Area variation in mortality in Tasmania (Australia): the contributions of socioeconomic disadvantage, social capital and geographic remoteness

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Abstract
This study investigated the association between socioeconomic disadvantage, social capital, geographic remoteness and mortality in the Australian state of Tasmania. The analysis is based on death rates among persons aged 25-74 years in 41 Statistical Local Areas (SLA) for the period 1998-2000. Multilevel binomial regression indicated that death rates were significantly higher in disadvantaged areas. There was little support for an association between social capital and mortality, thereby contesting the often held notion that social capital is universally important for explaining variations in population health. Similarly, we found little evidence of a link between geographic remoteness and mortality, which contrasts with that found in other Australian states; this probably reflects the small size of Tasmania, and limited variation in the degree of remoteness amongst its SLA.

Introduction

It has long been observed in Australia that geographic areas differ in their health profiles. Studies have documented area variations in mortality (Quine et al., 1995; Turrell and Mengersen 2000; Wilkinson et al., 2000; Yu et al., 2000), morbidity (Glover et al., 1999; Taylor et al., 1992; Mathers, 1994), health-related behaviours and risk factors (Phung et al., 2003; Mathers, 1994), and health service utilisation (Turrell et al., 2004a). These area-level heterogeneities in health have been established for differently-sized area-units ranging from States and Territories (Wilkinson et al., 2000; Siahpush and Singh, 1999) down to Statistical Divisions (Dasvarma, 1980; Wilkinson et al., 2001), Local Government Areas (Yu et al., 2000; Taylor et al., 1992), Statistical Local Areas (Turrell and Mathers, 2001; Glover et al., 1999) and Census Collectors' Districts (Turrell et al., 2004b). In attempting to account for area differences in health, Australian researchers have to date focused most of their attention on the contribution of socioeconomic factors, although some work has also examined the health consequences of living in rural areas of the country. Extant findings indicate that socioeconomically disadvantaged areas, and areas outside of the major metropolitan regions (especially remote and very remote locales) exhibit the poorest health: these areas typically have the highest mortality rates, poorer physiological and psychosocial health, and more adverse risk-factor and health-behaviour profiles.

Although important, socioeconomic disadvantage and geographic remoteness are unlikely to be the only determinants of area-variations in health in Australia. Very possibly, social capital may also contribute to health differences between areas. Social capital has been defined as "*features of social organization such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinated actions*" (Putnam, 1993: 167). Defined this way, social capital is a characteristic of ecologic units – states, communities, neighbourhoods – and not individuals (Lochner et al., 1999). Although social capital has its genesis in relations among individuals, and the nature and extent of people's civic and political participation and organisational and group memberships, the concept transcends and emerges from these micro-processes to characterise the quality of the social fabric. Health researchers have conceptualised social capital in myriad ways, including (but not limited to) perceptions of trust and reciprocity, altruism, social integration, participation, and memberships (Lochner et al., 1999). In quantitative research, these concepts are very often measured using single data items from health or social surveys, with individuals' responses within geographic areas being aggregated to form an indicator of the amount or quality of social capital in the area. Importantly, recent multilevel work on the validity of these types of measures (where the compositional and contextual components of the aggregated constructs can be delineated) suggests they do indeed capture to some extent an area's stock of social capital (Subramanian et al., 2003). Overseas studies have examined the relationship between social capital and mortality (Kawachi et al., 1997; Veenstra, 2002; Lochner et al., 2003; Skrabski et al., 2003), self-rated health (Subramanian et al., 2001; Subramanian et al., 2002; Kawachi et al., 1999) violent crime (Kennedy et al., 1998; Galea et al., 2002;) and health service use (Hendryx et al., 2002), and most of these show that health and well-being are better in areas with higher levels of social capital, independent of the socioeconomic characteristics of the areas. Although we can still only speculate about how and why social capital is related to health, it is believed to influence population health through (among other things) collective action that secures necessary community resources or services, the efficient dissemination and diffusion of information, and via promoting and protecting psychosocial wellbeing (Kawachi, 1999; Kawachi et al.,1999).

Within the Australian context, the number of publications by Australian writers that have dealt with the issue of social capital and health is relatively small and highly variable in focus. A search of the published health literature identified commentaries and discussions about the meaning, relevance, and importance of social capital for health (Cox 1997; Leeder and Dominello 1999; Baum 2000; Hawe and Shiell 2000; Vimpani, 2000; Henderson and Whiteford 2003); a quantitative study of social and civic participation in community life and their links with SES and other demographic factors (Baum et al., 2000); a qualitative study of the role of people's perception of 'place' and the influence of this on community participation and health (Baum and Palmer 2002); a glossary of key terms used in social capital discourse (Baum and Ziersch 2003); and an individual-level study examining how the relationship between household income and self-rated health in three welfare states (US, Sweden and Australia) was differentially affected by adjustment for social capital (trust, altruism, and citizenship) and socially oriented behaviours (membership in organisations and political activity)(Smith and Polanyi 2003). Only one Australian study was identified that used social capital as an ecologic construct and examined its relation to area-variation in health. Specifically, Siahpush and Singh (1999) investigated the association between social integration and mortality in the each of the Australian states and the Australian Capital Territory for the period 1990-1996 using five indicators of integration – percentage of people living alone, divorce rates, unemployment rates, proportion of people who were discouraged job seekers, and unionisation rates. Independent of socioeconomic conditions, higher levels of social integration (with the exception of unionisation rates) were associated with lower all-cause mortality, greater life expectancy, and lower death rates from a range of specific causes including cardiovascular disease, malignant neoplasms, respiratory disease, and suicide. On the basis of this one study it is too early to declare that area-level social capital is important for population health in Australia as it seems to be in a number of other countries: clearly, there is a need for more Australian research, especially work focusing on smaller-sized areas than States or Territories. In this paper, we respond to this need by examining small-area variation in all-cause mortality in the State of Tasmania among persons aged 25-74 for the period 1998-2000; and focus on whether and to what extent area-heterogeneity in death rates is attributable area differences in social capital, socioeconomic disadvantage, and geographic remoteness. Importantly, the inclusion of each of these three constructs will allow us to estimate the relative independent contribution of each factor to mortality variation between areas.

