



## **Continuous Mortality Investigation**

Institute and Faculty of Actuaries

# **The impact of socio-economic status on mortality and morbidity**

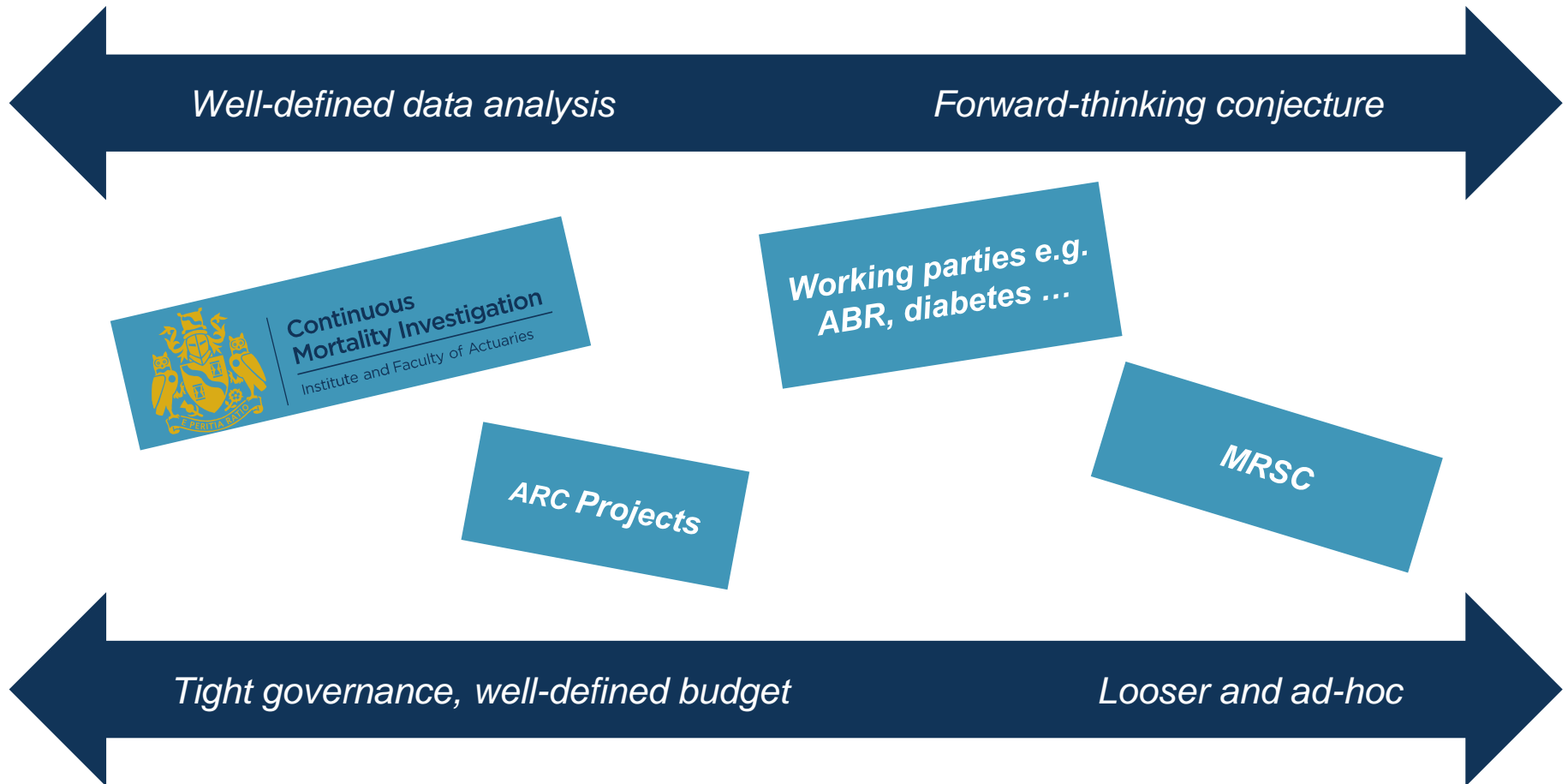
**Matthew Edwards and Hamish Wilson**

**22 June 2022**

# Introduction

- The [CMI](#)'s mission is:
  - To produce high-quality impartial analysis, standard tables and models of mortality and morbidity for long-term insurance products and pension scheme liabilities on behalf of subscribers and, in doing so, to further actuarial understanding.
- The CMI collects various data to understand how different factors are linked to mortality and morbidity.
- This talk is focused on how mortality and morbidity varies by socio-economic factors, and Index of Multiple Deprivation (IMD) in particular.

# Where is the CMI in the IFoA universe?

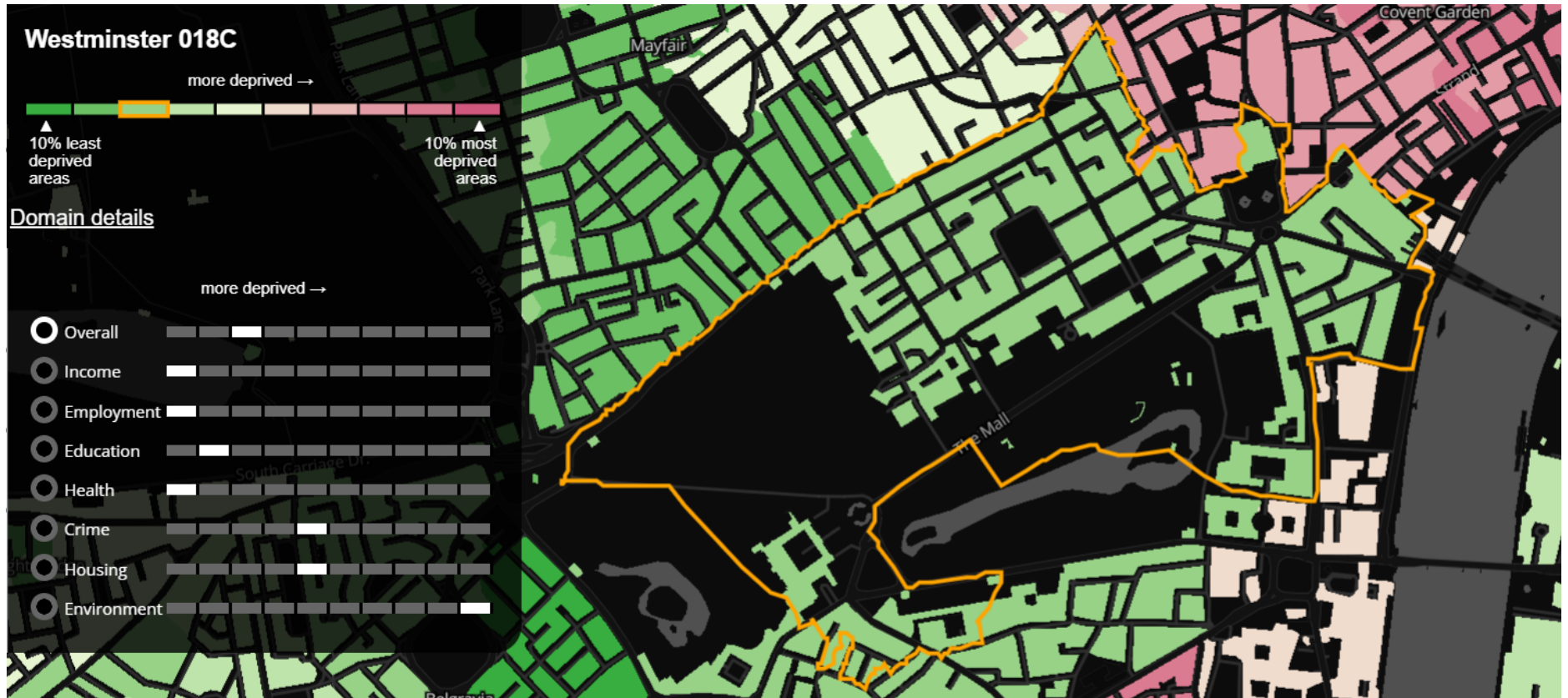


# Agenda

- What is IMD?
- Mortality and IMD in the general population
- Mortality, morbidity and IMD in CMI datasets
  - Annuities
  - Assurances
  - SAPS
- Future plans

# What is IMD?

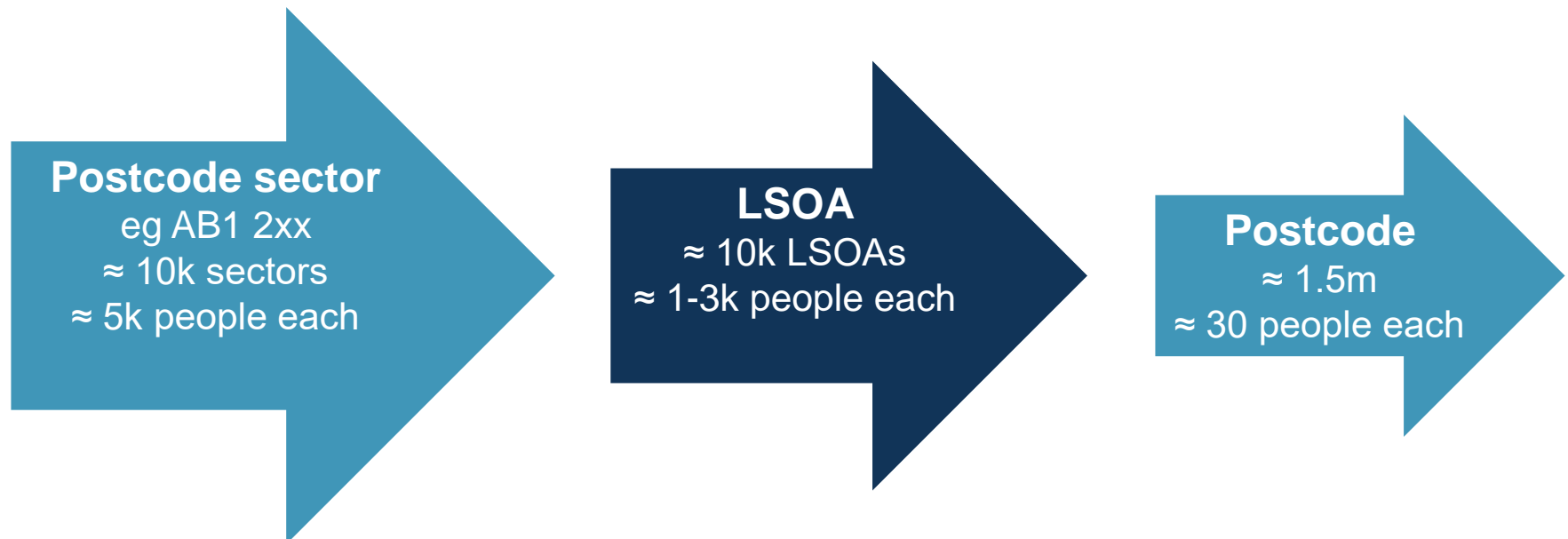
# IMD for “Westminster 018C”



Source: <https://fryford.github.io/imdmap/>

# Geographic areas

- IMD relates to geographic areas
- Produced for about 30,000 Lower Super Output Areas (LSOAs) in England
  - 1,000-3,000 people in each
  - Designed to improve the reporting of small area statistics



