Age and gender modify the association between socio-economic factors and heart disease in New South Wales, Australia

Subha Guha[1], Louise Ryan[1], Geoff Morgan[2] and John Beard[2,3]
[1]Harvard School of Public Health, [2]University of Sydney and [3]Southern Cross University

1. Introduction and Objectives

•Explore the relationship between socio-economic (SES) factors and heart disease in New South Wales (NSW), Australia

•Study interactions between SES, gender and age

•Investigate whether the relationship between SES and heart disease varies with gender and the association is stronger in males, as recent studies suggest

• Assess whether age modifies the relationship between SES and heart disease

•Meet the computational challenges of working with large administrative data sets: 33 million records!

•Propose a new statistical method that, unlike existing methods, provides exact model fits and is computationally efficient for large data sets

2. Data

•Outcome data abstracted from separation records - all public and private hospitals in NSW from July 1, 1996 to June 30, 2001

•Emergency room visits diagnosed as IHD

•Population data obtained from census collected by Australian Bureau of Statistics

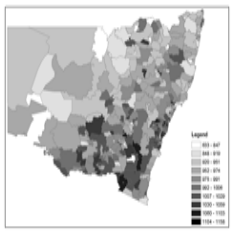
•Data grouped by residence postcode, patient gender and age category

•591 postcodes x 30 age/gender groups x 1826 days ≈ *33 million records*

3. Indicator of socioeconomic status (SES)

•SEIFA score for postal areas derived from census

•Low SEIFA index reflects low SES relative to other areas



4. Statistical models

Let Y_{ijk} be hospitalizations in postcode i on day j and age/gender category k among N_{ijk} subjects at risk

Model 1:

$\mathbf{Y_{ijk} \sim Po(\mu_{ijk})}$, where

$$\mathbf{\log(\mu_{ijk}) = \log(N_{ijk}) + \delta_k + \alpha_w + \beta_0 + \beta_{1g} \cdot seifa_{ij} + \beta_2 \cdot j}$$

δ_k - social category (age/gender) effect

α_w - day of week effect

β_{1k} - interaction between SES measured by SEIFA and gender g (with g=0 representing males and g=1 representing females)

Model 2:

$\mathbf{Y_{ijk} \sim Po(\mu_{ijk})}$, where

$$\mathbf{\log(\mu_{ijk}) = \log(N_{ijk}) + \delta_k + \alpha_w + \beta_0 + \beta_{1k} \cdot seifa_{ij} + \beta_2 \cdot j}$$

β1k - interaction between social category k and SEIFA

5. Problems with existing methods

•Internal standardization is computationally efficient but it results in biased estimates

•Cannot be used to fit models that they include interactions with age and gender

•Techniques that give exact fits are computationally expensive for large data sets

6. Efficient algorithm for large data sets

•**Gauss-Seidel algorithm** reduces computations by using sub-models and reduced versions of data

- •Quick convergence
- •Computes exact MLEs for complex models with interactions

•Easily implemented using standard procedures

•Classic version: series of univariate maximizations of log-likelihood with respect to individual parameters, holding remainder fixed

• Maximizations replaced by Newton-Raphson updates

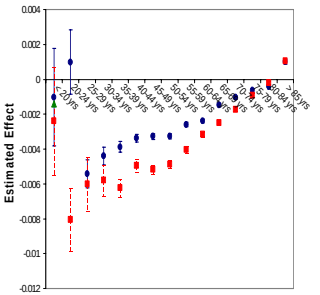
• Blocked version implemented

• Additional computational savings due to collapsibility property of Poisson models with a log link

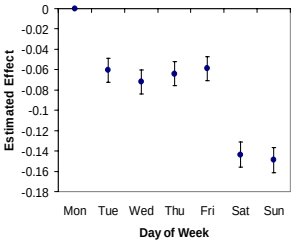
7. Model 1 SEIFA coefficients for men and women

Parameter	Estimate	SE
SEIFA interactions/10^3		
Men	-1.616	0.0394
Women	-1.444	0.0460

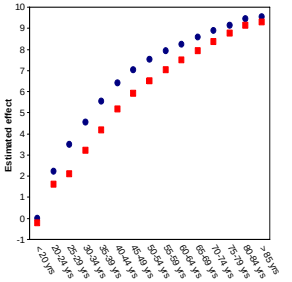
8. Model 2 SEIFA interactions for the 15 age groups of males (●) and females (■).



9. Day of week effects



10. Age/gender effects



11. Conclusions and discussion

•Men have a higher risk for heart disease than females of the same age group

•Strong association between SES and heart disease rates

•For Model 1 which includes only a gender/SEIFA interaction term, the association with SES is significantly weaker in females than in males

•But for Model 2 which also includes age/SEIFA interactions, the age-specific SES associations are significantly stronger in females than in males

•Highly significant interaction between SEIFA and age, with SES impact much stronger at younger ages

•The apparent lack of consistency between the Models 1 and 2 results is explained in terms of

- •Age/SES interaction confounding the gender/SEIFA interaction. Males tend to have heart disease at younger ages when the negative effect of low SES is much stronger