Methods

The study design that we use to investigate area-level mortality variation in Tasmania is essentially ecological: social capital, socioeconomic disadvantage, and geographic remoteness are measured for Statistical Local Areas (described later), and SLA heterogeneity in mortality is examined as a function of the three area-level predictors. Importantly however, our approach departs somewhat from the design of conventional ecologic studies of mortality (e.g. Kawachi et al., 1997; Veenstra 2002; Skrabski et al., 2003, 2004) by employing a multilevel method of structuring and analysing aggregated data as described by Subramanian et al., (2001b). In brief, we compiled a data set with a hierarchic two-level structure and then modelled these data on the basis of a 'constrained' multilevel analysis. Figure 1 presents the data-structure for two SLA. As the Figure shows, SLA are represented at level 2, and nested within each SLA are individuals grouped as 'types' (e.g. males, 25-29 years) which are denoted as 'cells' at level 1. Each cell contains the number of deaths for all causes that occurred during 1998-2000 (numerator) and the estimated population count in 1999 (denominator). Mortality in each cell is expressed as a proportion, that is, the number of deaths in each sex-age subgroup relative to the population in each subgroup; this proportion forms the outcome variable. Once structured in this way, the data are amenable to analysis using multilevel techniques, the advantages of which have now been extensively documented (e.g. Leyland and Goldstein, 2001; Snijders and Bosker, 1999). For our purposes, we used multilevel modelling to delineate the nature and extent of between-SLA variation in mortality conditional on within-SLA variation in age and sex, and then assessed whether socioeconomic disadvantage, social capital, and geographic remoteness contributed to the mortality variation. A further important advantage of our approach is that it overcomes problems of bias associated with age-adjustment in ecological studies (Milyo and Mellor, 2003).

See Figure 1

Setting and Unit of analysis

Tasmania is an island state of Australia, which in 1996 had a total population of 459,658 (Glover et al., 1999). As with all Australian states, Tasmania is divided into administrative units known as Statistical Local Areas (SLA). SLA correspond to council boundaries defined by Local Government Areas, and cover the whole of Tasmania without gaps or overlaps. Tasmania comprises 43 SLA (excluding 'Off-shore Areas and Migratory') which range in geographic area from 28.5 – 9,575 km^2 (mean 1722, SD 2316) and in population size (in 1996) from 914 – 59,618 persons (mean 11,728, SD 14,244). Due to data limitations, it was not possible to include all 43 SLA in this study: two pairs of contiguous SLA (Hobart [C] - Inner and Hobart [C] - Remainder; Launceston [C] - Inner and Launceston [C] - Part B) were combined due to very small population sizes. The final dataset used in the analysis therefore, comprised 41 SLA, or 95.3% of the total number of SLA for Tasmania.

Measurement of area-level socioeconomic status

Area-level SES for each SLA was measured using its Index of Relative Socioeconomic Disadvantage (IRSD) score. IRSD scores are derived by the Australian Bureau of Statistics using Principal Components Analysis (PCA), and they reflect the overall level of socioeconomic disadvantage of an area measured on the basis of attributes such as low income, low educational attainment, high levels of public sector housing, high unemployment, and jobs in relatively unskilled occupations (Australian Bureau of Statistics, 1998a). The IRSD scores used in this present study were calculated using data from the 1996 Australian Census. Across the 41 SLA, we scaled the IRSD values to range from 0 (Hobart) to 10 (Brighton [M]), with higher scores indicating greater levels of socioeconomic disadvantage.

Measurement of social capital

The measures of social capital used in this study were sourced from data collected as part of the Tasmanian *Healthy Communities Survey (HCS)*. Details of the scope and coverage of the HCS, its research design, sampling procedures and data collection methods have been published elsewhere (Department of Health and Human Services, 1999): only a brief overview is provided here. Conducted in 1998, the HCS was based on a random sample (n=25,000) of Tasmanian adults aged 18 years or more selected from the state electoral roll. To ensure that the sample was representative of adult Tasmanians, the electoral roll was stratified into age-gender groups within each SLA. Data were collected using a mail survey and a final (usable) response rate of 60% (n=15,112) was achieved.

The questionnaire used in the HCS included items that tapped a number of core social capital concepts; namely, political participation, trust, and social cohesion. As discussed below, we derived an index and a number of scales using items measuring these concepts and aggregated the scores to the SLA level as an estimate of the stock of social capital in each area. A similar approach has been used in other studies (Kawachi et al., 1997; Subramanian et al., 2002). When constructing the social capital measures it was necessary to exclude respondents who failed to provide a sufficient amount of data to estimate a reliable index or scale score. The final analytic sample used in this study, therefore, ranged from 13,764 to 13,885 respondents (reflecting different amounts of missing data across the measures). The mean number of respondents per SLA ranged from 335.7 to 338.7, with a minimum of 68 and maximum of 1659.