# English indices of deprivation 2019

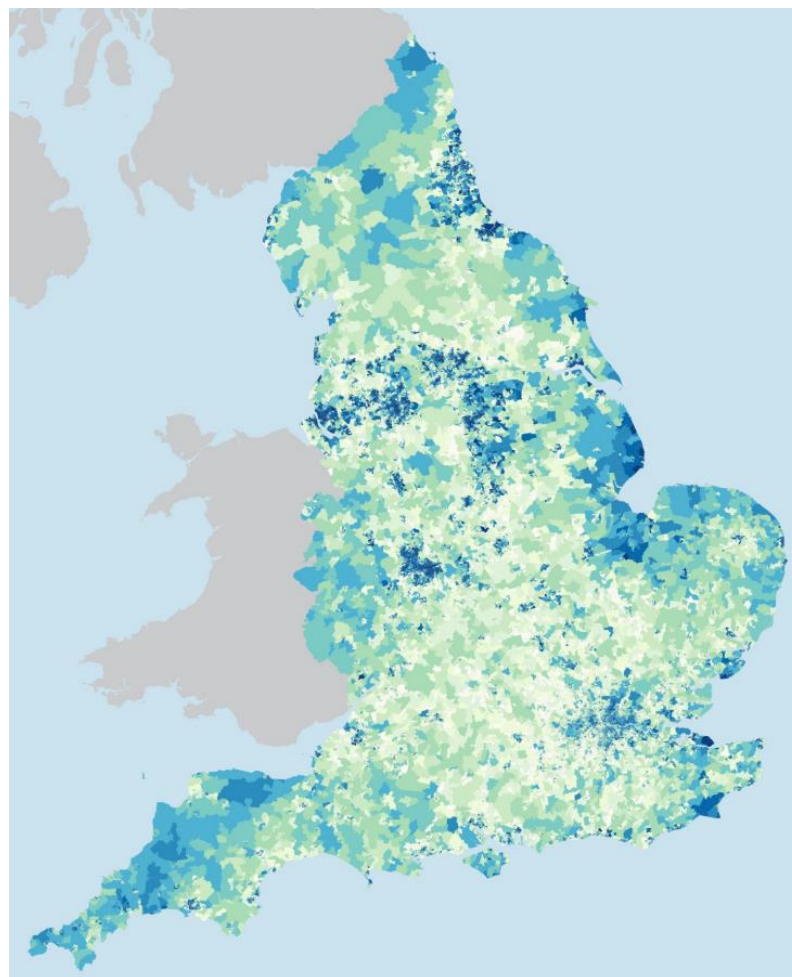
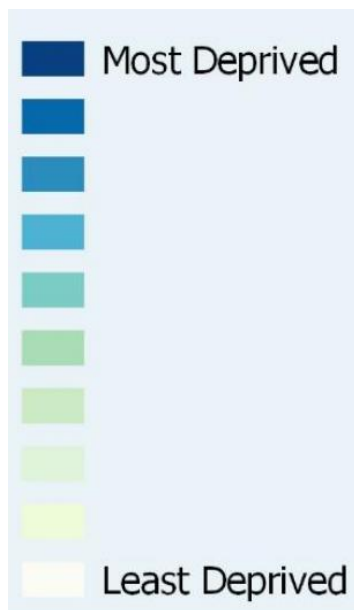
- Scores for seven “domains”:

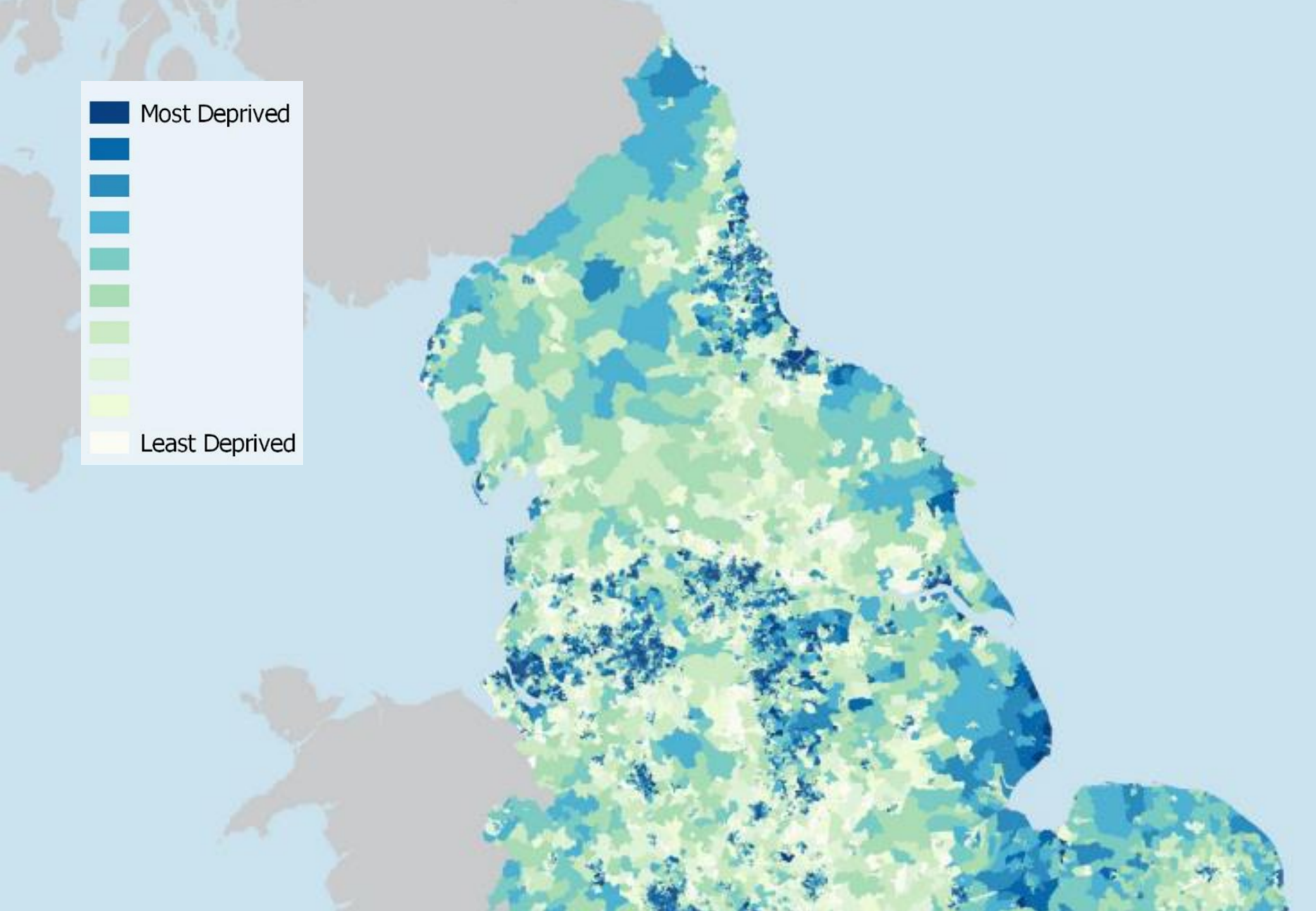


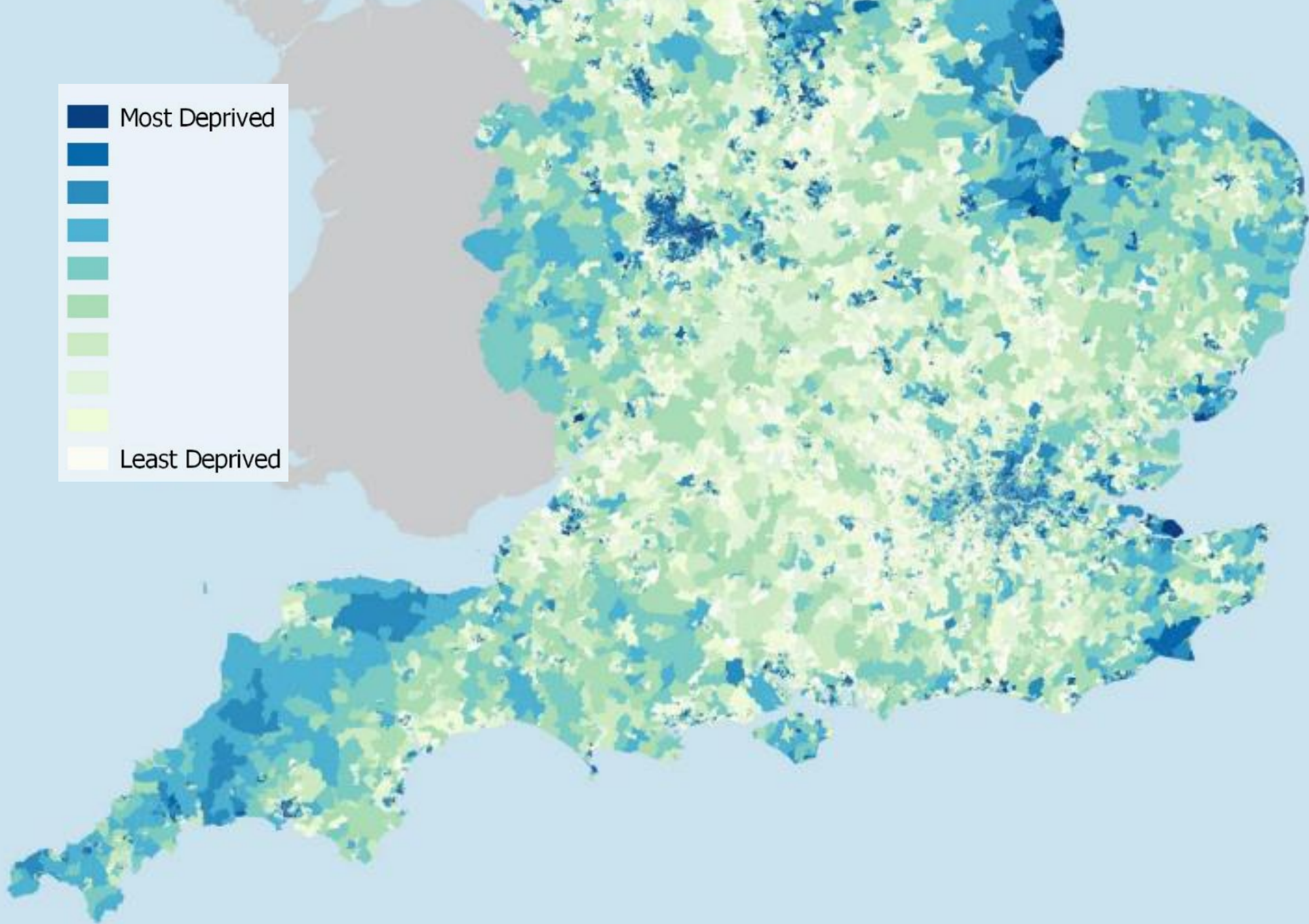
- Transformed score for each domain: best=0, median=16, worst=100
- Index of Multiple Deprivation (IMD) score is the weighted sum of these
- LSOAs assigned to deciles based on their ranked IMD scores



