

Defining “enduring prevalence”

SPI-M spatial variation subgroup
21st April 2021

Summary

These slides are compiled accompany the paper from the Regional Variation subgroup of SAGE on understanding factors that lead to enduring prevalence. Here we focus on identifying which regions these are from epidemiological data.

There is not a single agreed quantitative definition of “enduring prevalence” and there are a variety of plausible candidates. A range of approaches are applied by groups to the UK or England data below. While there are some small differences in precisely which areas are identified, the broad patterns are similar between all approaches, suggesting “enduring prevalence” is relatively robust to different choices of quantitative definition.

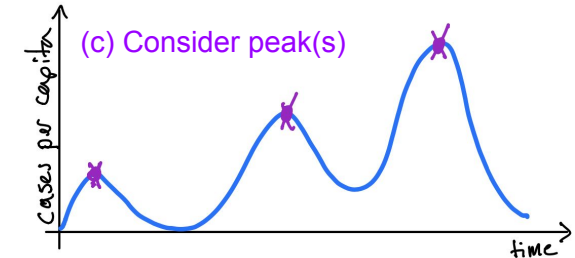
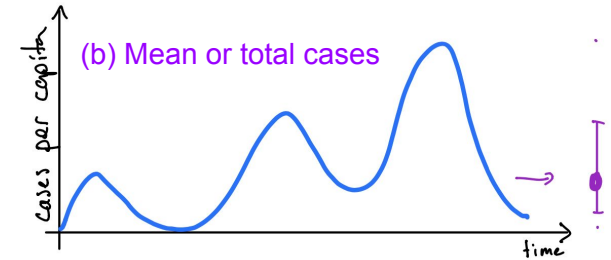
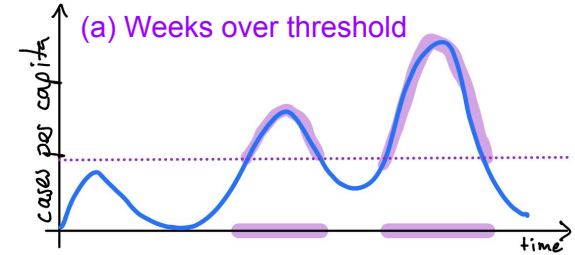
Note these considerations here are separate from “early warning” work: identifying places where there is a projected increase in prevalence not consistent with past patterns.

Some possible definitions:

Translating from a verbal description “enduring prevalence” or areas of “persistent transmission” or “long term concern” to a quantitative metric brings a number of choices. Here we present some options.

- (a) Number of weeks over a threshold
 - *may best identify first-up-last-down*(this threshold could be in terms of weekly cases per capita, ranking in top X, or weeks in “epidemic phase”)
- (b) Mean prevalence over time (or distribution) or total cases
 - *places that consistently run “hotter”*
- (c) Peak value(s)
 - *places where local patterns mean epidemic can spike*

In addition, these can all be considered in further detail by separating further in terms of timescale such as over a wave. Further, focussing within a smaller geography will show which places are outliers locally, which may help yield broader insights in what factors are behind “enduring transmission” by multiple comparisons across a set of regions.



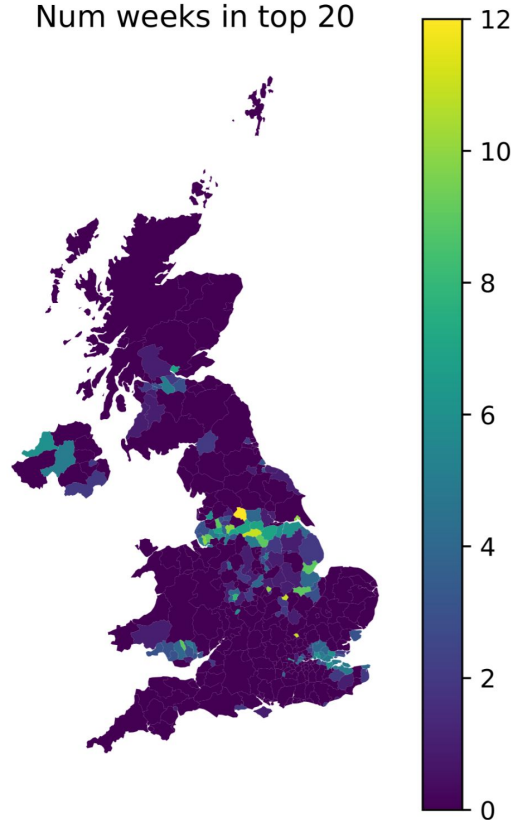
Lancaster -- Top k LADs by incidence

- “Incidence rank” is defined as the rank of each LAD ordered by positive test incidence per capita.
- Persistence is defined as the number of weeks between 1st October 2020 and 19th April 2021 that each LAD’s Incidence Rank has appeared in the top k rankings.
- Ranking LADs by positive tests per capita automatically adjusts for changing incidence over time, and helps to prevent artefacts due to different peaks occurring at different times.