(i) Political participation. Respondents were asked to indicate whether *"In the past 12 months have you done any of the following?"*: written to a newspaper or phoned a 'talk-back' radio program; signed a petition; talked with neighbours about a community problem; participated in a protest march or rally or meeting; attended a public meeting; contacted a state or federal MP; represented an organisation at an important meeting. Responses to the items were scored as 0=No and 1=Yes and summed to form an index, which had a potential minimum and maximum score of zero and seven respectively. Index scores across the 41 SLA ranged from 1.16 (Brighton [M]) to 2.95 (Kingborough [M] – Part B), with higher scores indicating higher average levels of political participation.

(ii) Trust. Respondents were asked *"In general, how often can you trust each of the following to act in your best interests?"* (a) Your relatives, (b) Your friends, (c) Your minister, priest, or other religious leader, (d) Your local GP, (e) Large corporations, (f) Small business, (g) Social workers, (h) Your local council, (i) Public servants generally, (j) Government, (k) Police, and (l) People in general. Response options ranged from 1=Never to 5=Always, and 9=Not Applicable. These items were submitted to a PCA using the Proc Factor procedure in SAS (Hatcher, 1996). Rotation was performed using the Varimax option. As part of this approach, items C and G were removed because a large proportion of respondents (41.6% and 29.5% respectively) reported 'Not Applicable'. Further, the initial PCA revealed that items D, K, and L had low component loadings and/or cross-loaded on more than one component, and these items were also removed from the analysis. The final PCA solution identified two components, which were subsequently interpreted as 'trust in public and private institutions' and 'social trust' (Table 1). Respectively, these two components had eigenvalues of 3.4 and 1.3, individually they accounted for 47.9% and 18.3% of the total variance, and their cumulative contribution was 66.2%. Standardised scoring coefficients were calculated for the items forming the two components and these were used to derive factor scales for each of the trust constructs. To aid interpretability, these scales were re-scored to range from 0-10, with higher scores indicating greater average levels of trust for the SLA. The lowest level of trust in public and private institutions was found in Derwent Valley (M) – Part B, and the highest level on King Island (M). The lowest level of social trust was observed in Sorell (M) – Part B, and the highest in the Northern Midlands (M) – Part A.

(iii) Social cohesion. Respondents were asked *"What do you think about the neighbourhood that you live in? How much do you agree with the following statements?"* (a) I would be really sorry if I had to move away from the people in my neighbourhood, (b) I have a lot in common with people in my neighbourhood, (c) I generally trust my neighbours to look out for my property, (d) My neighbours make it a difficult place to live, (e) I am good friends with people in this neighbourhood, (f) I like living where I live, (g) I have little to do with people in this neighbourhood, (h) My neighbours treat me with respect, (i) Children are safe walking around the neighbourhood during the day, (j) I get involved with most local issues, (k) People in my neighbourhood are willing to help each other out, (l) If I no longer lived here, hardly anyone around here would notice, and (m) It is safe to walk around the neighbourhood at night. Response options ranged from 1=Strongly Disagree to 5=Strongly Agree, and 9=Not Applicable. As before, the items were submitted to a PCA. Based on the initial rotated solution, items D, J and K were removed due to low loading and/or cross-loading. The final solution resulted in three components that were interpreted as 'neighbourhood integration', 'neighbourhood safety', and 'neighbourhood isolation' (Table 1). Respectively, the three components had eigenvalues of 4.1, 1.3 and 1.0, individually they accounted for 41.0%, 12.9% and 10.0% of the total variance, and their cumulative contribution was 63.9%. Standardised scale scores for each component were derived and then re-scored to range from 0-10, with higher scores indicating greater average levels of perceived neighbourhood integration, safety, and isolation for the SLA. The lowest neighborhood integration score was found in Sorell (M) – Part B and the highest in Glamorgan/Spring Bay (M). The lowest neighbourhood isolation and neighbourhood safety scores were observed in King Island (M) and Glenorchy (C), and the highest in Meander Valley (M) – Part A and Flinders (M) respectively.

See Table 1

Measurement of geographic remoteness

The geographic remoteness of each SLA was ascertained using the Accessibility/Remoteness Index of Australia (ARIA) (Department of Health and Aged Care, 2001). ARIA was developed using Geographic Information Systems network analysis to calculate actual distance travelled by road from 11,340 populated localities to four categories of ABS-defined urban centres: Category A= >250 000 persons; B= 48 000 – 249 999; C = 18 000 – 47 999; D = 5000 – 17 999 persons. ARIA is based on the minimum distance that people have to travel to reach an urban centre containing basic services (e.g. health, education, or retail). The ARIA methodology produces a continuous variable that, for Australia as a whole, ranges from 0 (areas of highest accessibility) to 12 (areas of highest remoteness). Among the 41 SLA in Tasmania, ARIA scores ranged from 1.2 (Hobart) to 9.8 (Flinders [M]).

Mortality and population data

Mortality data (used for the numerator in the mortality analysis) were obtained from the Australian Bureau of Statistics (ABS), the national statutory authority that compiles death statistics from information made available by the Registrar of Births, Deaths and Marriages in Tasmania. The analysis is based on deaths from all-causes (in 5 year age-groups) that occurred in each SLA among males and females aged 25-74 years in 1998-2000. An SLA is the smallest area-unit to which mortality is coded to ICD categories. Population data (used for the denominator) were also obtained from the ABS, and comprised estimated total mid-year populations in 1999 for each SLA for males and females aged 25-74 years (in 5 year age-groups).