# IMD 2019 for England

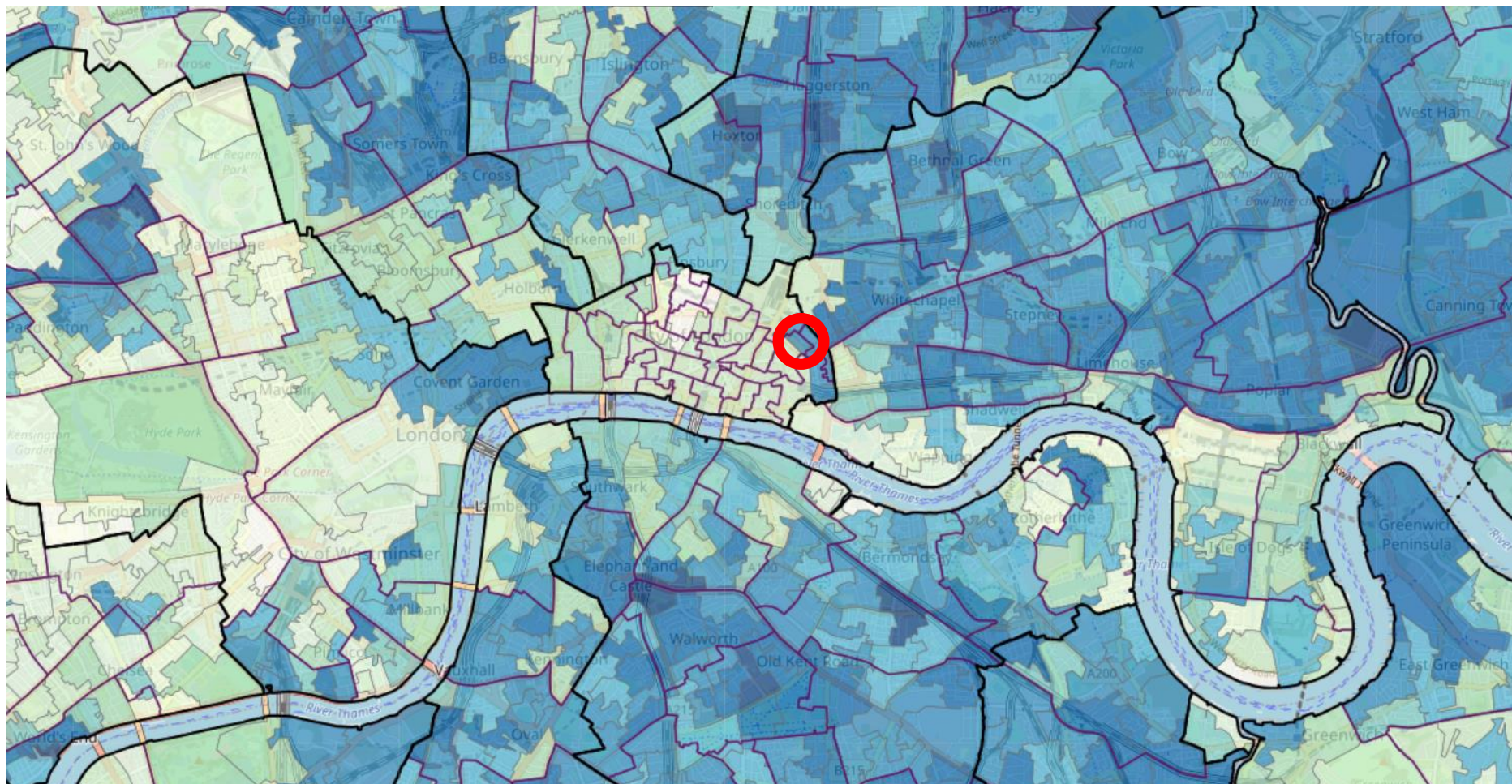








# IMD 2019 for Central London

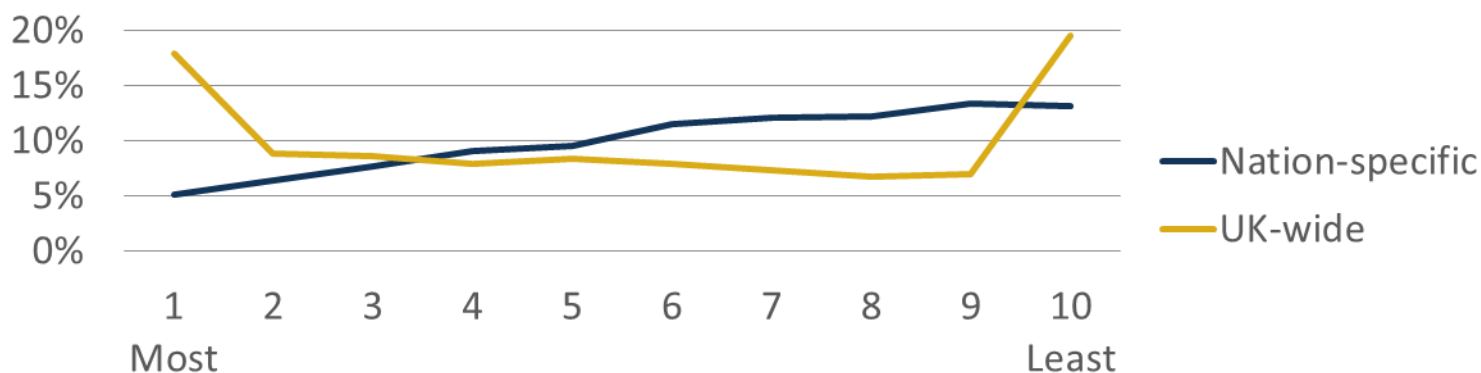


# Differences in IMD measures within the UK

- England, Scotland, Wales and Northern Ireland all use a similar approach:
  - i.e. a weighted score across multiple domains
- But there are differences between countries in:
  - area used (LSOA for England and Wales; Datazone for Scotland; SOA for Northern Ireland)
  - numbers of domains
  - indicators used within each domain
  - weights given to each domain
- So IMD is similar but not entirely comparable across countries

# UK-wide measure of IMD

- CMI also collects a “UK-wide” measure of IMD, based on research by Abel, Barclay and Payne (2016).
- However, the UK-wide measure does not appear to work well; e.g. for Wales in the Annuities dataset:
  - The nation-specific results look plausible, with more people in the less deprived deciles and a steady gradient across the deciles.
  - The UK-wide measure has large numbers in deciles 1 and 10.



# Why use IMD?

- Some firms use Acorn or Experian (and indeed different products of theirs) to segment the population to analyse mortality. CMI considered this, but:
  - Different firms preferred different measures
  - These measures are proprietary, so would require license fees
- In contrast, IMD is:
  - free – no costs involved
  - free – anyone can access it
  - used by the ONS to analyse mortality, enabling comparisons between CMI data and the general population
- However, Acorn and Experian are more granular (address or postcode) but IMD only varies by LSOA (or similar)

# CMI postcode mapping tool

- The CMI provides a [postcode mapping tool](#). This is a text file that allows a person's IMD decile and region to be determined based on their postcode.

| Postcode | Region | IMD<br>(National) | IMD<br>(UK-wide) |
|----------|--------|-------------------|------------------|
| AB1 0AA  | SC     | 10                | 9                |
| AB1 0AB  | SC     | 10                | 9                |
| AB1 0AD  | SC     | 10                | 9                |
| AB1 0AE  | SC     | 8                 | 8                |
| ...      | ...    | ...               | ...              |

- CMI analysis by IMD excludes Northern Ireland, due to licensing issues.

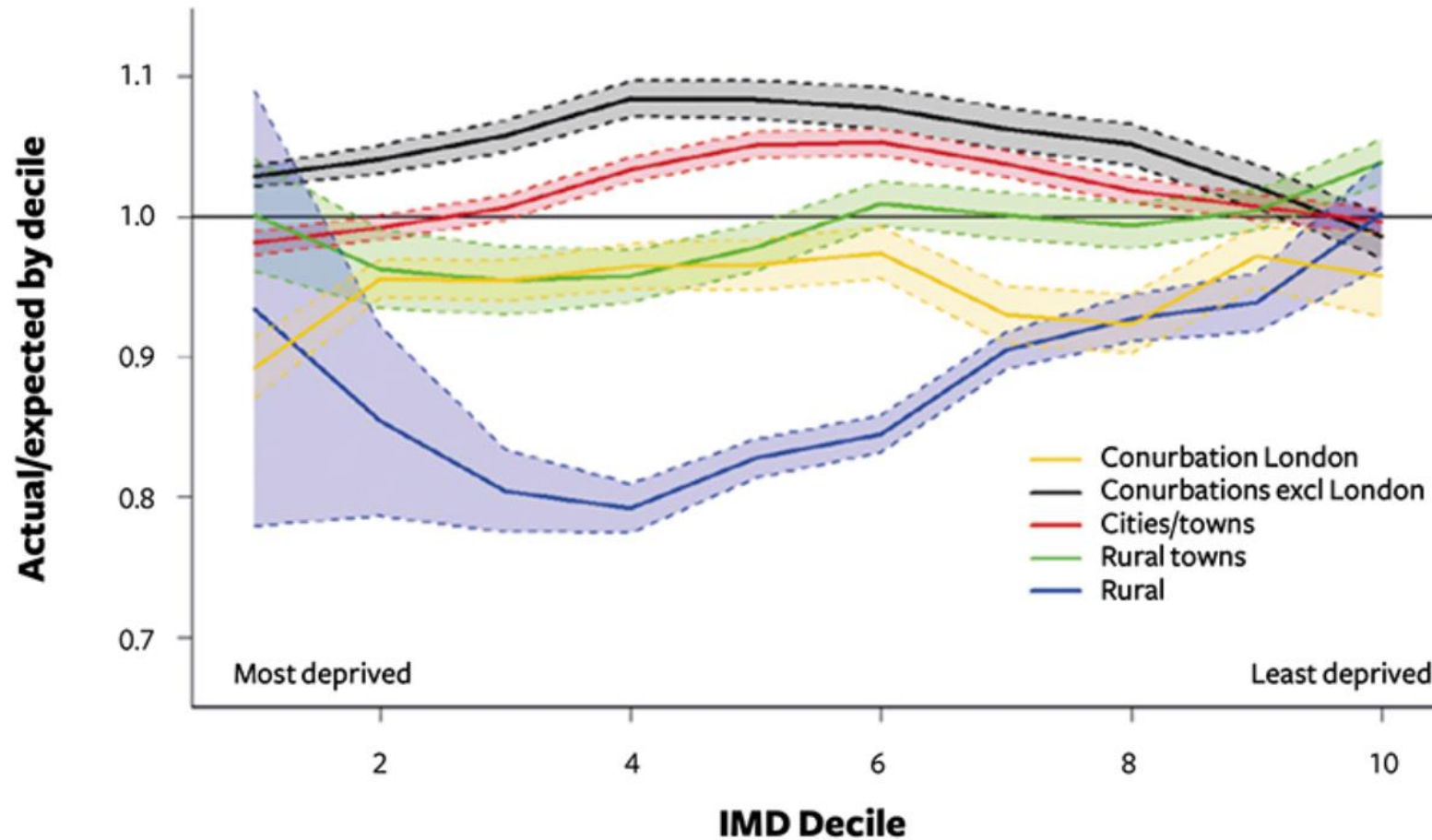


# LIFE index

- The “Longevity Index for England” (LIFE) considers a range of factors and fits a model to “explain as much as possible” of the variation observed in mortality by LSOA
- The authors note that IMD is a good starting point. But IMD is a broad measure of deprivation and was not designed with mortality specifically in mind.
- Factors used by LIFE include the domains of deprivation as well as care home population, and urban-rural class
- Open access app: <http://bit.ly/LIFEindex>

