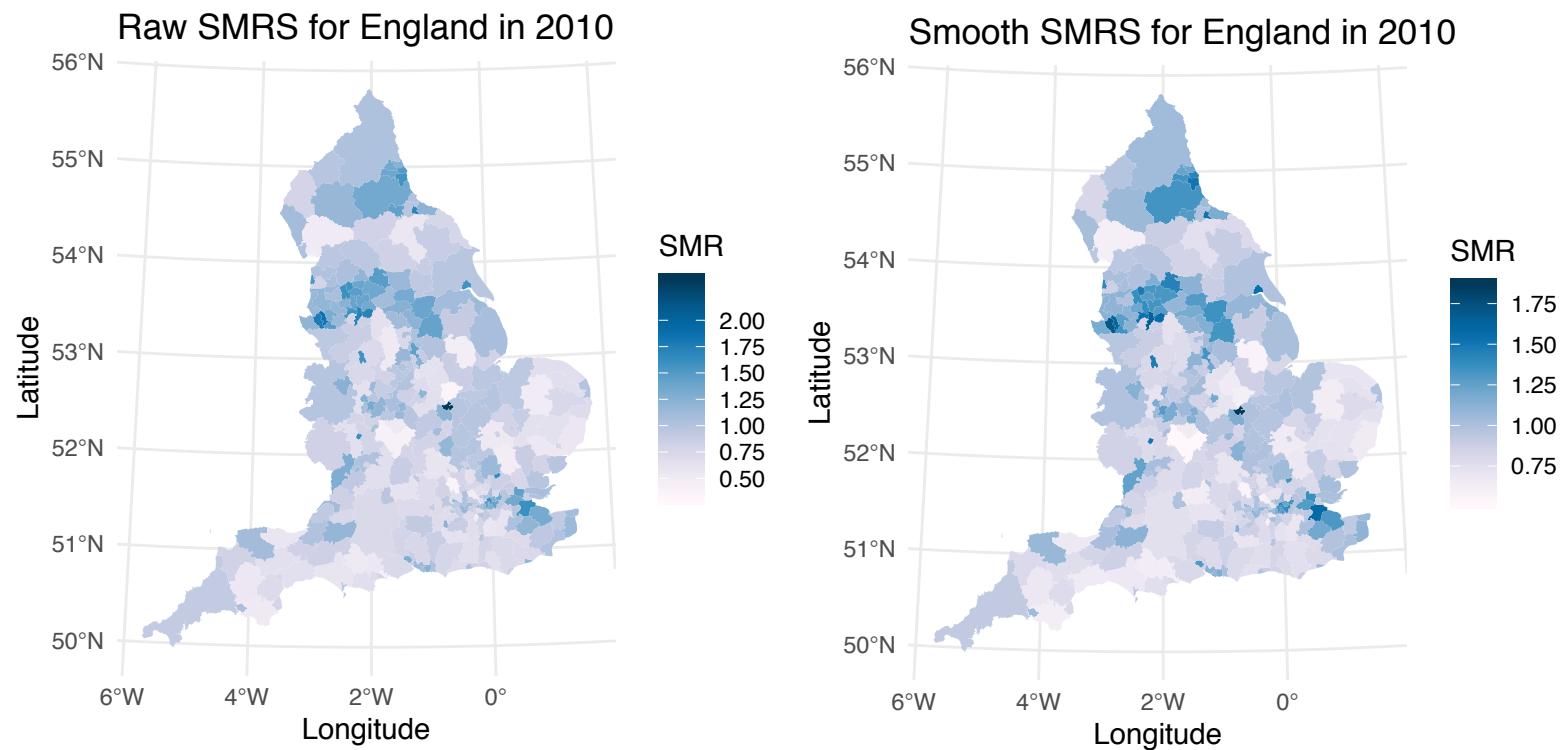
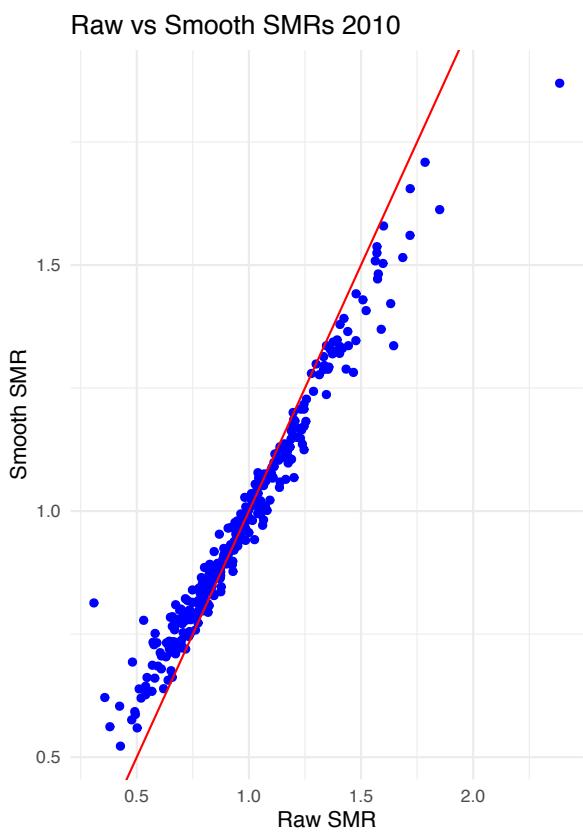