Analysis

For initial descriptive purposes, death rates in each SLA were expressed as indirectly standardised ratios. Specifically, we calculated the number of deaths that would have been expected to occur in each SLA if the rate among persons aged 25-74 in Tasmania (standard=100) was applied to the SLA. The actual number of deaths occurring in each SLA was then divided by this expected value to produce an age/sex standardised mortality ratio (SMR), which reflects the percentage by which the SLA differs from Tasmania as a whole.

We then present Pearson's correlations between socioeconomic disadvantage, geographic remoteness, and social capital, along with descriptive statistics describing the distributional characteristics of each measure (mean, SD, median). These analyses were undertaken using SAS, release 8.2 (SAS Institute, 2001).

Area-heterogeneity in mortality and its relation with socioeconomic disadvantage, geographic remoteness, social capital was analysed as a two-level multilevel model using *MLwiN* version 2.1c (Rasbash et al., 2000). Specifically, we fitted a multilevel binomial logit-link model with the Predictive-Penalised Quasi-likelihood procedure and second-order linearization, using the Iterative Generalized Least Squares algorithm (Goldstein, 2003). As proportions are not always best represented as a binomial distribution due to over or under dispersion (Collet 1991) allowance for this was made by using the 'Extra binomial' distribution assumption in *MLwiN*. The analysed two-level models consisted of cells (level 1) nested within SLA (Level 2) with cell characteristics pertaining to age and sex specified in the fixed part of the model, and residual variation estimated at the SLA level in the random part. To this baseline model we added SLA-level socioeconomic disadvantage, social capital, and geographic remoteness, and ascertained whether these factors contributed to SLA variation in mortality. A three-part modelling strategy was employed. First, the separate relationships between socioeconomic disadvantage and mortality, geographic remoteness and mortality, and social capital and mortality were examined (Table 4). Second, we then assessed the co-association between disadvantage, social capital and mortality (Table 5, Model 1). Third, we then assessed the co-association between socioeconomic disadvantage, social capital and geographic remoteness in a model that simultaneously adjusted for all factors (Table 5, Model 2). The results for all models are presented as regression coefficients and the ratio of the coefficient to its standard error: ratio values greater than ±2 are significantly different from 0 at $p \leq 0.05$.

Results

Table 2 presents the SMR for each of the 41 SLA relative to Tasmania as a whole. The SMR ranged from 0.21 in Sorell (M) – Part B (95% CI 0.05 – 0.84), which had a mortality rate approximately 80% lower than the state, to 1.84 in Flinders (M)(95% CI 1.13 – 3.01), where the death rate was about 80% higher than the Tasmanian rate.

See Table 2

Table 3 presents correlations between socioeconomic disadvantage, geographic remoteness, and social capital, along with basic descriptive statistics for these measures. Greater levels of socioeconomic disadvantage were significantly associated with lower levels of social trust ($p=0.038$). Geographic remoteness was associated with higher levels of political participation ($p \leq 0.0001$) and social trust ($p=0.072$), greater levels of perceived neighbourhood safety ($p \leq 0.0001$), and lower levels of neighbourhood isolation ($p \leq 0.0001$). Greater participation in the political process was associated with perceptions of neighbourhood safety ($p=0.02$) and lower levels of trust in public and private institutions ($p=0.033$) and neighbourhood isolation ($p=0.005$). SLA with higher levels of social trust were likely to be more socially integrated ($p=0.032$), and areas with higher levels of neighbourhood isolation were less likely to be socially integrated ($p=0.083$) and less likely to be characterised by feelings of neighbourhood safety ($p=0.0002$). Based on the descriptive statistics it is also worth noting the narrow range of observed values for the geographic remoteness and political participation measures relative to their potential ranges: this suggests that there are few remote or very remote SLA in Tasmania (King Island and Flinders Island being the most remote SLA), and that participation in politically-related activity is very limited.

See Table 3

Table 4 presents multilevel results for the effects of area-level variation, socioeconomic disadvantage, geographic remoteness, and social capital on all-cause mortality rates among persons aged 25-74 (all analyses are adjusted for age and sex). The SLA level random term for the baseline analysis was significant, indicating that mortality rates were not constant across the 41 areas (analysis A). The addition of the fixed effect term for area-level socioeconomic disadvantage showed that mortality rates were significantly higher in more disadvantaged SLA (analysis B); also, the inclusion of socioeconomic disadvantage reduced the SLA variation from 0.028 to 0.018 (approximately 36%) suggesting that the socioeconomic characteristics of areas partly accounted for the mortality differences between them, although significant variation remained after adjusting for socioeconomic disadvantage. Analyses examining the separate impacts of geographic remoteness and social capital (analysis C – I) showed that these factors on their own were not significantly associated with mortality, and they accounted for very little (if any) of the SLA variation in rates of death.

See Table 4

Table 5 presents the results of multilevel analyses that simultaneously adjusted for the effects of socioeconomic disadvantage, social capital, and geographic remoteness, on mortality. For each analysis (A-G) in Model 1, the SLA random term was significant and the fixed effect for disadvantage was significantly positively related to mortality. No significant independent association was found between any measure of social capital and mortality. For analyses A-F in Model 2, we again find significant area-level variation in mortality which was associated with socioeconomic disadvantage; but no significant association was observed between social capital and mortality, or remoteness and mortality. For analysis G however, socioeconomic disadvantage, social capital, and remoteness were each significantly related with mortality: death rates were higher in disadvantaged and remote SLA, but lower in areas with greater average levels of perceived neighbourhood safety.