# LIFE index – urban/rural differences

**FIGURE 1:** Actual/expected deaths by IMD decile and urban-rural class, ages 70-79, with 95% confidence intervals.

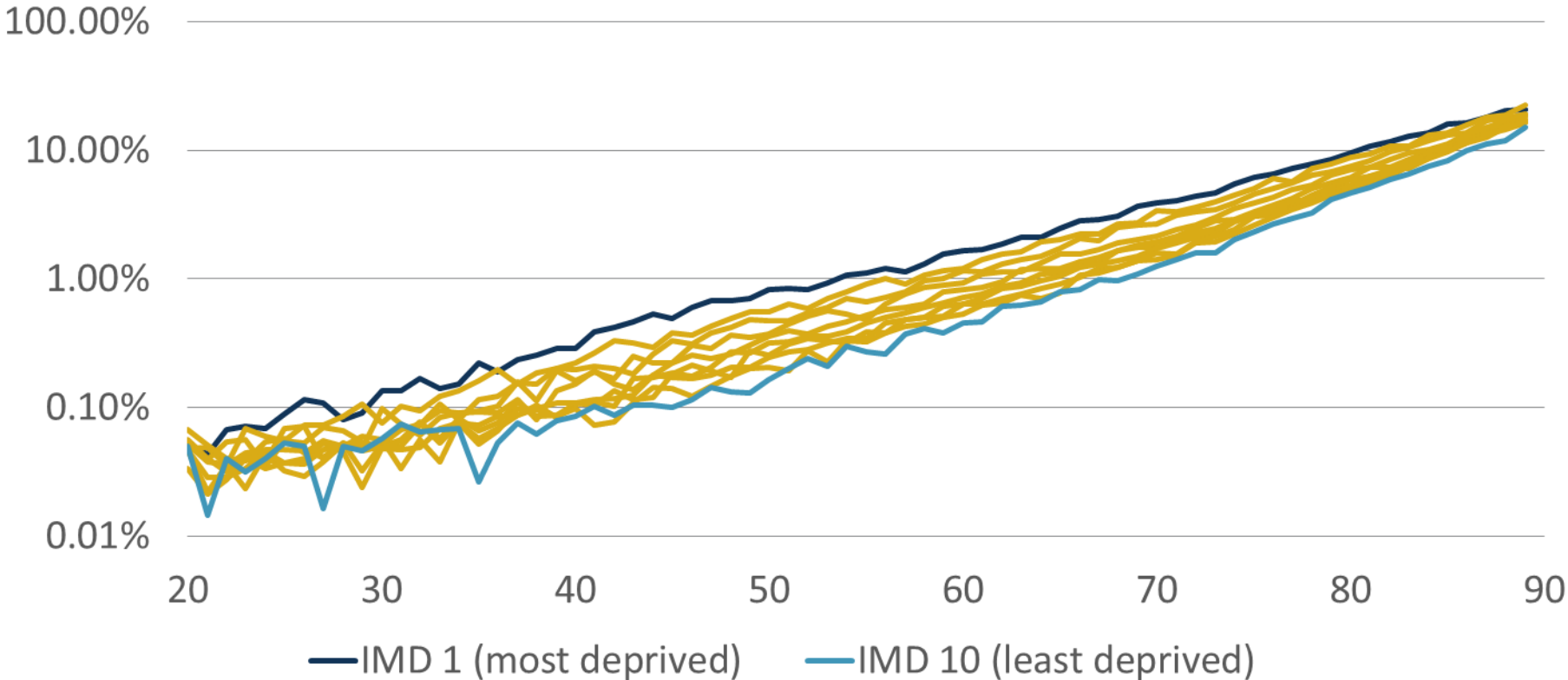


Source: <https://www.theactuary.com/2021/08/03/mapping-out-mortality>

# **IMD and mortality in the general population**

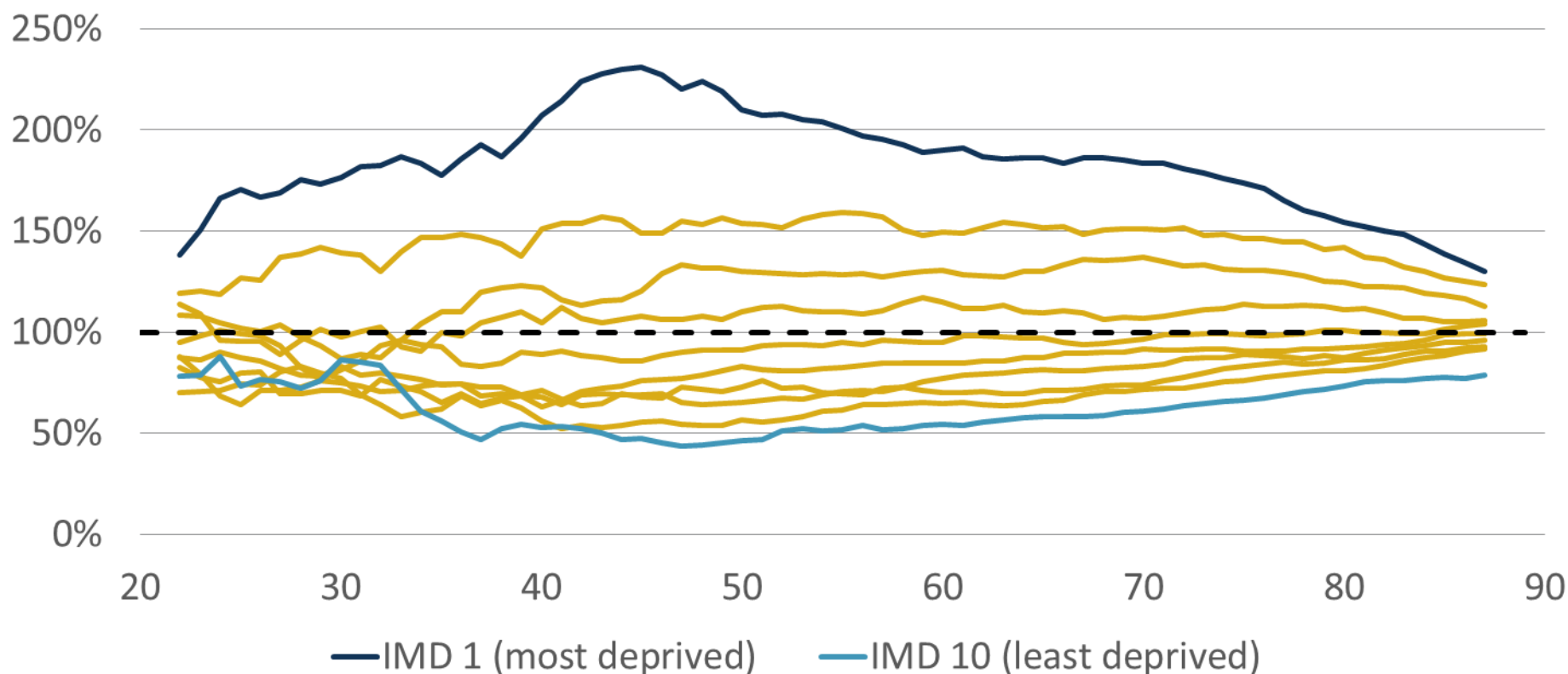
# Mortality by IMD

Crude mortality rate (log scale) for England males by IMD decile, 2020



# Mortality by IMD

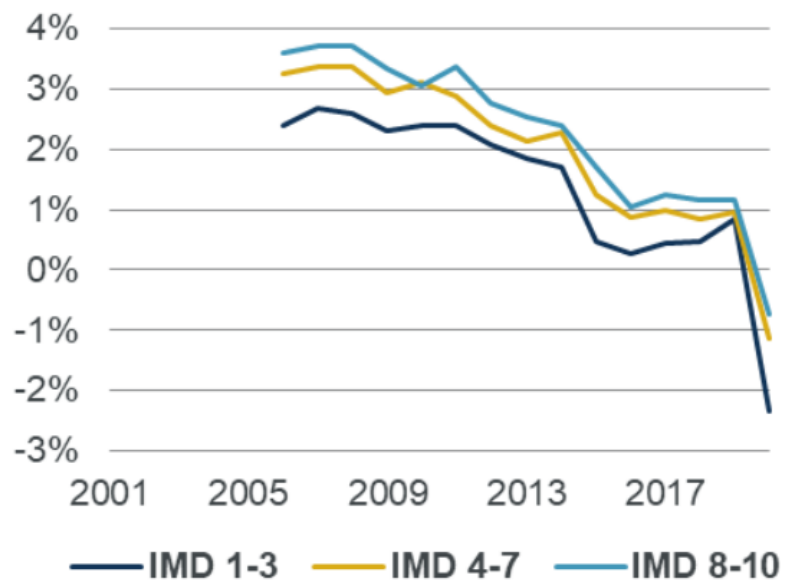
Relative mortality rate for England males by IMD decile, 2020  
(Averaged over five years of age)



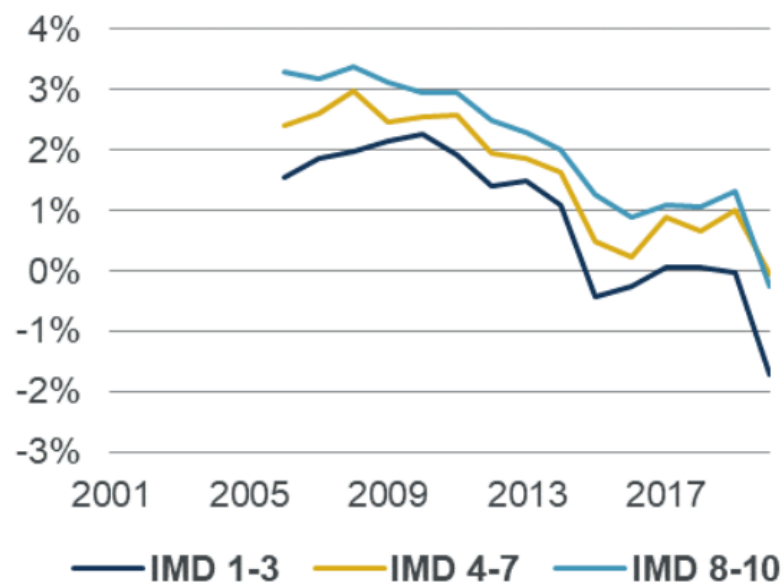
# Mortality improvements by IMD

- In recent years, mortality improvements in England & Wales have tended to be higher for less deprived groups; i.e. mortality has been diverging

**Chart 5K: Five-year average mortality improvements for ages 65-89, males**



**Chart 5L: Five-year average mortality improvements for ages 65-89, females**

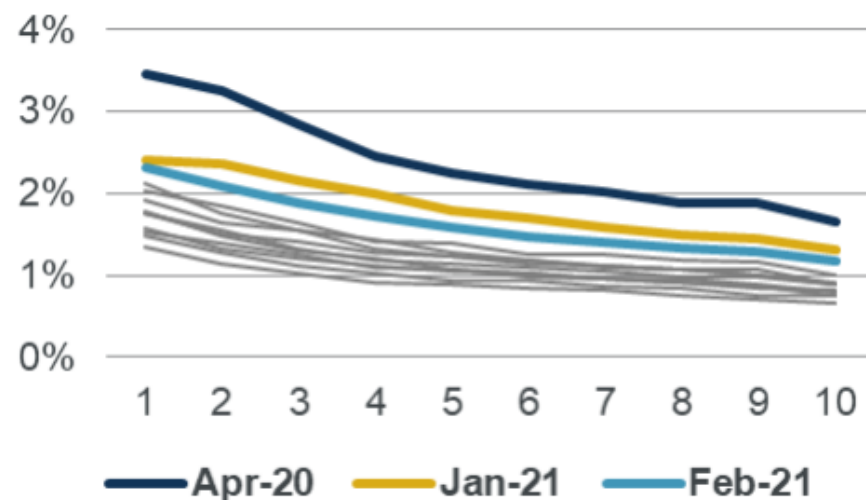


Source: [CMI Working Paper 159](#)

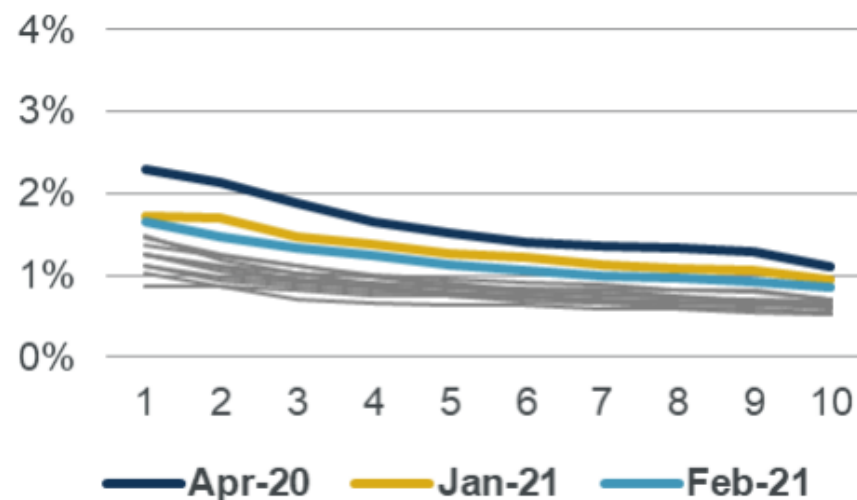
# Mortality and IMD during the pandemic

- Charts show one line per month for March 2020 to March 2021
- In **absolute** terms, mortality increased by more at the peak of the pandemic for those in more deprived areas