Figure 9



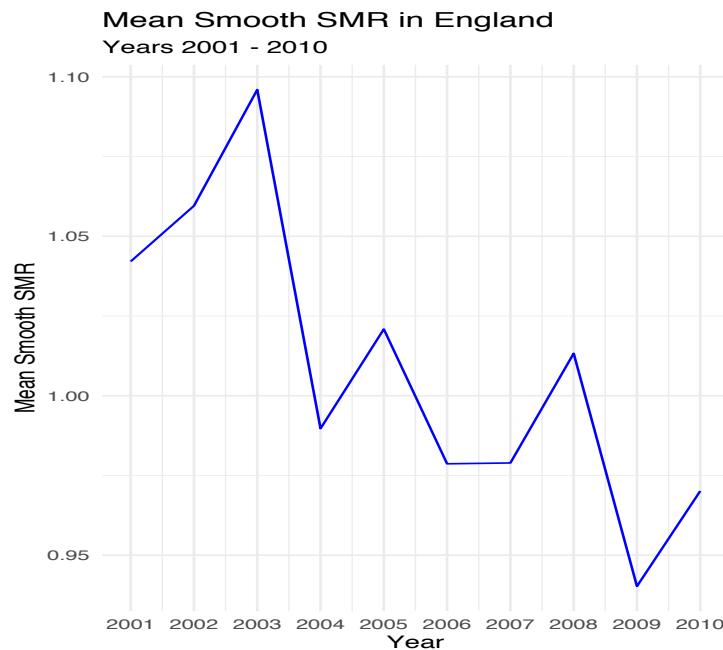
There were no major differences between the raw and smooth SMRs of 2010. However, the smooth model showed increases in the key areas (Table 4). Compared to 2008, the smooth SMRs in our key areas showed an overall decrease. Of all the years between 2001 and 2010, 2010 had the highest minimum smooth SMR of 0.5227.

#### Mean SMRs

A smooth SMR model is a better fit for the data - reducing extreme values. Figure 10 shows that, overall, when looking at the entire population of England had overall decreased smooth SMRs (although this wasn't a smooth decline and there was a significant spike in 2003) between 2001 and 2010.

Therefore, the mean smooth SMRs (over 2001-2010) were calculated for each local authority. Local authorities with a mean smooth SMR value above 1.5 were then isolated. With respect to the general population, these 12 local authorities (Table 11) showed the highest increase in morbidity (over 50%) and therefore should be seen as priority areas for allocation of hospital resources to cope with COPD. Table 11 also demonstrates that these local authorities are located in the key areas previously identified.

**Figure 10**



**Table 11: Local authorities with the highest smooth SMR mean values between 2001 -2010**

Local Authority	County	Region	Smooth SMR Mean
Knowsley	Merseyside	Metropolitan	1.75
Liverpool	Merseyside	Metropolitan	1.74
Barking and Dagenham	Greater London	South East	1.60
Gateshead	Tyne & Wear	Metropolitan	1.59
Manchester	Greater Manchester	Metropolitan	1.59
St. Helens	Merseyside	Metropolitan	1.59
Sunderland	Tyne & Wear	Metropolitan	1.56
Salford	Greater Manchester	Metropolitan	1.54
Middlesbrough	North Yorkshire	North East	1.53
Tameside	Greater Manchester	Metropolitan	1.52
County Durham	County Durham	North East	1.51
Greenwich	Greater London	South East	1.50

## Conclusion and Recommendations

Risk of hospitalisation due to COPD are denoted here by their smooth SMR values where a smooth SMR over 1 shows an increase in the risk of hospitalisation due to COPD.