See Table 5

Discussion

In 1998-2000, all-cause mortality rates among persons aged 25-74 years varied significantly across the 41 SLA comprising the Australian state of Tasmania: these area-differences were found prior to and after adjustment for within-SLA variation in age and sex, and between area-variation in socioeconomic disadvantage, geographic remoteness, and social capital. Area-level socioeconomic disadvantage accounted for approximately one-third of the mortality variation between SLA: by contrast, with one single exception, geographic remoteness and social capital made no statistically significant contribution to the observed area-heterogeneity in death rates.

Methodological issues

Before discussing this study's findings in more detail, we need to consider a number of methodological and analytic issues that may affect how we understand and interpret the findings. First, the research design used in this study was essentially ecological. Certainly, compared with conventional ecologic approaches, we made methodological gains by compiling a dataset with a two-level hierarchic structure and then analysed these data using multilevel modelling (Subramanian et al., 2001); however, our approach and findings are subject to caveats that are applicable to ecologic designs more generally. In particular, due to the lack of available individual-level data on the decedents (e.g. information on their socioeconomic characteristics, or levels of social support, their networks, or organisational memberships) we were not able to delineate contextual from compositional effects. Even though we found significant area-variation in mortality in Tasmania, this does not necessarily mean that the areas per se were important in terms of influencing the life-expectancy of the individuals who were resident in the areas. The results of ecologic studies such as the one we conducted leave open the possibility that the geographic variations in mortality are nothing more than an artefact of varying population compositions, and unless these are taken into account (which ecologic studies cannot do), individual- and area-level sources of variation remain confounded (Subramanian et al., 2001). These limitations notwithstanding however, from a public health perspective, findings showing an ecologic association between area-level factors and health are important (Diez Roux, 2003), for they identify broad etiologic determinants of population health in need of focus and attention from public policy, health policy, health promotion, or other forms of intervention. Second, as this analysis was based on only 41 SLA, it may have been somewhat underpowered to detect statistically significant area effects. Despite this however, our research was based on a larger number of areas than that used in other ecologic studies that reported significant area-level findings between socioeconomic disadvantage, social capital, and mortality (e.g. Skrabski et al., 2003), and a similar number of areas to that employed in the benchmark paper by Kawachi et al (1997). Indeed, this latter ecologic study was based on aggregated responses from 7,654 persons in 39 US states (mean number of respondents per state = 196, SD=146, range 58-729) and reported strong associations between socioeconomic disadvantage (poverty), social capital, and mortality. By comparison, this Tasmanian study was based on aggregated responses from 13,764-13,885 respondents in areas considerably smaller in geographic- and population-size than a state (mean number of respondents per SLA=335-338, range 68-1659). Arguably then, the area-level effects for each of the predictor variables in this present work should have been highly concentrated and sensitive to detection, more so than was likely in Kawachi et al's (1997) state level analysis. This increases our confidence in the reliability of our study's findings, and reduces the likelihood that any null or inconsistent associations were an artefact of sample size. Third, our use of an SLA as the ecologic unit of analysis was constrained by the sampling design of the original survey. SLA do not correspond to local communities or culturally defined neighbourhoods, thus selection and information bias associated with using an administrative unit as a proxy for a more socially meaningful unit is likely to result in an underestimation of area-level effects (Boyle and Willms, 1999; Curtis and Jones, 1998). Importantly however, SLA in Tasmania (either singularly or in combination) are based on the boundaries of incorporated bodies of local government, which are governed and administered by local councils. It might be therefore, that part of the variation in death rates between SLA reflects different historical approaches to political governance (Rice and Sumberg, 1997; Veenstra and Lomas, 1999). Fourth, this was a cross-sectional analysis of the relationship between socioeconomic disadvantage, social capital, geographic remoteness and mortality, therefore, it was not possible to establish causality among the predictor variables, and it was for this reason that we did not stipulate a causal ordering among them. Indeed, Putnam (1993) himself has cautioned against the application of linear theories and models to social phenomena (such as socioeconomic development and social capital) that are historically-tied in an ongoing continuously changing dialectic relation.

Socioeconomic disadvantage and mortality

Our finding that greater levels of disadvantage were associated with higher rates of death is consistent with previous area-based studies of mortality inequality in Australia (e.g. Turrell and Mathers, 2001; Mathers, 1994; Glover et al., 1999; Quine et al., 1995; Turrell and Mengersen 2000; Wilkinson et al., 2000; Yu et al., 2000) and it concurs with a now large body of overseas evidence (Raleigh and Kiri, 1997; Eames et al., 1993; Anderson, 1997; Waitzman and Smith, 1998a; Congdon, 1995; Ecob and Jones, 1998; Yen and Kaplan, 1999). Moreover, socioeconomic disadvantage was related with mortality independent of social capital and geographic remoteness. As was mentioned in the section on study limitations, our use of an ecologic design made it impossible to identify the specific contributors to the higher death rates in socioeconomically disadvantaged areas. These could have been due to compositional factors such as the lower average incomes of people residing in these areas, or their limited educational attainment, or their greater propensity to be unemployed, or a combination of these. Alternatively, higher mortality rates in the disadvantaged areas might reflect the impact of wider contextual and environmental influences that transcend the characteristics of individuals, including inadequate housing, lack of health care facilities, pollution, poor public transport, or limited access to healthy and nutritious food.