**Chart 10: Monthly standardised mortality rate by IMD decile – England males**



**Chart 11: Monthly standardised mortality rate by IMD decile – England females**



Source: [CMI mortality monitor for week 17 of 2021](#)

# Mortality and IMD during the pandemic

- Charts show one line per month for March 2020 to March 2021
- In **relative** terms, the increase in mortality due to the pandemic was broadly similar for all IMD deciles

Chart 12: Standardised mortality rate relative to 2018 by IMD decile – England males

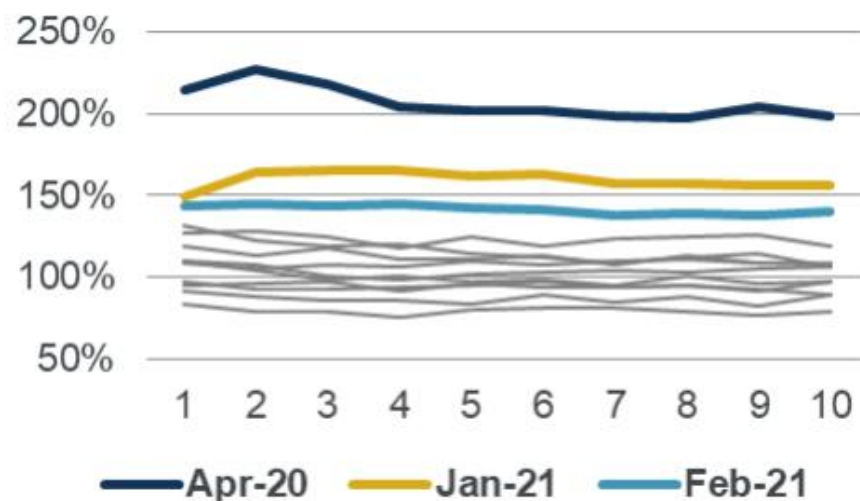
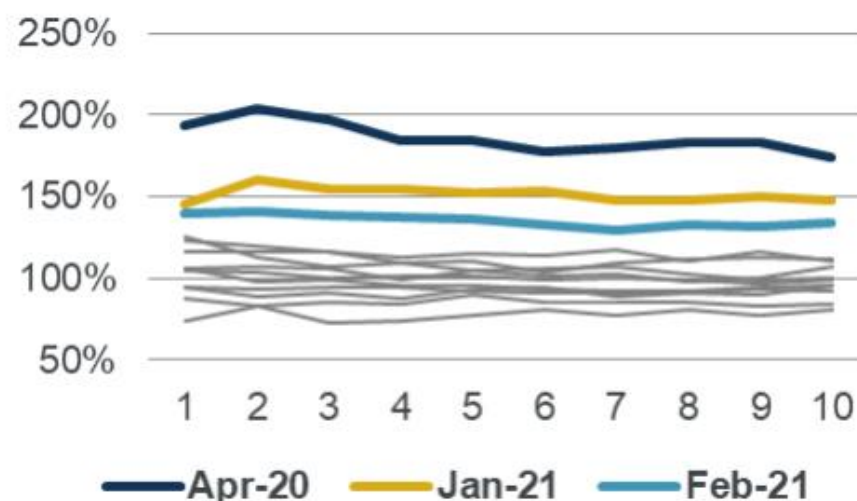


Chart 13: Standardised mortality rate relative to 2018 by IMD decile – England females



Source: [CMI mortality monitor for week 17 of 2021](#)



# **CMI analysis: Annuities dataset**

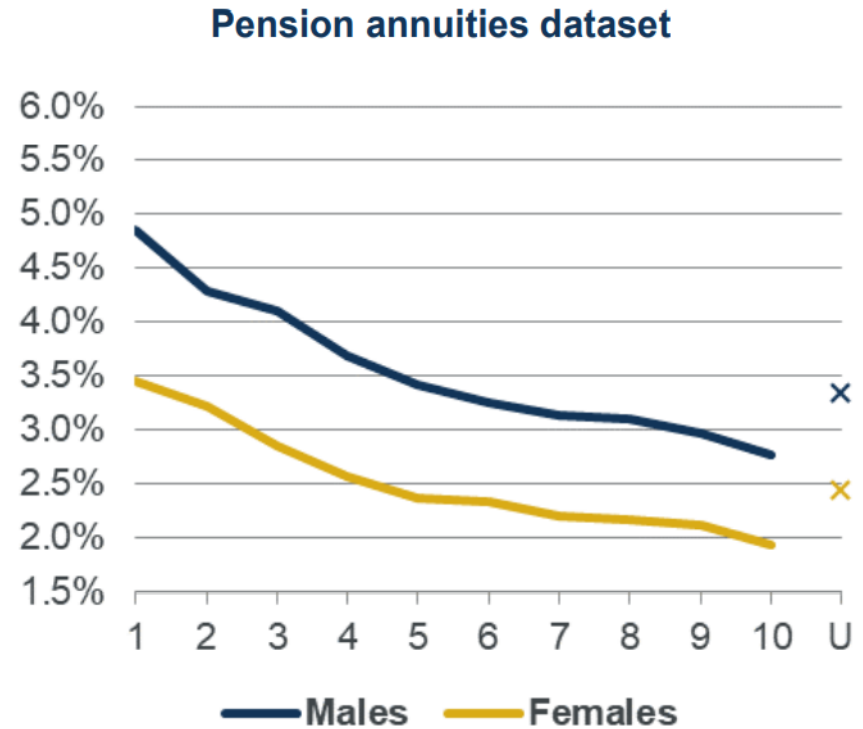
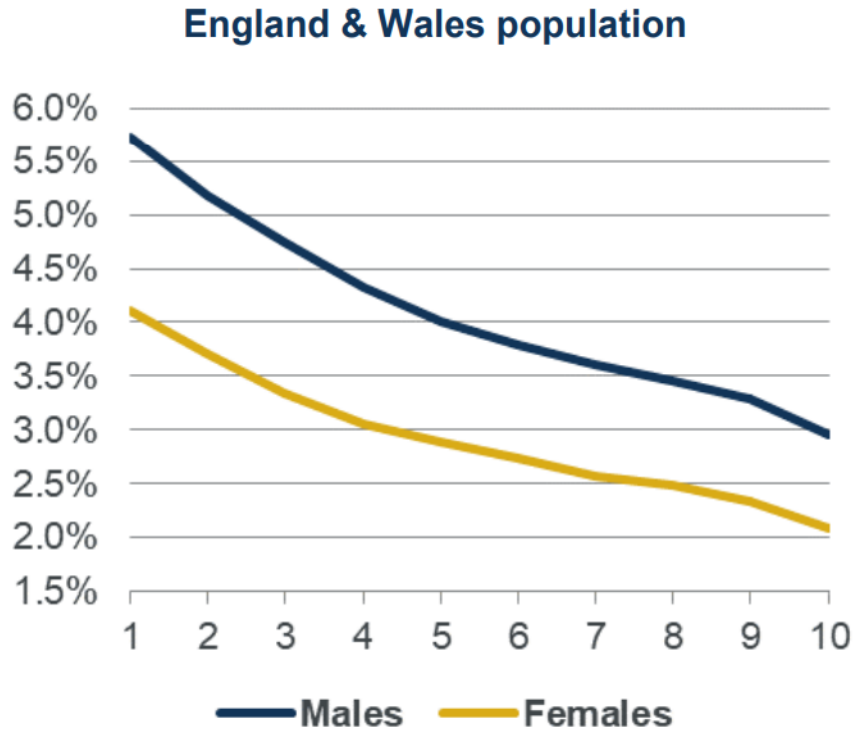
# CMI analysis – Annuities 2015-2018

- [Working Paper 138](#): Experience of pension annuities in payment with IMD fields, 2015-2018
- Data with IMD received from six offices
- Volume of data analysed is around half of the full 2015-2018 dataset

# Annuities mortality by IMD

- Mortality gradient by IMD seen for pension annuities and general population

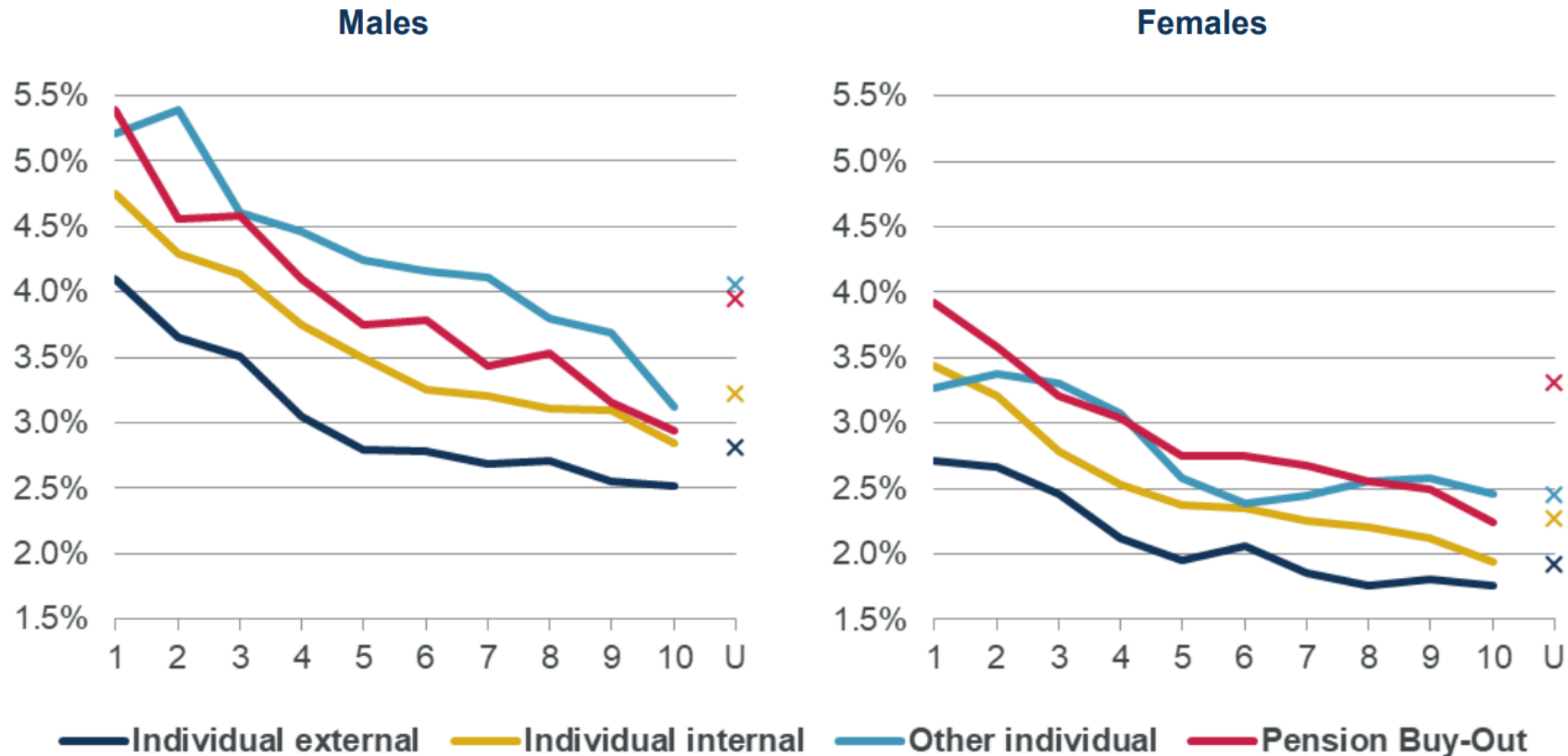
**Chart 4A: ASMRs in 2015-2018 for the population and the annuities dataset, by IMD decile**



