Modelling Changes in Small Area Disability Free Life Expectancy: Trends in London Wards between 2001 and 2011.

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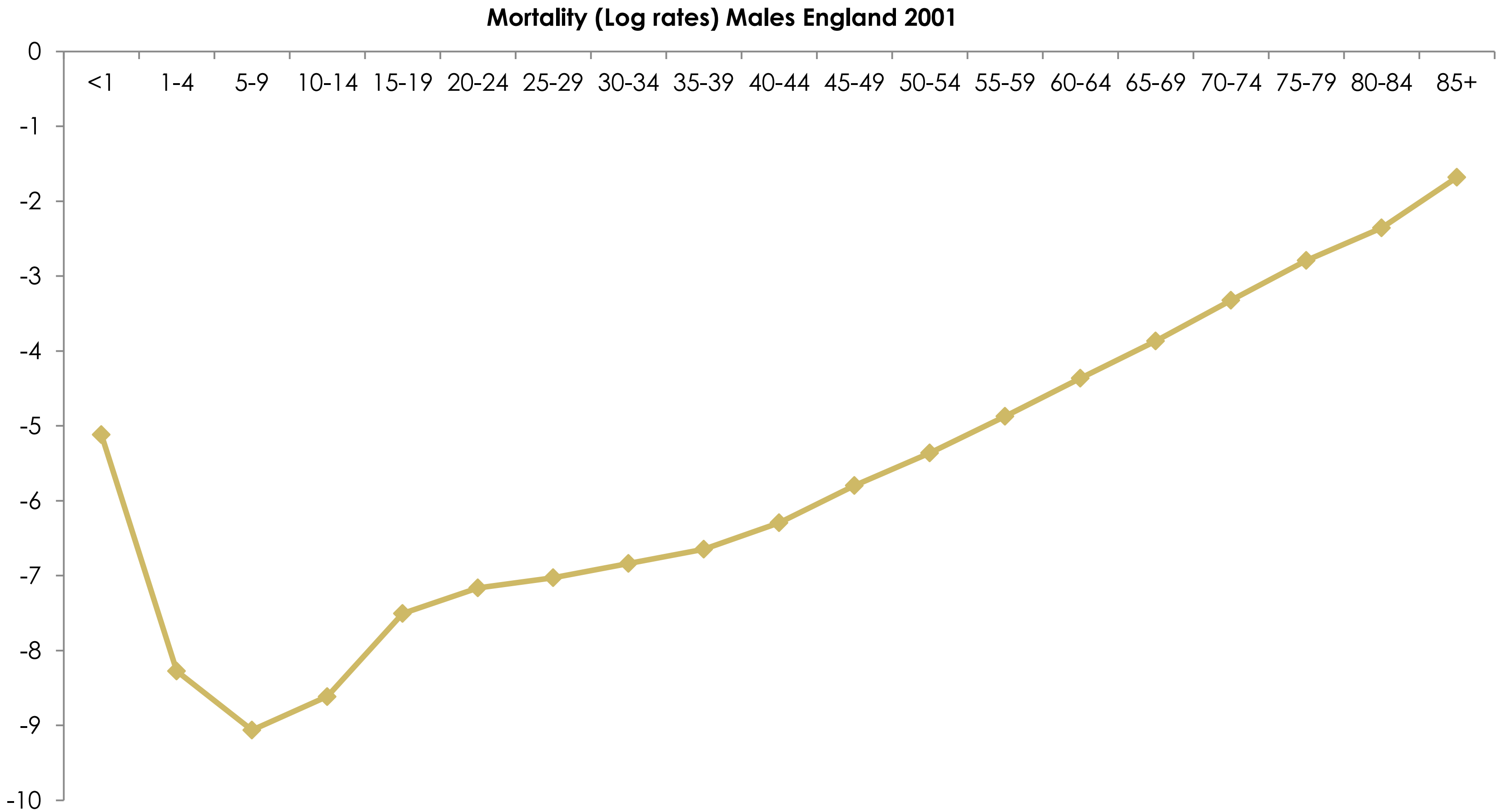
Background

