S2 Appendix for ‘Hospital admissions for dementia in England: the effect of primary care quality’

P. Kasteridis, A. Mason, M. Goddard, R. Jacobs, R. Santos, G. McGonigal

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**Calculation of IRR for variables involving interaction terms**

This note explains how the IRR for the Attendance Allowance (AA) and deprivation (IMD) variables reported in table 3 and 4 in the manuscript are calculated. AA is a continuous variable measuring the percentage of AA claimants and $IMD_L$, $IMD_M$, $IMD_H$ are dummy variables indicating low, medium and high levels of deprivation:

- $AA$: % of AA claimants
- $IMD_L$: % of people age 60 or older living in income deprivation is <20%
- $IMD_M$: % of people age 60 or older living in income deprivation is 20% - 35%
- $IMD_H$: % of people age 60 or older living in income deprivation is >35%

Using interaction terms we are able to calculate incident rate ratios for AA at different deprivation levels. We denote these IRRs as:

- $IRR_{AA|IMD_L}$: IRR for AA given that deprivation is low
- $IRR_{AA|IMD_M}$: IRR for AA given that deprivation is medium
- $IRR_{AA|IMD_H}$: IRR for AA given that deprivation is high

Similarly we denote the IRRs for medium and high deprivation as $IRR_{IMD_M}$ and $IRR_{IMD_H}$.

Suppressing practice and time subscripts, the conditional mean for the Poisson model with multiplicative gamma distributed random effects is:

$$E[y|Z, \theta] = \exp \{ \alpha(AA) + \beta_1(IMD_M) + \beta_2(IMD_H) + \gamma_1(AA) \times (IMD_M) + \gamma_2(AA) \times (IMD_H) + X\delta \} \quad (1)$$

where $Z = (AA, IMD_M, IMD_H)$ is the vector of all explanatory variables and $\theta = (\alpha, \beta_1, \beta_2, \gamma_1, \gamma_2, \delta)$ is vector of parameters.

Then the IRRs are calculated as follows:
\[ IRR_{AA|IMDL} = \frac{\exp\{\alpha(AA + 1) + X\delta\}}{\exp\{\alpha(AA) + X\delta\}} = \exp(\alpha) \quad (2) \]

\[ IRR_{AA|IMDM} = \frac{\exp\{\alpha(AA + 1) + \beta_1 + \gamma_1(AA + 1) + X\delta\}}{\exp\{\alpha(AA) + \beta_1 + \gamma_1(AA) + X\delta\}} = \exp(\alpha + \gamma_1) \quad (3) \]

\[ IRR_{AA|IMDH} = \frac{\exp\{\alpha(AA + 1) + \beta_2 + \gamma_2(AA + 1) + X\delta\}}{\exp\{\alpha(AA) + \beta_2 + \gamma_2(AA) + X\delta\}} = \exp(\alpha + \gamma_2) \quad (4) \]

\[ IRR_{IMDM} = \frac{\exp\{\alpha(AA) + \beta_1(IMDM + 1) + \gamma_1(AA)(IMDM + 1) + X\delta\}}{\exp\{\alpha(AA) + \beta_1(IMDM) + \gamma_1(AA)(IMDM) + X\delta\}} = \exp(\beta_1 + \gamma_1 AA) \quad (5) \]

\[ IRR_{IMDH} = \frac{\exp\{\alpha(AA) + \beta_2(IMDH + 1) + \gamma_2(AA)(IMDH + 1) + X\delta\}}{\exp\{\alpha(AA) + \beta_2(IMDH) + \gamma_2(AA)(IMDH) + X\delta\}} = \exp(\beta_2 + \gamma_2 AA) \quad (6) \]