# Annuities mortality by IMD and product

- Mortality gradient by IMD seen for all product types

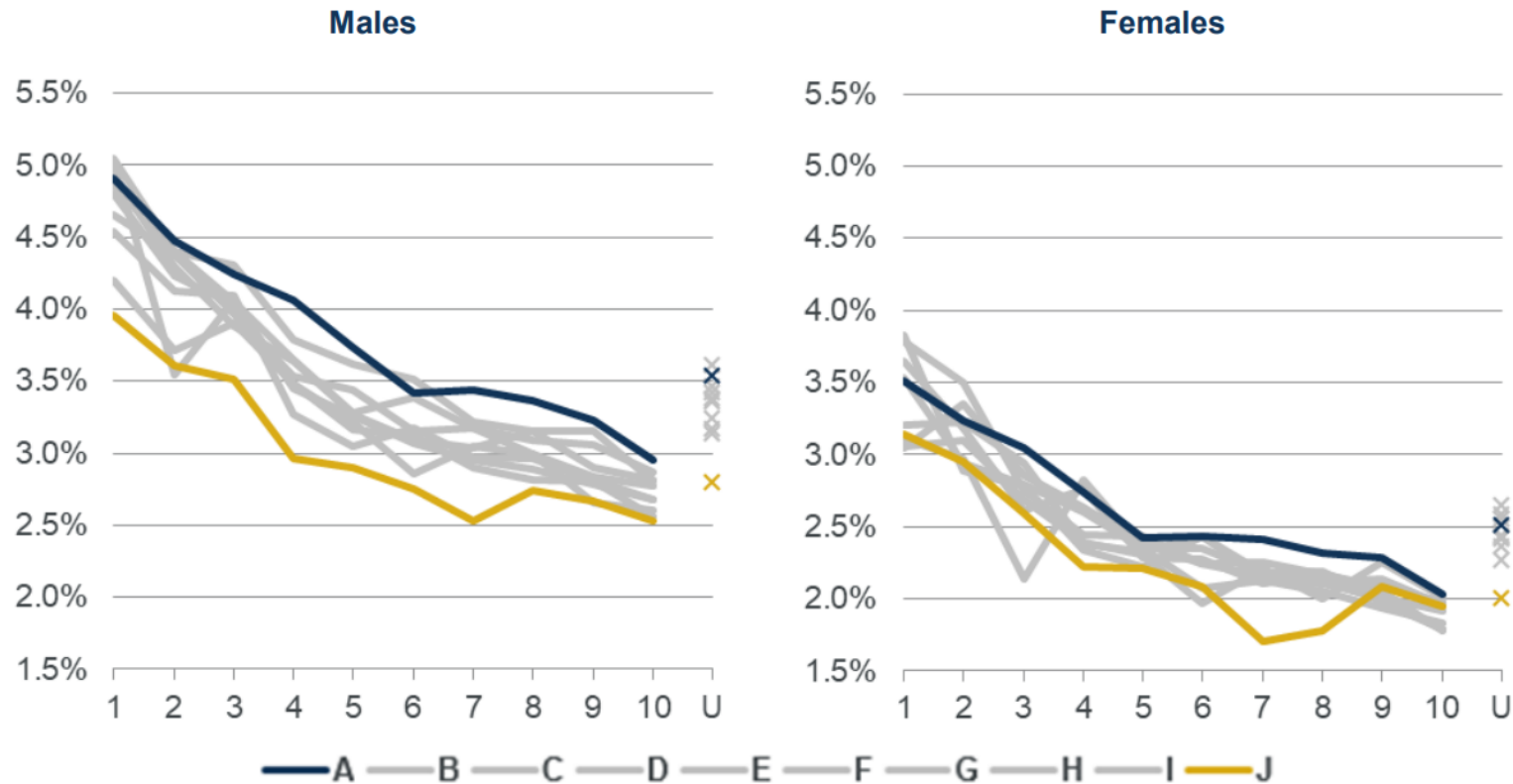
Chart 4D: ASMRs in 2015-2018 for the IMD dataset, by product type and IMD decile



# Annuities mortality by IMD and amount

- Mortality gradient by IMD seen for all amount bands

Chart 4F: ASMRs in 2015-2018 for the IMD dataset, by amount band and IMD decile<sup>10</sup>



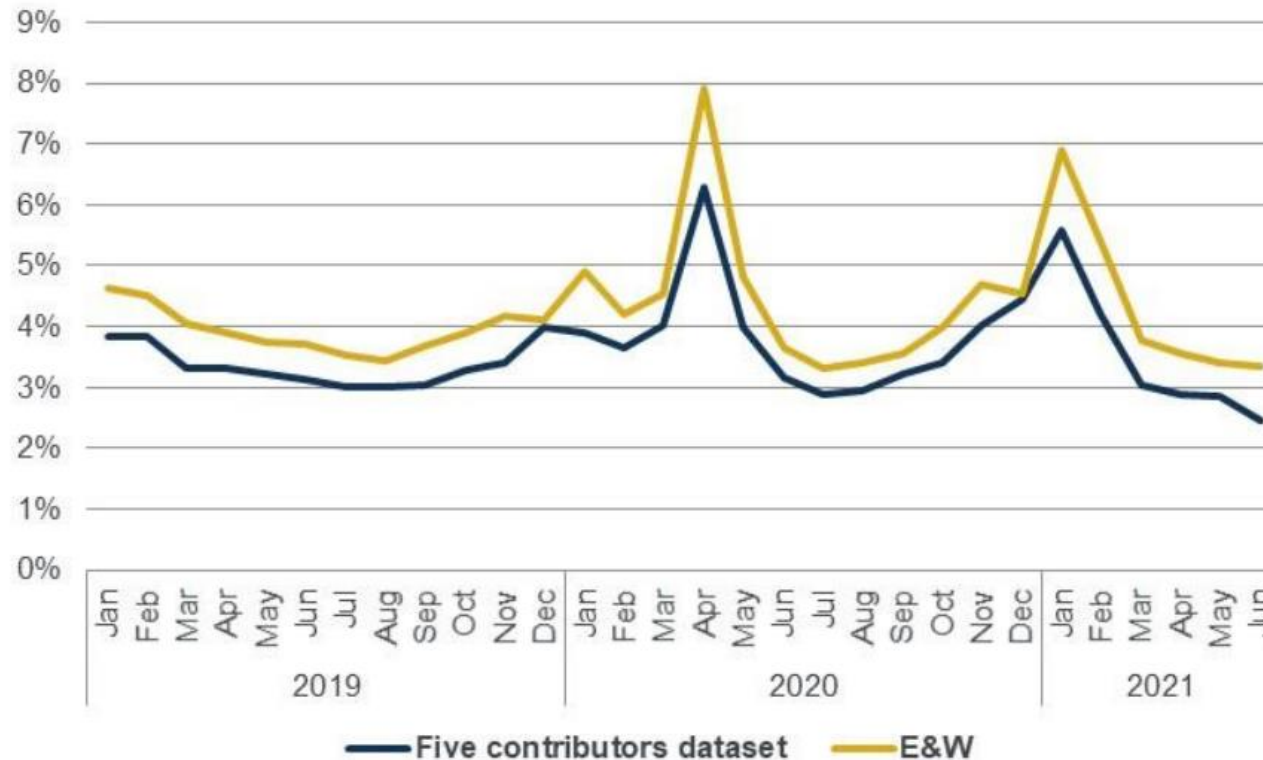
# CMI analysis – Annuities in the pandemic

- [Working Paper 161](#): All offices experience of pension annuities in payment in 2020 plus indicative analysis of experience to mid-2021
- Published in March 2022 – assumes late-reported deaths
- We show:
  - All-IMD mortality to mid-2021
  - By-IMD mortality to mid-2020
- Not enough data to show IMD to mid-2021
- Each analysis uses data from five offices – but not the same in each case

# Annuities mortality in the pandemic

- Similar pattern to mortality seen for annuities and the general population

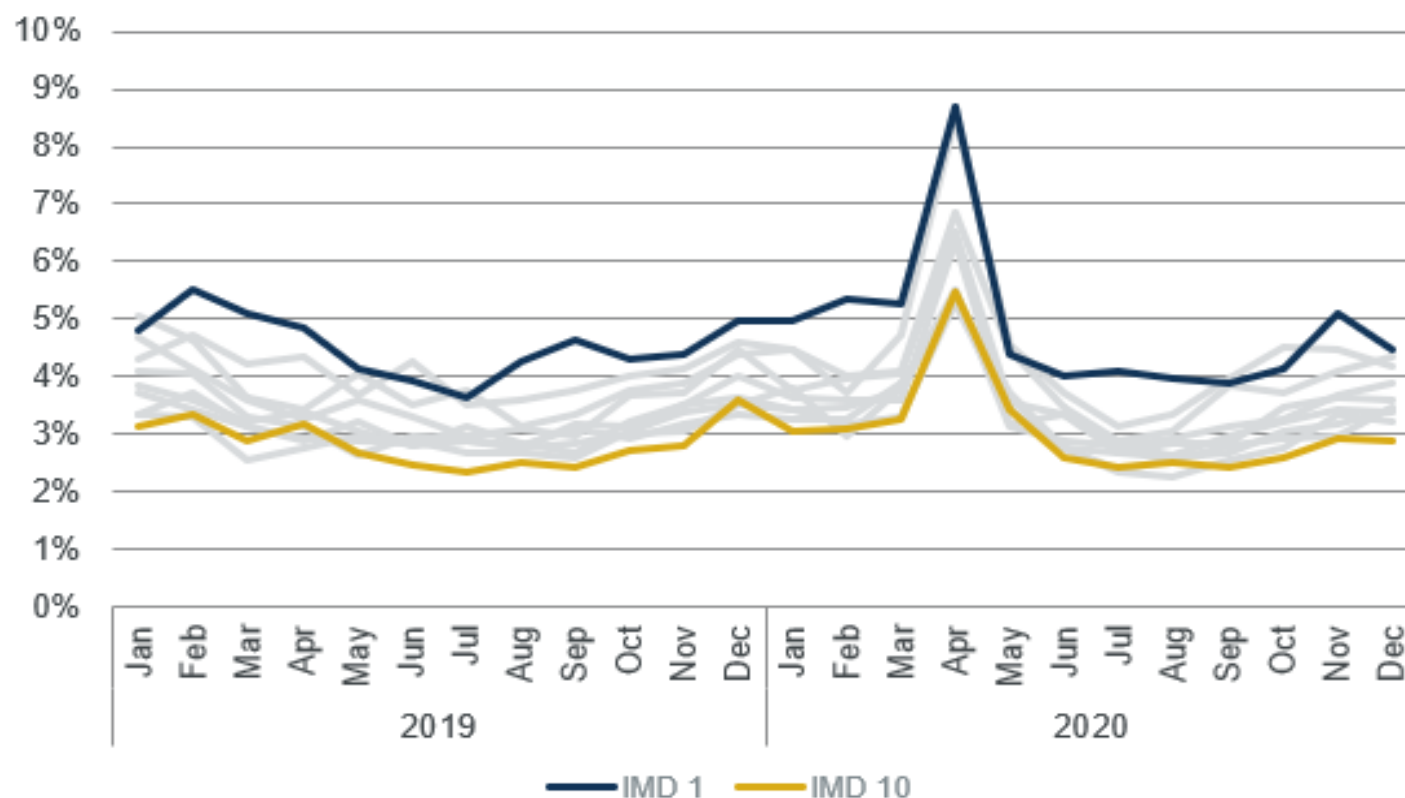
**Chart 7H: SMRs by month in 2019, 2020 and 2021 for the E&W population and the pension annuity dataset – five contributors dataset**