- **Analysis of geographic (regional and small-area) trends in disability free life expectancy (DFLE) and years lived in disability (YLD=TLE-DFLE) important for assessing inequity in disease burdens**
- **Existing analyses of trends in healthy (or disability free) life expectancy mostly for geographic aggregates: nations or broad regions**
- **Evidence regarding morbidity compression or expansion based on spatially disaggregated studies is lacking.**

Small Area Focus

- **Use borrowing strength techniques (exploit relatedness between observations), and Bayesian Markov chain Monte Carlo (MCMC) estimation.**
- **Use explicit likelihood and model approach**
- **Applied to mortality and disability trends across 625 small areas (wards) in London (average total population: 13 thousand).**
- **Classical mixed effects approaches possible but broader inferences more readily obtainable with Bayes approach**

Borrowing strength relevant for representing correlated age and area effects. Example: correlation of 0.91 in successive log age mortality rates



Methodological Issues/Obstacles

- **Conventional life table methods for estimating area TLEs and DFLEs use unsmoothed age-area specific death or illness rates (unrelated fixed effects method)**
- **Resulting estimates for small areas subject to variance instability (Anselin et al, 2006), with wide confidence intervals for life expectancy estimates.**
- **Also specific numeric problems (e.g. zero deaths in final age interval) in deriving TLE.**
- **Can aggregate neighbourhoods in various ways, but potential biases in so doing**

Borrowing Strength Approach

- **Instead use random effects to represent correlations over age groups and areas, and also to borrow strength between related units and hence stabilize estimates.**
- **Assume binomial likelihood for deaths and illness data (by gender and period; illness data for 2001 and 2011 using Census question on long term limiting illness; deaths 2000-02, 2010-12)**
- **While borrowing strength is primary consideration, so also is model parsimony**

Model Comparison

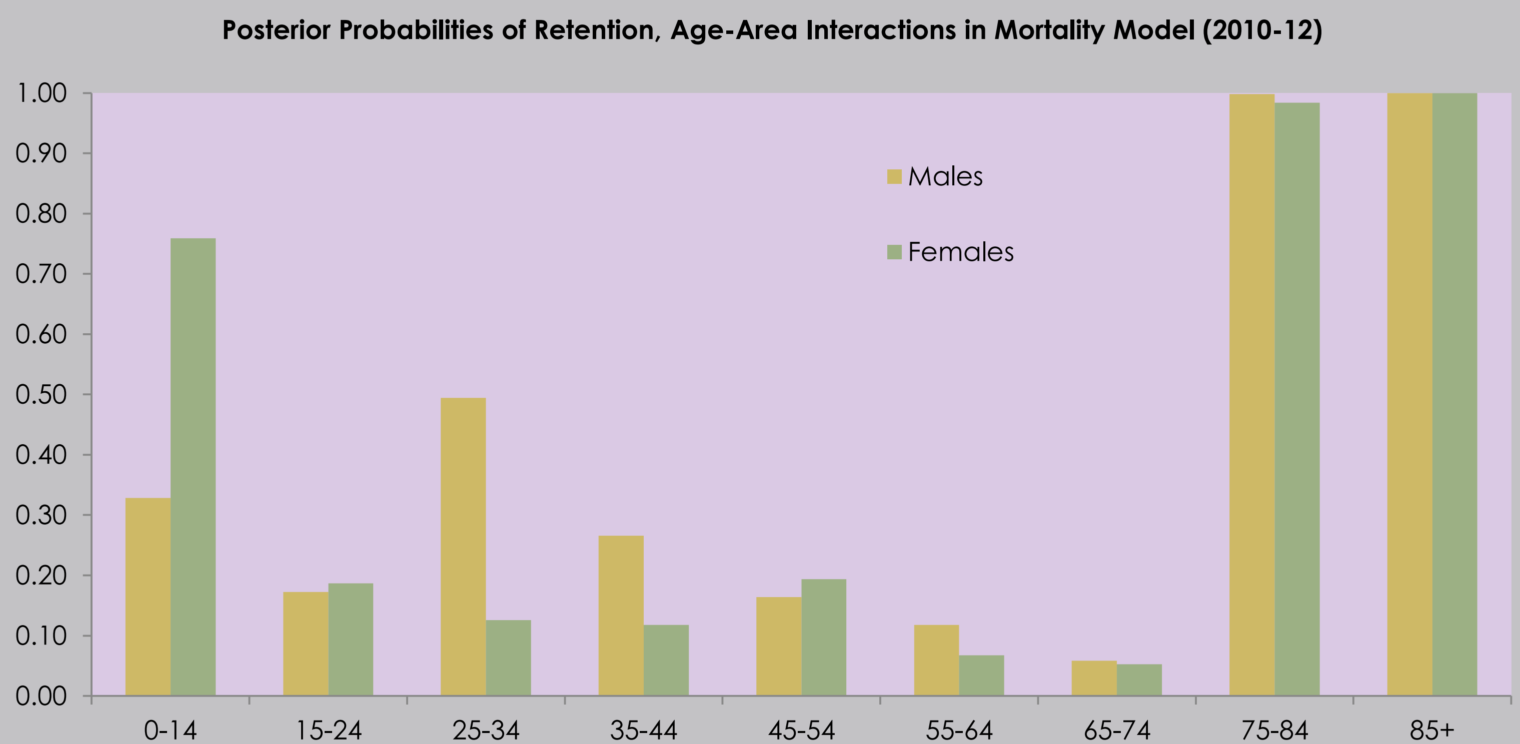
- **Use Deviance Information Criterion (as measure of fit, analogous to AIC).**
- **Also consider precision of life expectancy estimates (measure of parsimony and borrowing strength).**
- **Higher precision → less variance instability**
- **Precision (inverse variance) of estimate of each area's TLE and DFLE obtained from MCMC sampling**

