Analysing the Impact of MAUP on the March of Atopy in England using Hospital Admission Data

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1. Introduction

The Modifiable Areal Unit Problem (MAUP) is well known in geographical studies (Openshaw, 1984), but is very rarely discussed in spatial epidemiology work. Results from analysis of health datasets are very sensitive to how the spatial zones are constructed, which makes the needs to consider MAUP very clear. In particular, zone design is likely to influence descriptive statistics of the health variables as well as the coefficients of any correlation or regression analysis undertaken (Flowerdew et al., 2008).

This work considers an epidemiological phenomenon known as the March of Atopy, which proposes that childhood eczema and/or allergies lead to increased rhinitis and asthma (Ker and Hartert, 2009). The phenomenon is not universally accepted and has different elements, with more evidence for eczema and asthma being involved and less for allergy (McNally et al., 2000; Bousquet et al., 2008). It is estimated that managing adult asthma costs the NHS over £1bn per year (Gupta et al., 2004), so if there is a causal link between childhood eczema and adulthood asthma, even a small reduction in childhood eczema could result in a large reduction in cost of managing adulthood asthma.

Data for the March of Atopy are collected at a variety of spatial scales including individual cases and aggregated data at different levels, with the different scales often not discussed in the literature. This study will use hospital admissions data to examine the hypothesis that the relationship between the three elements of the March of Atopy is different at different spatial scales.

MAUP is often thought of as having two aspects; the scale effect and the aggregation effect. The scale effect is the tendency for different statistical results to be obtained from the same set of data when the information is grouped at different spatial levels. The aggregation effect is when different results are obtained from different areal units of the same size (Sabel et al., in press). This work will only consider the scale effect as data for the aggregation effect is not available.

2. Methods

Data on hospital admissions (Hospital Episode Statistics, HES) were obtained for patients suffering from childhood eczema and allergies (aged 0-14) and adulthood asthma (aged 15+)

for 2008/9 to 2010/11. The diseases were selected using established ICD-10 codes used to define cases of these conditions (Anandan et al., 2009). Data were collected at Local Authority (LA), Primary Care Trust (PCT) and Strategic Health Authority (SHA) aggregation levels for England and age-sex specific rates were calculated for each spatial unit. Due to the relatively low prevalence of eczema severe enough to result in hospital admissions, a number of local authorities had data for eczema suppressed for confidentiality reasons (where n < 6). Rates were calculated for those that had data and alternative methods of rate calculation will be used to address this issue.

3. Results

Preliminary results are presented here. Table 1 shows age-sex specific rates for asthma for SHA, PCT and LA spatial units in England.

Table 1. Age-sex specific rates for asthma, eczema and allergies by SHA (10 in England), PCT (152 in England) and LA (354 in England).

Age-sex specific rates per 1000 population per year		**SHA**	**PCT**	**LA**
Asthma (aged 15+)	Mean	9.238	9.727	9.207
	St Dev	1.170	2.117	2.993
Eczema (aged 0-14)	Mean	0.064	0.188	0.253
	St Dev	0.038	0.325	0.477
Allergies (aged 0-14)	Mean	0.316	0.889	0.759
	St Dev	0.078	0.349	0.447

A linear regression was used to evaluate the relationship between asthma, eczema and allergies (see Table 2). Asthma was the dependent variable and eczema and allergies the independent variables. The HES data at PCT and LA levels are not significantly different, with the coefficient for eczema between 1 and 2. Correcting for IMD (Indices of Multiple Deprivation) made no significant difference to the results. The coefficient for allergies was not statistically significant at conventional levels, so the allergy data was removed from the regression; however this had no significant effect on the results. Allergies are not represented well with the ICD-10 coding system and this systematic bias may have led to the non-significant results seen, in contradiction to some of the previous literature.

Table 2. Linear regression analysis for asthma, eczema and allergy, corrected for IMD.

	Eczema				**Allergy**		**Constant**	
	Coef.	**p**	**95% Conf. Int.**		**Coef.**	**p**	**Coef.**	**p**
PCT	2.19	0.003	0.74	3.64	0.05	0.923	7.33	<0.001
LA	1.21	0.001	0.47	1.94	-0.20	0.545	7.02	<0.001

While the linear regression showed that there was no variation in the relationship between asthma and eczema between PCT and LA spatial levels, the different spatial levels will affect spatial patterns and clustering seen within each variable. Figure 1 shows the asthma rate for LA and PCTs, and differences in the spatial pattern of the rate can be seen across England, because of the change in spatial scale.