Social capital and mortality

Our search of the published health literature identified five overseas studies examining the area-level relation between social capital and mortality: two from the US (Kawachi et al., 1997; Lochner et al., 2003), one from Canada (Veenstra 2002), and two from Hungary (Skrabski et al., 2003, 2004). Four of the studies were based on an 'unmixed' ecologic design (Kawachi et al., 1997; Veenstra 2002; Skrabski et al., 2003, 2004), and one used a multilevel approach (Lochner et al., 2003). Each study operationalised social capital on the basis of individual-level responses to single survey items aggregated to the area-level, and included measures such as civic participation, (mis)trust, reciprocity, voter turnout, and organisational membership. The number of areas included in their analyses ranged from 20 (Skrabski et al., 2003) to 343 (Lochner et al., 2003), and the areas were highly variable in size, ranging from states (Kawachi et al., 1997) and provinces (Veenstra 2002), to counties (Skrabski et al., 2003), sub-regions within counties (Skrabski et al., 2004), and neighbourhood clusters (Lochner et al., 2003). Each of the studies was consistent in finding an association between social capital and mortality independent of area-level socioeconomic disadvantage (variously measured): typically, areas with greater stocks of social capital exhibited better health profiles.

The results of this Australian study contrast markedly with that observed overseas: of six measures of social capital used in our analysis, only one showed an association with area variations in mortality (and only after simultaneous adjustment for other factors). Specifically, no significant association was found between mortality and political participation, trust in public and private institutions, social trust, neighbourhood integration, and neighbourhood isolation, either prior to or after adjustment for socioeconomic disadvantage and geographic remoteness. Moreover, our results are at odds with the only other area-based Australian study of social capital, which found evidence of an association between social integration and mortality (Siahpush and Singh 1999). This work however was based on a state- and territory-level analysis, and in the Australian context at least, this type of approach has been criticised as being ‘at the wrong order of aggregation to investigate health inequalities….because of the demographic dominance of the cities’ (Wilkinson et al., 2000:228). Further, it is questionable whether the measures of integration used by Siahpush and Singh (2001) were capturing social capital per se, and we would contest the method of using data from six states and one territory over seven contiguous years (1990-1996) as the basis for examining 49 discrete areas. In short, this work, and our study conducted in Tasmania are not directly comparable.

The null and inconsistent relationship between social capital and mortality in Tasmania leads inexorably to the question of whether the findings are ‘real’ or a consequence of a methodological artefact. Although we cannot provide a definitive or conclusive answer to this question, for a range of reasons, the former seems more likely. First, the study design used for our research was in most respects identical to that used in overseas studies that find an association between social capital and mortality: indeed our design represented a methodological advance on extant ‘unmixed’ ecological approaches. Second, as previously mentioned, the number of areas examined in our study was comparable with other studies, as was the ratio of survey respondents to the population of the areas, thus resulting in similar coverage, stability and concentration of social capital “effects” within each area. Third, our use of Principal Components Analysis to derive each multi-item measure of social capital arguably produced a more reliable and conceptually coherent construct than is captured when using a single-item indicator; thus the quality and relevance of the measures used in our study were not likely to have hindered our chances of detecting a significant association between social capital and mortality. Fourth, with the exception of political participation, each social capital index was reasonably normally distributed and seemingly exhibited adequate variation; in fact, the distributional properties of the social capital measures (excluding the exception) were very similar to the index of socioeconomic disadvantage which showed a strong and consistent association with area-variations in mortality.

If methodological issues were unlikely to have accounted for the essentially null associations between social capital and mortality in Tasmania, what then might be a substantive reason? Again we can only speculate, but it may reflect the limited extent of spatial segregation of the Tasmanian population along social lines vis-à-vis other countries. Specifically, over the last few decades, the US, UK, and elsewhere have witnessed increasing spatial differentiation on the basis of their social and economic characteristics (Shaw et al., 1999; Acevedo-Garcia et al., 2003; Waitzman and Smith, 1998b), and this seems to have been sufficient to produce area-variation in stocks of social capital that are detectable in health differences between areas. While areas in Tasmania are also socially and economically segregated (Australian Bureau of Statistics, 1998b) the nature and extent of this separation may be qualitatively different (i.e. less extreme) than that seen in many overseas countries, resulting in relative homogeneity across the SLA in terms of the quality of their social fabric, and insufficient to differentially impact on the probability of death between areas.

Importantly, while the aforementioned methodological and substantive issues might help explain why we found no support for an association between mortality and social capital for five of the measures, we did find a significant conditional relation between neighbourhood safety and mortality which requires some discussion. On its own (i.e. unadjusted for any potentially confounding factors), and when examined in co-association with socioeconomic disadvantage, neighbourhood safety was not significantly related with area-variation in mortality. It was only after additional simultaneous adjustment for geographic remoteness that neighbourhood safety emerged as a significant predictor of mortality. Possibly, the adjusted association partly reflected shared variation with geographic remoteness, as captured by their correlation (r=0.68). Thus, the adjusted association between neighbourhood safety and mortality was suggestive of a suppressor effect (Cohen and Cohen, 1975). Put simply, once the shared variance between neighbourhood safety and geographic remoteness was removed by statistical adjustment, the unique variance linking safety and mortality was "freed-up" and the formers' importance as a predictor of the latter was strengthened such that the relationship became significant. Suppressor effects caution against the relatively common practice in epidemiology (eg Sternfeld et al., 1999; Smedslund and Ahn, 1999) of including in a multi-variable model only those variables that are shown to be significantly related with the outcome on the basis of bivariate analyses. Clearly, the significant conditional association between neighbourhood safety and mortality is difficult to interpret. Given that the weight of all the other evidence (unadjusted and adjusted) suggests that social capital had little impact on mortality in Tasmania, it would seem appropriately circumspect at this point to not place too great a significance on one discrepant result.