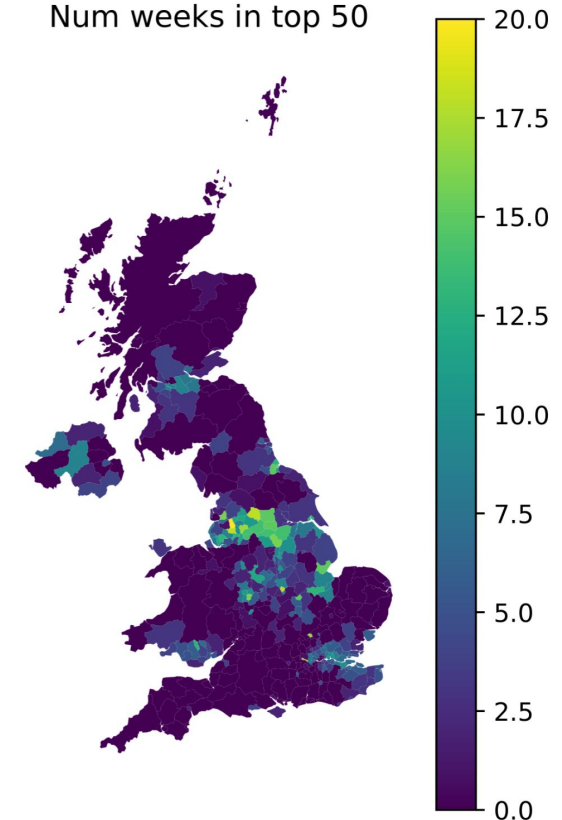
LAD	Num weeks in top 20
Bradford	12
Corby	11
Barnsley	11
Luton	11
Leicester	10
Knowsley	10
Rochdale	10
Hull	10
St. Helens	9
Merthyr Tydfil	9

Top 10 LADs by number of weeks in top 20 Incidence Rank

Num weeks in top 20



Num weeks in top 50



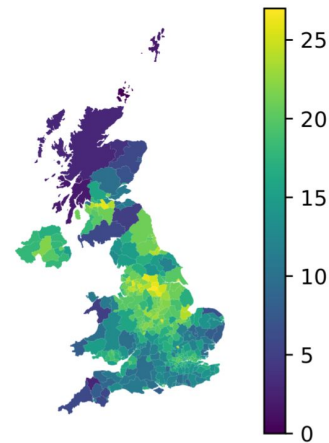
Lancaster -- incidence thresholding

- LADs are coloured by number of weeks between 1st October 2020 and 19th April 2021 in which positive test incidence per capita exceeds 100, 200, 300, and 400 cases per 100,000.
- Persistence is shown best for the 400 cases per 100,000 threshold.
- Artefacts are introduced in sparsely population areas (e.g. Eden, Copeland, Breckland) due to differing epidemic peak timings relative to the overall UK total incidence.

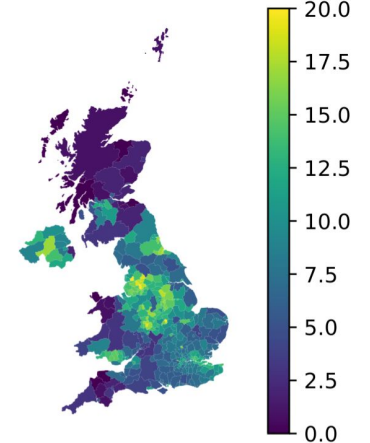
LAD	Num weeks > 400/1e5
Pendle	11
Burnley	11
Blackburn with Darwen	11
Thanet	10
Swale	10
Medway	9
Knowsley	9
Hyndburn	9
Merthyr Tydfil	9
Blaenau Gwent	9

Top 10 LADs by number of weeks above 400 cases per 100,000.

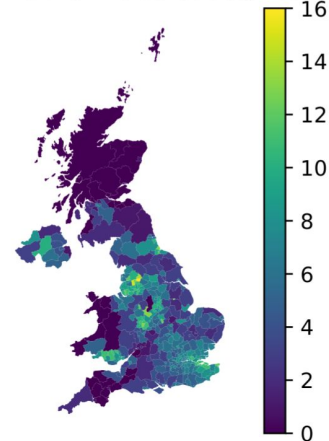
Num weeks > 100 cases/1e5



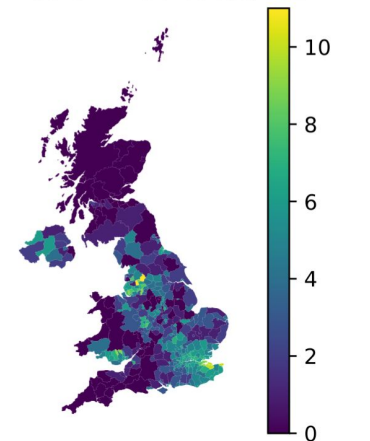
Num weeks > 200 cases/1e5



Num weeks > 300 cases/1e5



Num weeks > 400 cases/1e5



Warwick

Definitions of local authorities of 'long term concern'

The local authority is labelled as 'long term concern' if the following measure is above a given threshold:

Case I: Number of weeks that the (smooth) proportion of Pillar 2 positive tests in a local authority is above England's average with (estimated) probability 1.