2003 and 2008 saw the highest observed mean hospital admissions between 2001 and 2010 of 73.44 and 71.40 respectively (Table 1). However, figures 2, 4, 6 and 8 showed that these did not result in a countrywide increase in the risk of hospitalisation due to COPD but rather increases in the risk in key areas (Table 4 and 11) - and their surrounding areas that already had higher smooth SMRs relative to the population.

It must be noted that overall, in England, risk of hospitalisation due to COPD decreased between 2001 and 2010 (Figure 10). The mean smooth SMR for the entire country did not exceed 1.10, therefore, on average, the increase in risk, countrywide did not exceed 10% between 2001 and 2010.

After adjusting for the effect of differences in age and sex structure for the whole of England, disease mapping was done through estimating standardised mortality ratios (SMRs) utilising data on hospital admission rates for COPD.

Through close analysis of the years 2001, 2003, 2008 and 2010 it was found that significant increases in SMRs did not necessarily happen country wide but in areas that already had higher increased risk (higher SMR values). However, in 2008, areas such as Swale that are located near areas with consistently high smooth SMR values (such as Greater London), saw noticeable increases in the risk of hospitalisation due to COPD – shown by their smooth SMR values.

The results showed that the key areas with the highest increased risk of hospitalisation due to COPD were in Metropolitan areas (Merseyside, Tyne & Wear, Greater Manchester, South Yorkshire, West Yorkshire), North East (Northumberland, County Durham, North Yorkshire (north), Kingston upon Hull) and Greater London.

Additionally, 8 of the local authorities with the highest smooth SMRs in the country were in the Metropolitan area. These results are unsurprising for a few reasons. Firstly, according to the NHS, “smoking is the main cause of COPD and is thought to be responsible for around 9 in every 10 cases” (NHS UK, 2019). Given this statistic, one can assume that all of the key areas identified in tables 4 and 11 have high levels of smokers. Additionally, in England, the prevalence of cigarette smoking is higher in more deprived areas of England (Cancer Research UK, 2019). This

can partly explain the fact that Liverpool, Middlesbrough, Manchester and Knowsley have some of the highest smooth SMR values observed and are also 4 of the local authorities with the highest proportion of lower layer super output areas (LSOAs) amongst the most deprived in England in 2010 (Department for Communities and Local Government, 2011).

Other causes of COPD are non-cigarette smoke, air pollution (exposure over long periods of time) and even jobs. Especially jobs involving fumes, dust (silica, grain, flour, cadmium, coal to name a few) (NHS UK, 2019). The North East and the Metropolitan areas host many jobs exposing workers to these factors. Additionally, London also has poor air quality.

Given the factors and analysis in this report, I would recommend increasing resources to hospitals in the counties of Northumberland, County Durham, North Yorkshire (north), Kingston upon Hull, Merseyside, Tyne & Wear, Greater Manchester, South Yorkshire, West Yorkshire and Greater London.

Within these counties, priority should be given to local authorities with the highest mean smooth SMRs and therefore risk of hospitalisation due to COPD: Knowsley, Liverpool, Barking and Dagenham, Gateshead, Manchester, St. Helens, Sunderland, Salford, Middlesbrough, Tameside, County Durham and Greenwich.

## **References**

BLF. (2019). *Chronic obstructive pulmonary disease (COPD) statistics* / British Lung Foundation. [online] Available at: <https://statistics.blf.org.uk/copd> [Accessed 6 Oct. 2020].

Cancer Research UK. (2019). *Tobacco statistics*. [online] Available at: <https://www.cancerresearchuk.org/health-professional/cancer-statistics/risk/tobacco> [Accessed 6 Oct. 2020].

Great Britain. Department for Communities and Local Government. (2011). *The English Indices of Deprivation 2010*. Available at: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/6871/1871208.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/6871/1871208.pdf) [Accessed 6 Oct. 2020].

NHS UK. (2019). *Chronic obstructive pulmonary disease (COPD)*. [online] Available at: <https://www.nhs.uk/conditions/chronic-obstructive-pulmonary-disease-copd/> [Accessed 6 Oct. 2020].