A univariate LISA (Local Indicators of Spatial Autocorrelation) (Anselin, 1995) analysis was used to highlight the clusters in the LA level data and show whether they were still present in

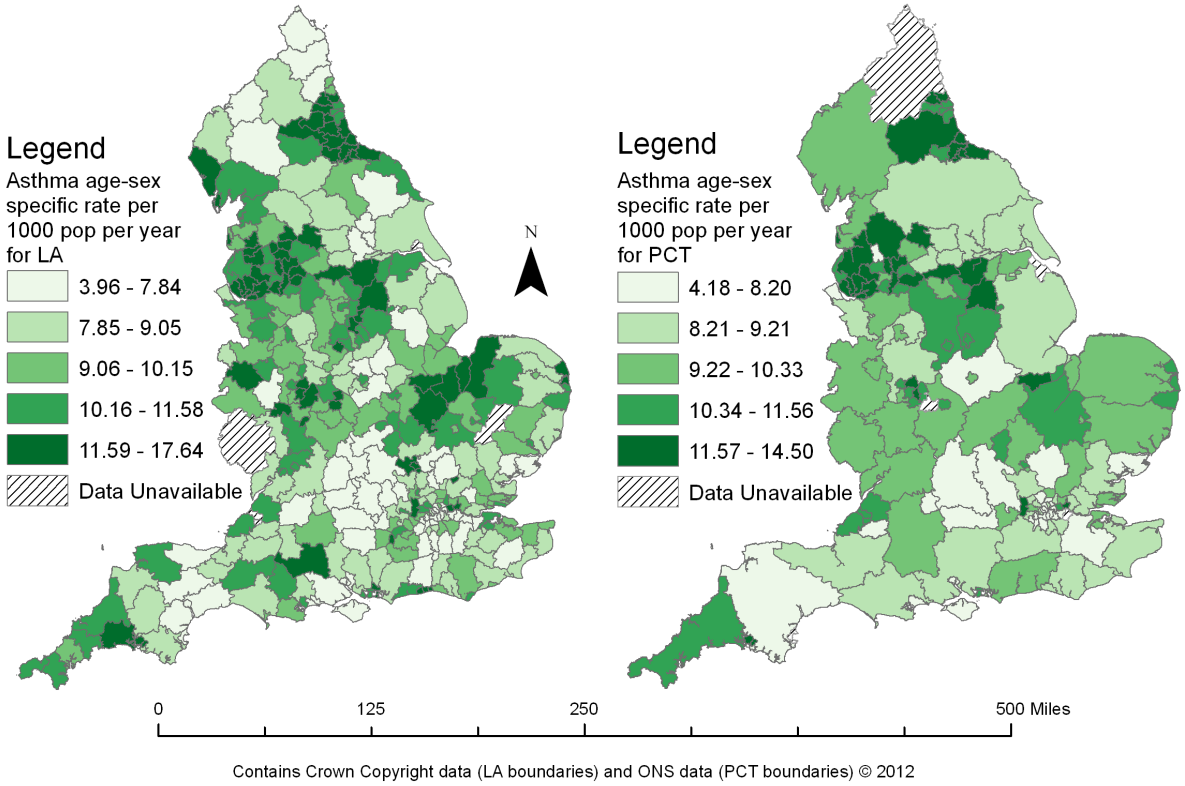

Figure 1. Asthma age-sex specific rate maps for LA (left) and PCT (right).