Case II: Number of weeks that the (smooth) proportion of Pillar 2 positive tests in a local authority is above the regional average with (estimated) probability 1.

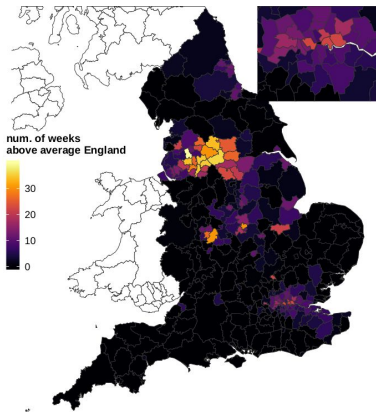
Method

Model: The proportion of positive Pillar 2 samples per day per local authority is fitted using a beta-binomial distribution and a Gaussian Process (GP). For a fixed day, samples are generated from the posterior distribution of the GP to estimate the probability of a local authority being above average $P(x_{it} > \text{mean}(X_{it}))$.

Dates: 01 June 2020 - 13 April 2021

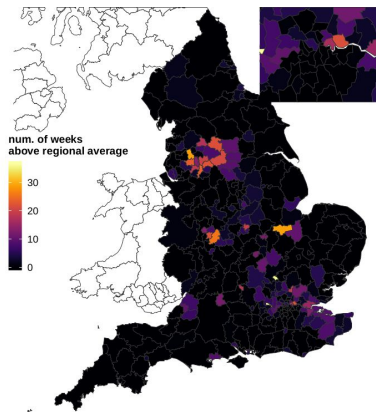
***Average IMD rank:** Average IMD rank of people with positive swabs.

CASE I



Local Authority	Number of weeks	Region	Average IMD rank*
1 Blackburn with Darwen	39.7	North West	8462
2 Kirklees	35.7	Yorkshire and Humber	12250
3 Oldham	35.0	North West	9366
4 Rochdale	34.7	North West	9109
5 Manchester	34.6	North West	6268
6 Bolton	34.0	North West	10939
7 Bradford	33.7	Yorkshire and Humber	7862
8 Birmingham	30.6	West Midlands	6957
9 Leicester	30.3	East Midlands	9907
10 Calderdale	30.3	Yorkshire and Humber	12257
11 Salford	28.6	North West	9532
12 Sandwell	26.7	West Midlands	7318
13 Pendle	26.1	North West	9390
14 Bury	26.0	North West	14632
15 Wakefield	26.0	Yorkshire and Humber	12411
16 Leeds	24.9	Yorkshire and Humber	13062

CASE II



Local Authority	Number of weeks	Region	Average IMD rank*
1 Slough	36.6	South East	12998
2 Luton	35.7	East of England	11287
3 Blackburn with Darwen	29.0	North West	8462
4 Peterborough	29.0	East of England	10664
5 Birmingham	25.4	West Midlands	6957
6 Manchester	23.7	North West	6268
7 Bolton	23.1	North West	10939
8 Oldham	22.3	North West	9366
9 Sandwell	22.0	West Midlands	7318
10 Bradford	21.9	Yorkshire and Humber	7862
11 Newham	21.7	London	8695
12 Kirklees	21.0	Yorkshire and Humber	12250
13 Rochdale	20.0	North West	9109
14 Leicester	19.4	East Midlands	9907
15 Broxbourne	19.1	East of England	16989
16 Salford	18.7	North West	9532
17 Oxford	17.7	South East	16946
18 Pendle	17.6	North West	9390

PHE

England map showing the number of days since 1st March 2020 that each local authority has spent in the epidemic phase.

This output comes from a hidden Markov switch model that uses reported case data to assign a probability that each local authority is in the epidemic phase. The epidemic phase is characterised by a greater mean number of daily cases, higher variability, and a stronger correlation between case numbers across consecutive days.

A local authority is assumed to be in the epidemic phase if the probability of epidemic exceeds 0.75.

The ten local authorities with the highest number of days spent in the epidemic phase are:

Peterborough
Bradford
Kirklees
Rochdale
Leicester
Luton
Blackburn with Darwen
Northampton
Oldham
Sheffield

Number of days in epidemic phase