Three Models Compared

- **Model 1:**
  - **random age effects (represent London wide age gradient in mortality or illness)**
  - **random spatially correlated effects (represent overall neighbourhood risk, 625 neighbourhoods)**
  - **age-area interactions to represent over-dispersion**
- **Model 2: as Model 1, but including area deprivation decile (additional element of borrowing strength: similarly deprived areas tend to have similar illness and mortality profiles)**
- **Model 3: same as Model 2, but with selection of age-area interaction effects (retain only significant effects)**

Three Models Compared

- **Model 3 has lowest DIC and highest precision.**
- **Age-area interaction selection most relevant to mortality. All interactions for illness retained. For 2010-12 deaths data, interaction effects only retained for age bands 75-84 and 85+.**



Assessing Neighbourhood Morbidity Trends

- Can use MCMC samples to monitor, for each neighbourhood:
  - Years lived in disability YLD=TLE-DFLE at times 1 and 2
  - As measure of disease burden, Percent years in disability %YLD = 100*YLD/TLE at times 1 and 2
  - Probability that %YLD is higher at time 2 (equivalent to morbidity expansion)

Region Wide Trends

- **Across London, results show**
- **(a) that total life expectancy has risen faster than disability free life expectancy (for both genders)**
- **(b) female excess in DFLE has diminished more than the female excess in TLE (gender convergence in DFLE)**
- **(c) proportion of life spent in disability has increased for both sexes, but more markedly for females.**