# Annuities mortality by IMD in the pandemic

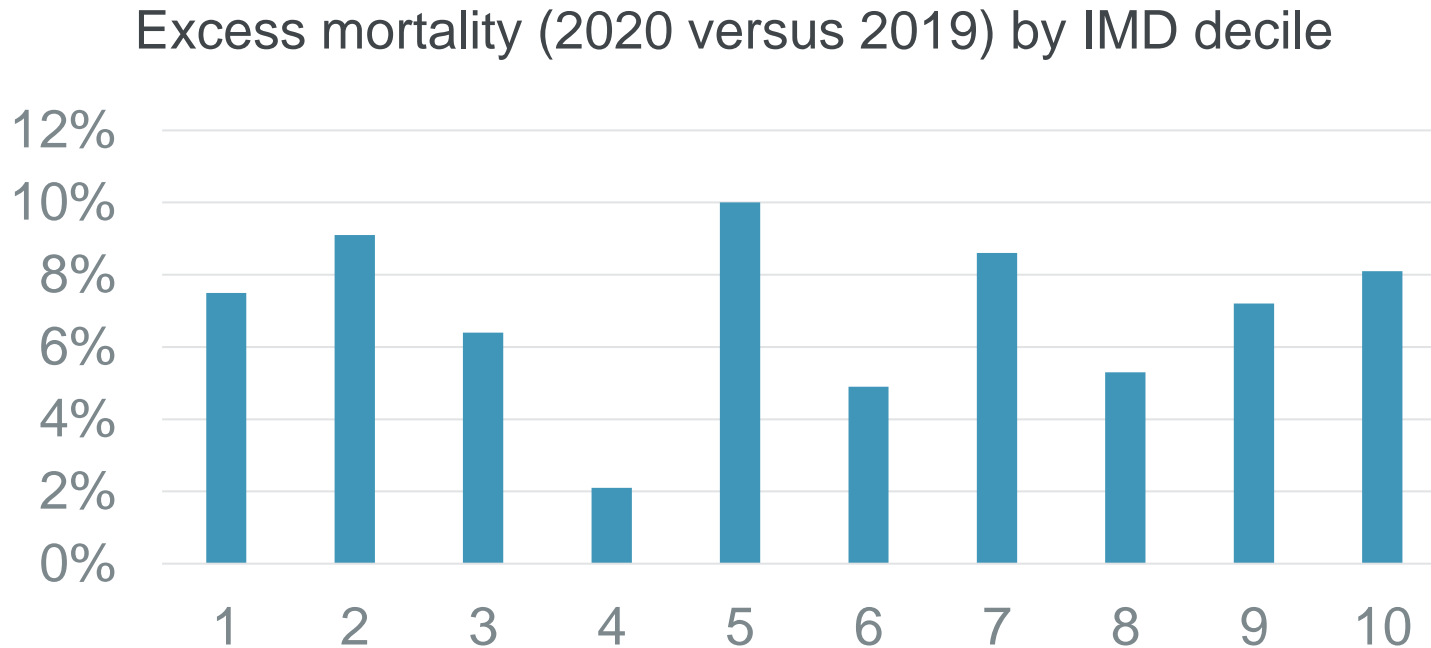
- Similar pattern seen for all IMD deciles

Chart 7Q: SMRs by month in 2019 and 2020 for the pension annuities dataset by IMD – IMD dataset





# Annuities mortality by IMD in the pandemic



- No obvious pattern by IMD
- Suggests all deciles affected broadly similarly in relative terms – as seen for the general population

# **CMI analysis: Assurances dataset**

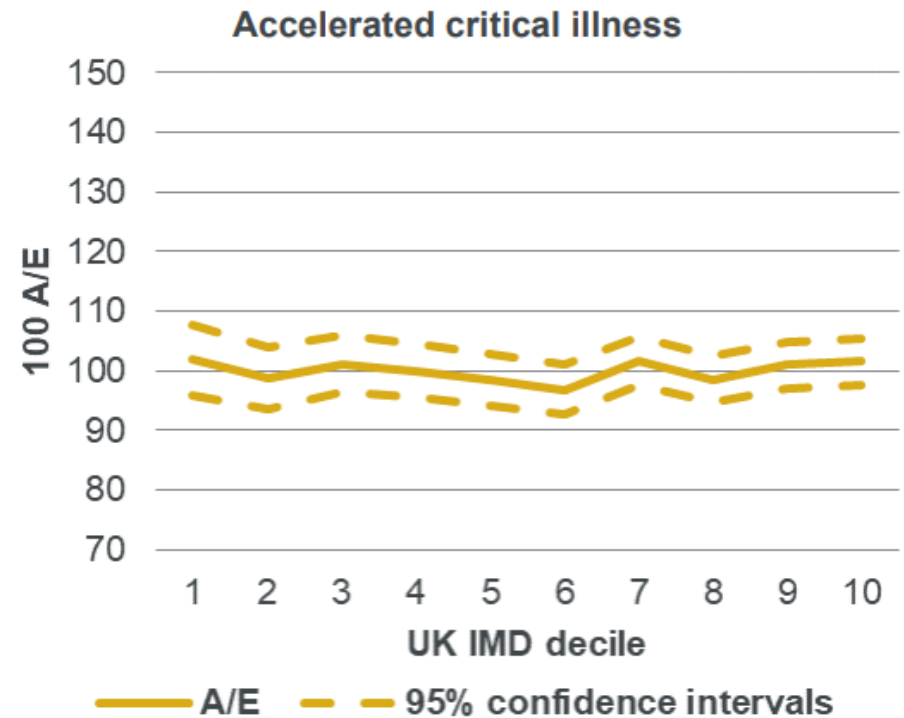
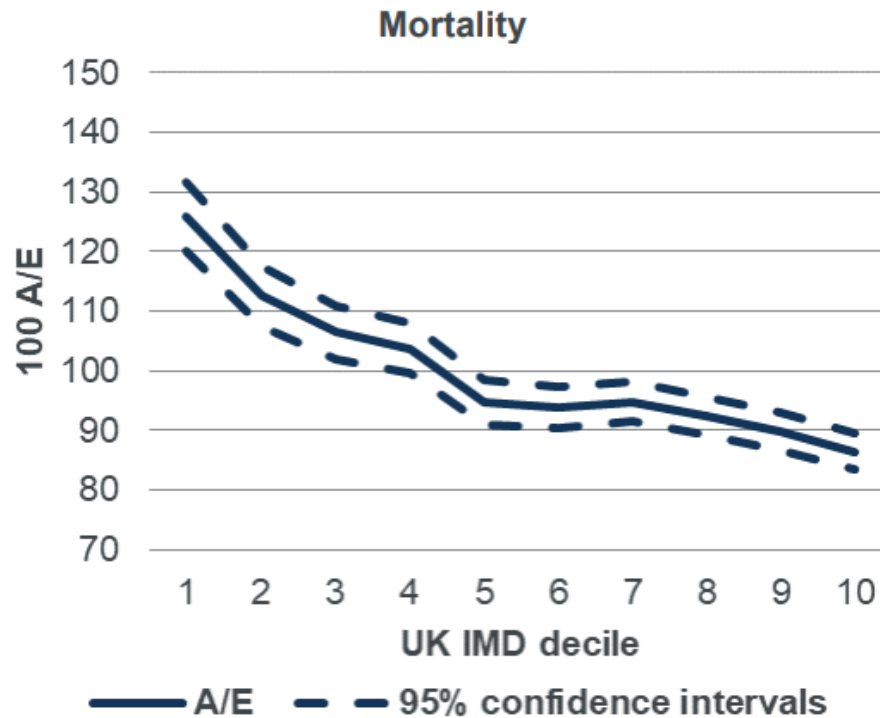
# CMI analysis – Assurances 2016-2020

- [Working Paper 162](#): “All offices” experience of term assurances in 2020
- IMD data received from a subset of offices.
- Volume of data in the IMD analysis:
  - Mortality – around 75% of the total dataset
  - Accelerated critical illness – around 60% of the total dataset

# Assurances experience by IMD – 2016-2019

- IMD gradient for mortality
- No IMD gradient for accelerated critical illness

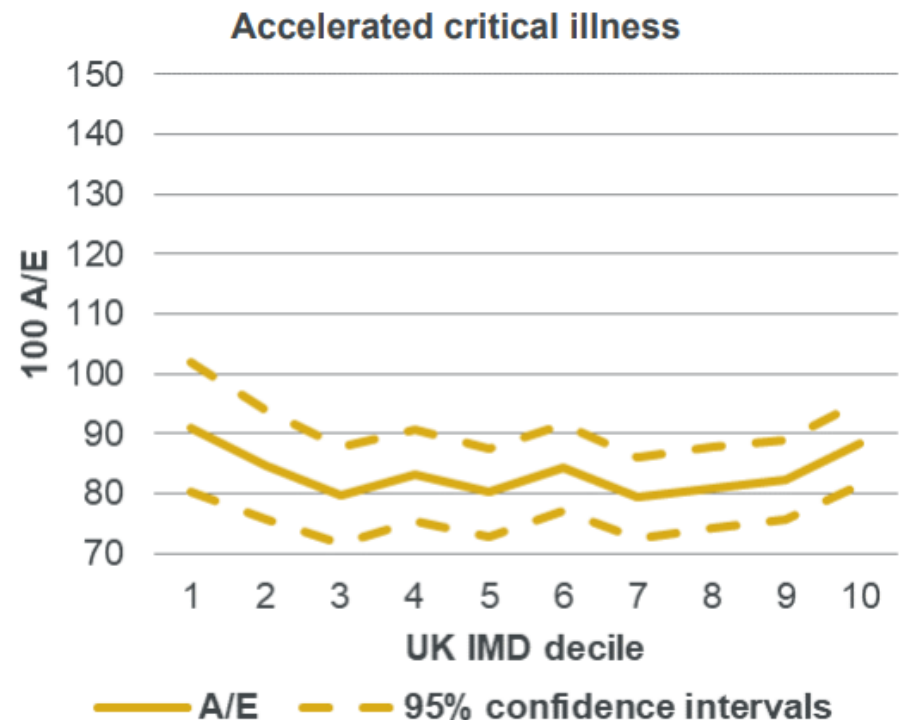
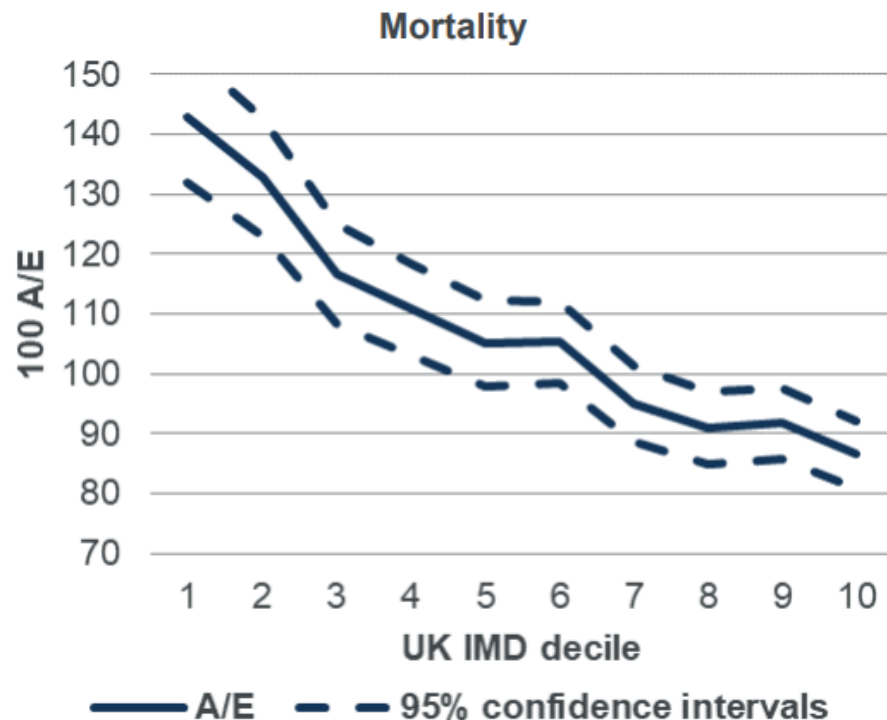
Chart A5C: 100 x Actual / Expected values by UK IMD for 2016-2019



# Assurances experience by IMD – 2020

- Heavier mortality than 2016-2019, and stronger IMD gradient
- ACI experience lower than 2016-2019, and a hint of a U-shape by IMD?

