**A small area estimation model of comorbidity for England**

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**Abstract**

 Background Cardiovascular disease, diabetes, and obesity as single health conditions are rising in prevalence, but a growing body of evidence suggests that individuals are increasingly experiencing two or more of these conditions at the same time. Previous research on comorbidity has focused on identifying the most common groupings of illnesses among elderly health-care users by use of hospital administrative data. Using small area estimation techniques, we developed a population-wide dataset of comorbidity of cardiovascular disease, diabetes, and obesity for England at the small area level.

**Methods**

Matching data from the 2011 Health Survey for England and the 2011 Census in England and Wales, we proposed a new global optimisation (GO) survey calibration method for the estimation of small area estimates of comorbidity. Unlike previous small area estimation methods, the GO method is time efficient and always convergent, uses initial weights a priori for the small area distribution, and allows the user to confirm the best solution. Validation of the newly simulated data involved comparison of the fit (as measured by the relative difference of the sum of squared *Z*-scores, *Z*2rel<0) of the benchmark constraints and non-benchmark constraints with census data.

**Findings**

Validation revealed a significant fit for the benchmark constraints, age and sex (*Z*2rel<0). Validation of the simulated non-benchmark constraint (health status) also revealed a significant fit (*Z*2rel<0). In the absence of small area data on comorbidity, the close fit of both the benchmark and non-benchmark constraints allowed us to assume that the simulated estimates of comorbidity were statistically robust.

**Interpretation**

WHO has identified increased rates of comorbidity as a major challenge for health policy. GO, a new approach to small area estimation, allows the prevalence of cardiovascular disease, diabetes, and obesity as both single and comorbid health conditions to be estimated at the small area level. The newly estimated data have the potential to highlight comorbidity hotspots across England and inform future health policy.

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**Contributors**

KM developed the code and wrote the abstract. FE developed the code and produced the estimates of comorbidity. PW developed the code to produce the comorbidity estimates. SH helped produce the validation results reported in this abstract. KM was the principle investigator of this study.

**Declaration of interests**

We declare no competing interests.