Region Wide Trends

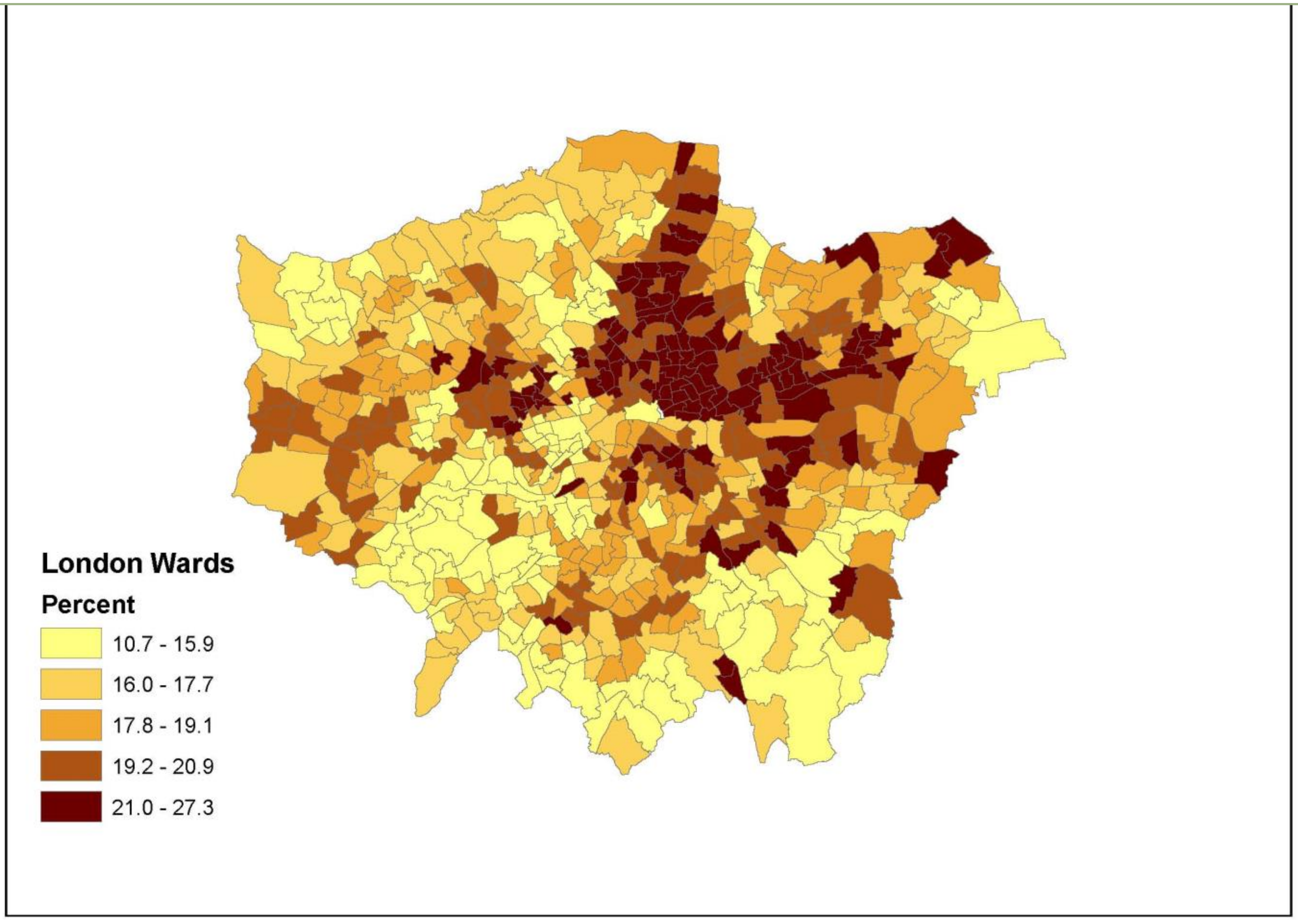
Trends in Life Expectancy (Total and Disease Free), London Region

Males	Period 1, Centred on 2001	Period 2, Centred on 2011
Total Life Expectancy	75.3	79.3
Disability Free Life Expectancy	61.8	64.7
Years Lived with Disability	13.6	14.6
Percent of Life in Disability	18.0	18.4
Females		
Total Life Expectancy	80.1	83.4
Disability Free Life Expectancy	64.2	65.2
Years Lived with Disability	15.9	18.2
Percent of Life in Disability	19.8	21.8