Chart A5D: 100 x Actual / Expected values by UK IMD for 2020



# **CMI analysis: Self-administered pension scheme (SAPS) dataset**

# CMI SAPS – dataset

- [Working Paper 146](#): “Mortality experience of pensioners by Index of Multiple Deprivation 2012-2019”
- Compared to the full 2012-2019 dataset:
  - Excluded submissions without IMD
  - Excluded submissions where IMD coverage was low – may be biased
  - Excluded records with missing or overseas postcodes
- WP146 exposure compared to the full 2012-2019 dataset:
  - 33% overall
  - >70% in later years, so coverage should be better for future analyses
  - Split by sector (private, local government, other public sector) is quite different to the full SAPS dataset

# SAPS variation by IMD decile

Chart 4E: Distribution of lives-weighted exposure by IMD decile and pensioner type

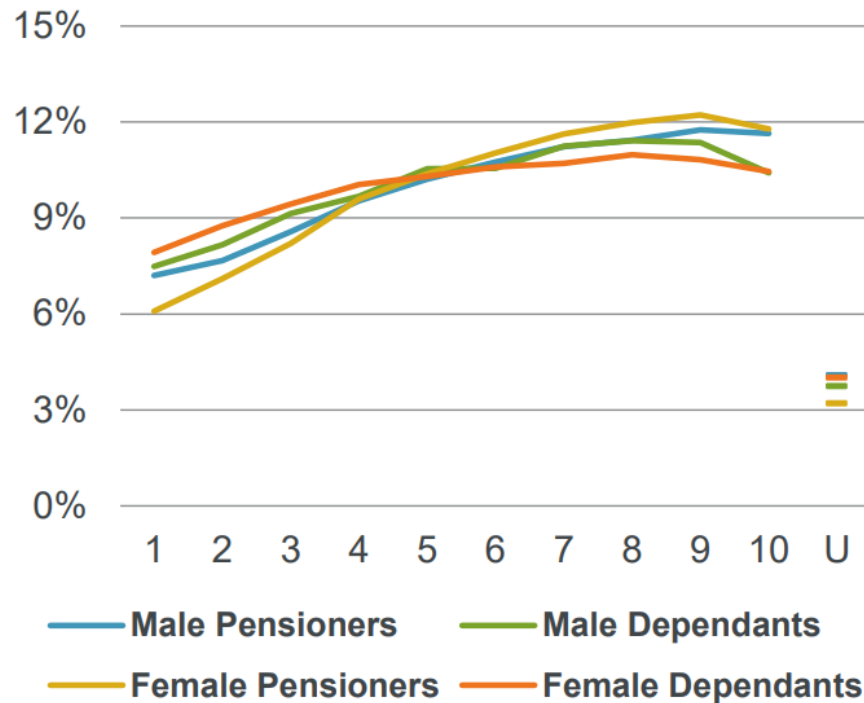


Chart 4F: ASMR by IMD decile and pensioner type

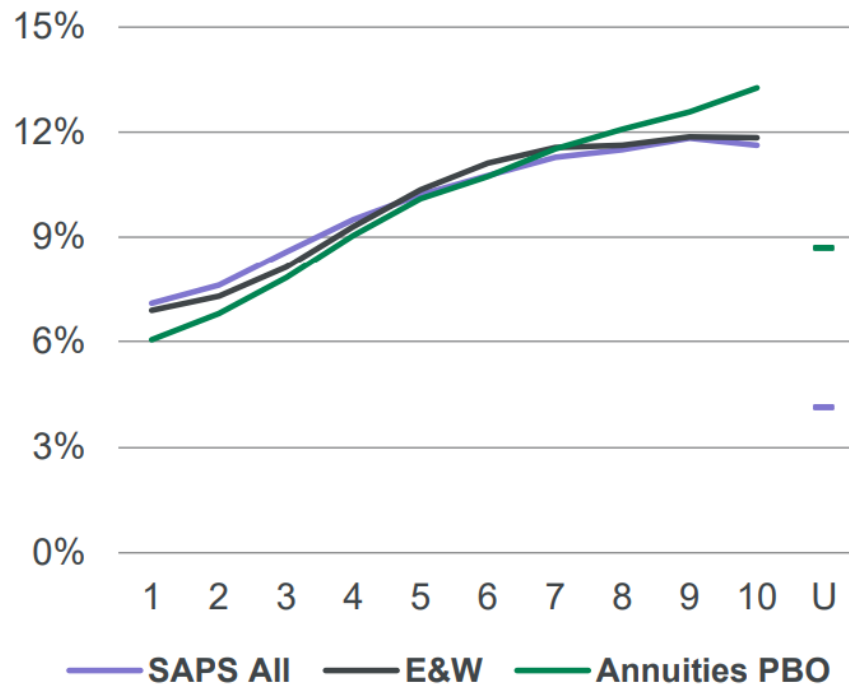


- More data in less-deprived deciles
- Gradient to mortality by IMD decile

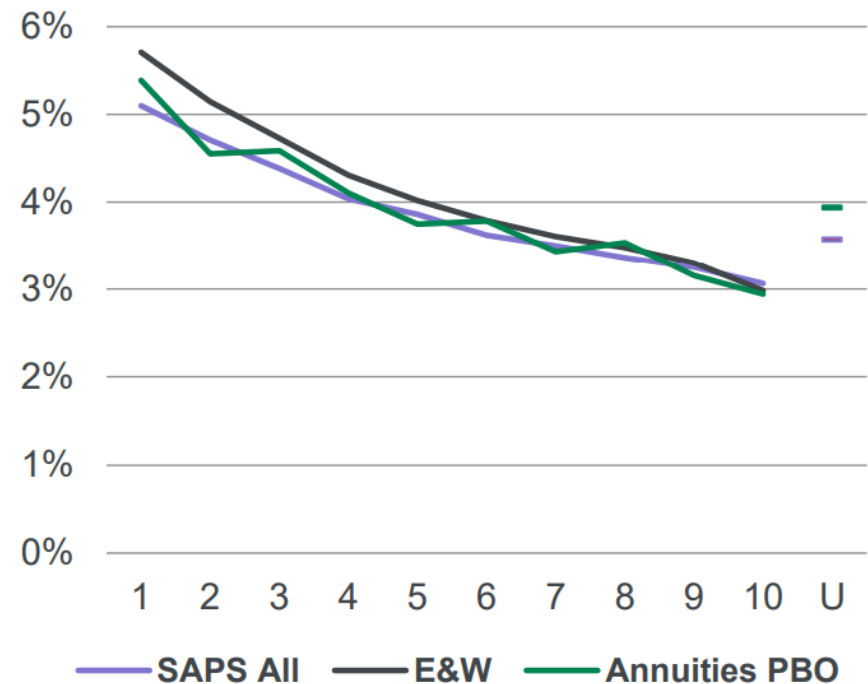


# SAPS versus other datasets

**Chart 4I: Distribution of lives-weighted exposure by IMD decile and population (male)**



**Chart 4J: ASMR by IMD decile and population (male)**



- Similar shapes by IMD for SAPS, general population and pension buyout
- Lower mortality for SAPS than population data at more deprived deciles

# SAPS by amounts and IMD – males

Table 6.2: Relative ASMR by amount band and IMD decile (male Pensioners)

|       | £300 -<br>£2,500 | £2,500 -<br>£5,000 | £5,000 -<br>£8,500 | £8,500 -<br>£13,000 | £13,000 -<br>£20,000 | £20,000 -<br>£40,000 | £40,000+ | Total |
|-------|------------------|--------------------|--------------------|---------------------|----------------------|----------------------|----------|-------|
| 1     | 127%             | 133%               | 136%               | 137%                | 127%                 | 122%                 |          | 131%  |
| 2     | 125%             | 120%               | 123%               | 119%                | 125%                 | 112%                 |          | 121%  |
| 3     | 115%             | 117%               | 119%               | 110%                | 110%                 | 104%                 | 80%      | 113%  |
| 4     | 107%             | 111%               | 109%               | 107%                | 100%                 | 93%                  | 88%      | 106%  |
| 5     | 106%             | 108%               | 106%               | 108%                | 95%                  | 89%                  | 80%      | 103%  |
| 6     | 95%              | 100%               | 100%               | 100%                | 94%                  | 89%                  | 78%      | 96%   |
| 7     | 97%              | 98%                | 98%                | 97%                 | 95%                  | 82%                  | 72%      | 94%   |
| 8     | 91%              | 92%                | 95%                | 96%                 | 90%                  | 80%                  | 77%      | 89%   |
| 9     | 92%              | 90%                | 96%                | 91%                 | 85%                  | 78%                  | 74%      | 87%   |
| 10    | 89%              | 88%                | 91%                | 87%                 | 81%                  | 74%                  | 76%      | 83%   |
| Total | 104%             | 105%               | 106%               | 104%                | 97%                  | 85%                  | 76%      | 100%  |
| U     | 90%              | 95%                | 91%                | 99%                 | 92%                  | 93%                  | 107%     | 93%   |

- Males: greater variation in mortality by IMD than pension amount

# SAPS by amounts and IMD – females

Table 6.4: Relative ASMR by amount band and IMD decile (female Pensioners)

|       | £0 -<br>£1,000 | £1,000 -<br>£2,000 | £2,000 -<br>£4,000 | £4,000 -<br>£8,000 | £8,000 -<br>£16,000 | £16,000+ | Total |
|-------|----------------|--------------------|--------------------|--------------------|---------------------|----------|-------|
| 1     | 122%           | 114%               | 121%               | 137%               | 139%                | 136%     | 126%  |
| 2     | 114%           | 111%               | 115%               | 123%               | 120%                | 125%     | 117%  |
| 3     | 109%           | 110%               | 110%               | 111%               | 112%                | 116%     | 110%  |
| 4     | 100%           | 103%               | 103%               | 107%               | 106%                | 106%     | 104%  |
| 5     | 99%            | 92%                | 99%                | 101%               | 102%                | 103%     | 99%   |
| 6     | 98%            | 101%               | 102%               | 97%                | 95%                 | 108%     | 99%   |
| 7     | 96%            | 99%                | 98%                | 96%                | 95%                 | 95%      | 97%   |
| 8     | 91%            | 99%                | 95%                | 92%                | 89%                 | 99%      | 93%   |
| 9     | 98%            | 90%                | 85%                | 89%                | 95%                 | 91%      | 91%   |
| 10    | 86%            | 83%                | 86%                | 85%                | 85%                 | 90%      | 85%   |
| Total | 100%           | 99%                | 100%               | 101%               | 100%                | 101%     | 100%  |
| U     | 104%           | 98%                | 97%                | 94%                | 96%                 | 142%     | 101%  |

- Females: little variation in mortality by amount once we allow for IMD

# Future plans

# Future plans

- Encourage greater submission of IMD data
- Extend analysis to CMI Income Protection dataset
- Consider a better UK-wide measure of IMD
- Consider alternative measures:
  - LIFE index
  - More granular data (e.g. LSOA) subject to data protection concerns
- Consider the use of IMD in graduations, including the forthcoming SAPS “S4” Series tables (consult on methods in early 2023):
  - Interaction between IMD, amount and sector
  - Balance between accuracy, complexity, and practicality



# Questions



# Comments

The views expressed in this presentation are those of the presenter.



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