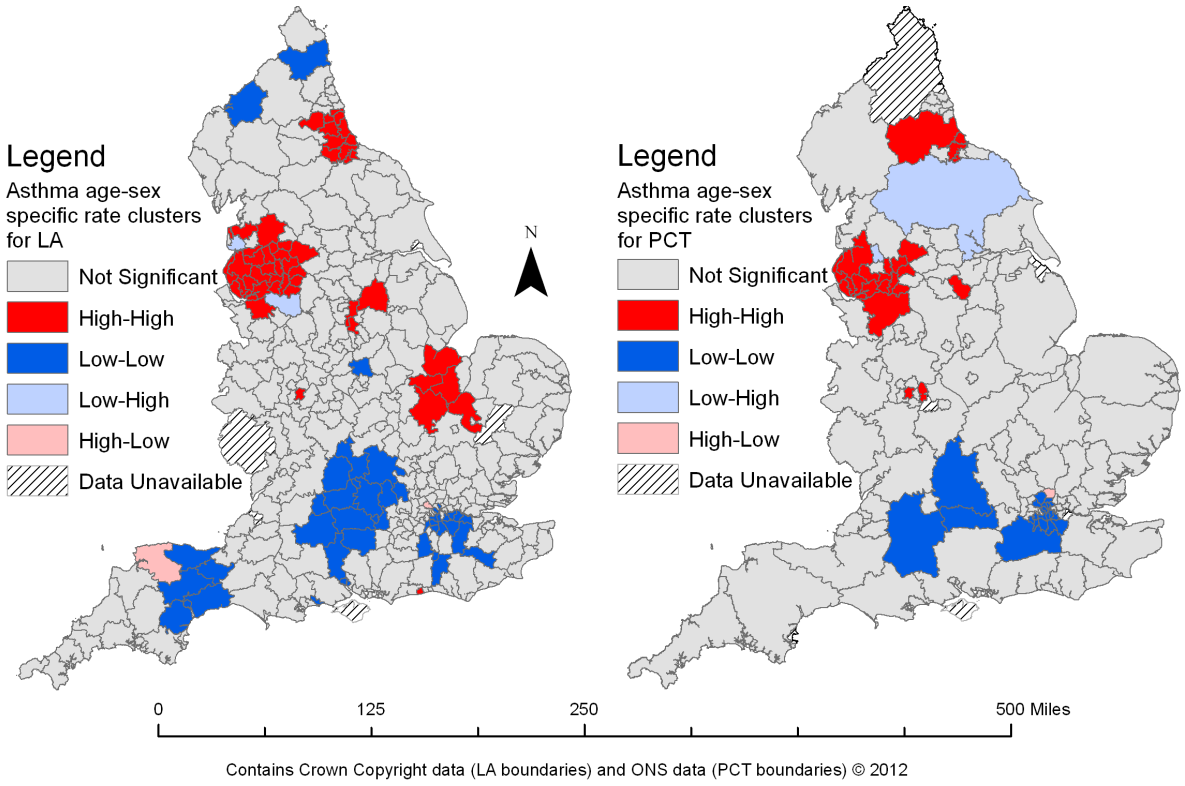

Figure 2. LISA of asthma rates for LA (left) and PCT (right), with blue representing a cluster of higher values than expected, and red representing a cluster of lower values than expected. Light red and light blue represent clusters where a high value is next to a low cluster and a low value next to a high cluster, respectively.

the PCT level data. As Figure 2 shows, some clustering does remain (e.g. Manchester / Liverpool area), but some of the clusters do disappear (e.g. Devon/Somerset border and Peterborough / Fens area) highlighting the potential loss of data through aggregation.

4. Conclusions

This work shows that the scale effect of MAUP does not impact the March of Atopy cross-sectional relationships when comparing PCT and LA level hospital admission data. The maps of asthma rates and clusters highlight the impact different levels of aggregation can have on spatial patterns of results. Additional work investigates GP practice level data on asthma, eczema and allergy to see what effect MAUP has at this larger scale. It also considers the impact of MAUP on spatial clustering of all three atopic march elements (asthma, eczema and allergy).

While this analysis only looks at the scale element of MAUP, the aggregation element may also play a factor in the uncertainty surrounding the March of Atopy. Unfortunately the data required for this is currently unavailable, but existing GP practice level data could be aggregated into different spatial aggregations and the impact of MAUP evaluated in future research.

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Biography

Nick Bearman is an Associate Research Fellow in GIS, interested in the use of geospatial data by non experts and how information regarding the impacts of using this data can be communicated to non GIS experts, including the use of novel methods such as sonification.
Dr. Nicholas Osborne is a Senior Research Fellow, with experience in epidemiology studies examining the complex genetic and environmental aetiology of disease.
Prof. Clive Sabel is an Associate Professor in Human Geography and his major interests are focused around the Geography of Health, spatial analysis and innovative quantitative research methods.