Geographic remoteness and mortality

Australian research investigating the association between geographic remoteness and mortality has suggested that death rates are higher in rural and remote areas than in cities or other large metropolitan centres (Wilkinson and Blue, 2002). Generally speaking however, this previous work has tended to focus on Australia as a whole (where Tasmania is not separately identifiable) or the analysis has been confined to the mainland states and territories which are typically much larger than Tasmania, which is an island, and the smallest state. In short, it is not clear whether the findings of Australian studies of geographic variations in mortality apply to Tasmania specifically. Our failure to find a clear and consistent association between geographic remoteness and mortality very likely reflects the state's limited variability in the extent of remoteness among the SLA. For example, based on a recently developed categorical measure of the ARIA Index that was outlined in the Methods (Department of Health and Aged Care, 2001), Tasmania in 1998-2000 consisted of 34 SLA defined as 'Highly Accessible' or 'Accessible', 5 defined as 'Moderately Accessible', 2 defined as 'Remote', and no SLA defined as 'Very Remote'. The disproportionate concentration (n=34, 83%) of Tasmanian SLA in geographic categories that are characterised by adequate access to a wide range of goods and services and opportunities for social interaction (Department of Health and Aged Care, 2001) militates against finding an association between remoteness and health. While geographic remoteness was not significantly related to mortality on its own, or after adjustment for socioeconomic disadvantage and five measures of social capital, a significant association with mortality was observed with additional simultaneous adjustment for neighbourhood safety. This again was likely due to the influence of suppressor effects as outlined earlier. Moreover, it remains unclear how to interpret with confidence this single conditional association between geographic remoteness and mortality.

Finally, it is worth noting that the correlation analysis showed that levels of political participation, social trust, and neighbourhood integration (along with neighbourhood safety) were significantly higher in more rural and remote areas of

Tasmania. The nature of these associations are generally consistent with Putnam's (2000) research in the US and Baum's (1999) work in Australia, which show that rural towns and areas have greater stocks of social capital. This is probably due to rural and remote areas typically having smaller more stable populations, thus information and knowledge that residents have about each other is likely to be greater, fostering feelings of trust and engendering norms of reciprocity, leading to social cohesion (integration), and feelings of safety and belonging.

Conclusion

This study found strong evidence that area-level socioeconomic disadvantage was associated with area-variation in all-cause mortality in Tasmania: this result is consistent with that observed elsewhere in Australia and in other countries. By contrast we found little evidence of a relation between social capital and mortality: this result therefore represents a challenge to the often held assumption that social capital is universally important for explaining variations in population health. Further, there was little support in our data for a link between geographic remoteness and mortality in Tasmania, which may have been due to the limited variation in remoteness among the state's 41 SLA. Clearly, confirmation of these findings and claims about the influence of social capital and geographic remoteness on mortality in Tasmania will require that the research reported here be replicated in other areas of Australia.

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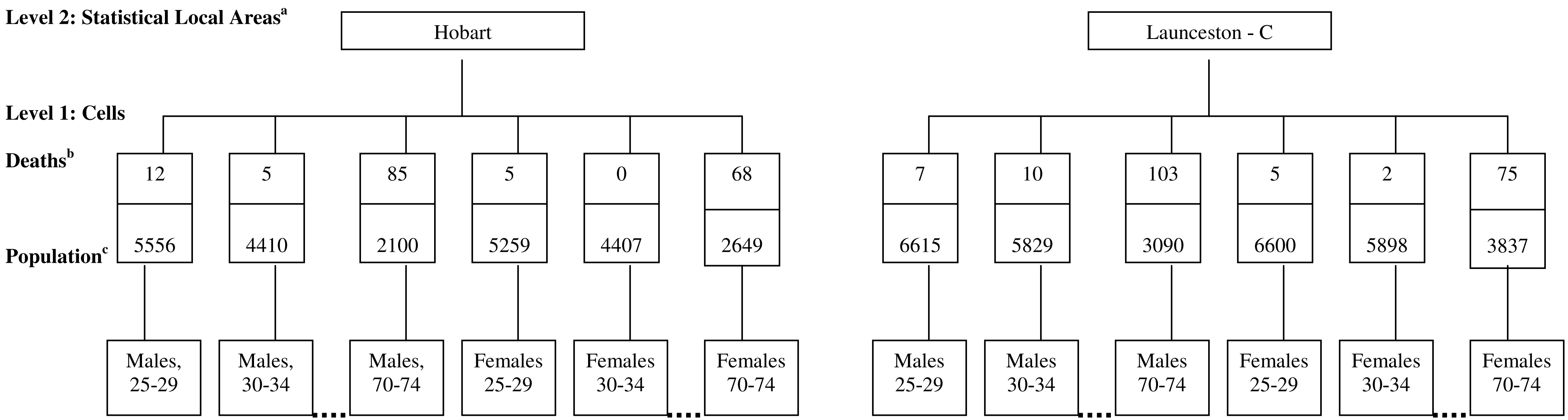
Figure 1: Diagrammatic representation of the multilevel data-structure used to analyse area-variation in mortality in Tasmania