Disaggregated Trends

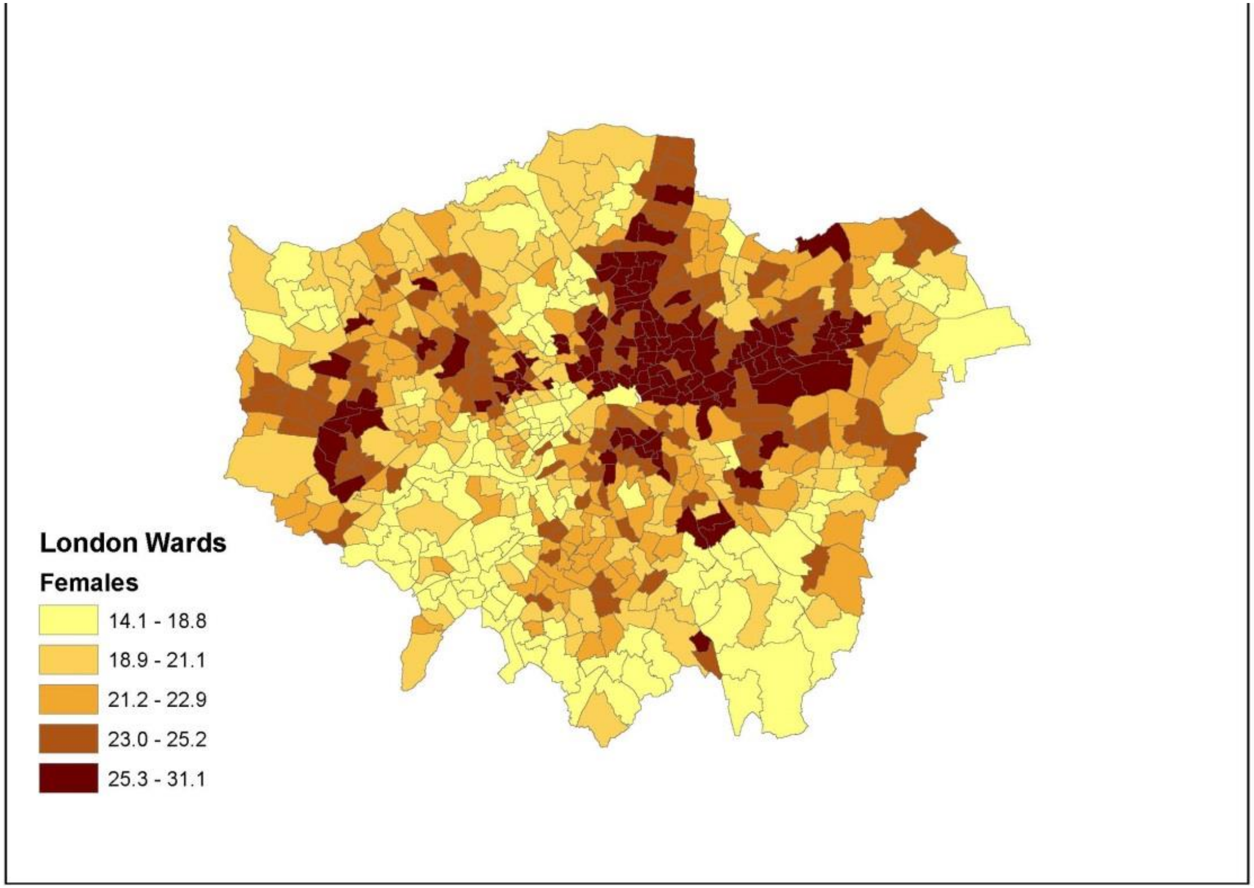
- **This pattern is maintained in trends identified at individual area level (i.e. the 625 London wards)**
- **For majority of areas (407 out of the 625), female probabilities of morbidity expansion (between 2001 and 2011) exceed 0.95.**
- **By contrast, for males, only 142 out of 625 areas have significant probabilities of morbidity expansion.**

Establishing current public health priorities: map out disease burden in 2011



% Life Spent in Disability, London Wards 2011, Males

Ward level variation in disease burden 2011



% Life Spent in Disability, London Wards 2011, Females

Ward level variation in disease burden

- **Maps show spatial concentration/clustering of disease burdens.**
- **Burden similar between males & females (correlation between genders of 0.92).**
- **Percent years in disability correlate closely with area deprivation (IMD2010): 0.87 (M), 0.85 (F)**
- **Percent years in disability in earlier period has slightly higher correlations with IMD 2004, namely 0.90 (M), 0.89 (F).**
- **Suggests slight reduction in inequality (between deprived and affluent areas) in disability burden between 2001 and 2011.**

Final Remarks

- Have considered Census data for this work
- New sources of data allow for geographically disaggregated analysis of disease burdens based on years lived with diagnosed conditions
- Can extend analysis to distinguish expected years spent with single condition as against multiple morbidity
- Model based approach relevant to estimating neighbourhood TLE and DFLE. Bayesian approach permits sensitive inferences for small areas