(a) An example of the data-structure for two Statistical Local Areas (n=41 in the analysed data set)
(b) The number of deaths from all-causes that occurred in the Statistical Local Area for each sex/age subgroup during 1998-2000
(c) The estimated resident population for each sex/age subgroup in the Statistical Local Area in 1999

Table 1: Factor loadings for a Principal Components Analysis with Varimax Rotation for survey items measuring social capital

	Retained components (loadings) [a]		
Trust	1	2	3
Trust in public and private institutions			
Public servants generally	**0.812**	0.112	
Government	**0.787**	0.063	
Large corporations	**0.776**	0.110	
Local council	**0.775**	0.152	
Small business	**0.741**	0.184	
Chronbach's Alpha [b]	0.837		
Social trust			
Your Relatives	0.108	**0.869**	
Your Friends	0.161	**0.854**	
Chronbach's Alpha		0.687	
Social Cohesion			
Neighbourhood Integration			
I'd be sorry if I had to move away from the people in my neighbourhood	**0.767**	0.264	0.004
I have a lot in common with people in my neighbourhood	**0.730**	0.326	0.004
My neighbours treat me with respect	**0.713**	0.012	0.209
I like living where I live	**0.711**	0.011	0.204
I am good friends with people in this neighbourhood	**0.706**	0.343	0.084
I generally trust my neighbours to look out for my property	**0.700**	0.227	0.182
Chronbach's Alpha	0.850		
Neighbourhood Safety			
It is safe to walk around the neighbourhood at night	0.031	0.106	**0.859**
Children are safe walking around the neighbourhood during the day	0.295	0.004	**0.774**
Chronbach's Alpha			0.590
Neighbourhood Isolation			
If I no longer lived here, hardly anyone around here would notice	0.224	**0.799**	0.016
I have little to do with people in this neighbourhood	0.161	**0.798**	0.088
Chronbach's Alpha		0.587	

(a) Loadings in an orthogonal (Varimax) solution are bivariate correlations between each item and the component

(b) Chronbach's Alpha based on standardised variables

Table 2: **Number of deaths, population counts, and standardised mortality ratios for 41 Statistical Local Areas in Tasmania: persons 25-74 years, 1998-2000**

Statistical Local Area (N=41)	Deaths [a]	Population [b]	SMR [c]	95% CI
Sorell (M) - Part B	2	604	0.21	0.05 – 0.84
Latrobe (M) - Part B	2	399	0.39	0.10 – 1.56
Glamorgan/Spring Bay (M)	27	2667	0.57	0.39 – 0.83
Burnie (C) - Part B	9	1206	0.64	0.33 – 1.23
Central Coast (M) - Part B	17	1869	0.70	0.43 – 1.13
West Tamar (M) - Part A	129	11073	0.72	0.60 – 0.86
Kingborough (M) - Part A	158	14969	0.75	0.64 – 0.88
West Tamar (M) - Part B	10	1082	0.76	0.41 – 1.41
Meander Valley (M) - Part A	40	4159	0.77	0.56 – 1.05
Kentish (M)	37	3353	0.78	0.56 – 1.08
Latrobe (M) - Part A	60	4572	0.78	0.60 – 1.01
Meander Valley (M) - Part B	84	6228	0.86	0.69 – 1.07
Devonport (C)	210	14516	0.89	0.77 – 1.02
Clarence (C)	430	29483	0.92	0.83 – 1.02
Southern Midlands (M)	46	3430	0.92	0.69 – 1.23
Waratah/Wynyard (M)-Part B	20	1646	0.92	0.59 – 1.43
King Island (M)	14	1078	0.93	0.55 – 1.57
Sorell (M) - Part A	81	5895	0.97	0.78 – 1.21
Northern Midlands (M)-Part A	62	4377	0.98	0.76 – 1.26
Launceston (C) [d]	537	34138	1.00	0.91 – 1.09
Dorset (M)	77	4408	1.03	0.82 – 1.29
Huon Valley (M)	123	8058	1.03	0.86 – 1.23
George Town (M) - Part A	53	3389	1.06	0.81 – 1.39
Hobart [e]	410	26784	1.06	0.96 – 1.17
Tasman (M)	26	1423	1.08	0.73 – 1.59
Burnie (C) - Part A	168	10201	1.09	0.93 – 1.27
Waratah/Wynyard (M)-Part A	116	6574	1.09	0.91 – 1.31
Circular Head (M)	71	4808	1.11	0.88 – 1.40
Derwent Valley (M) - Part B	24	1827	1.11	0.74 – 1.66
Central Highlands (M)	26	1578	1.13	0.77 – 1.66
Derwent Valley (M) - Part A	72	4005	1.14	0.90 – 1.44
Break O'Day (M)	73	3620	1.15	0.91 – 1.45
Launceston (C) - Part C	26	1805	1.15	0.78 – 1.69
Central Coast (M) - Part A	203	10714	1.16	1.01 – 1.34
Glenorchy (C)	509	26014	1.20	1.09 – 1.32
Northern Midlands (M) - Part B	53	2756	1.23	0.94 – 1.61
Kingborough (M) - Part B	34	1658	1.24	0.88 – 1.74
West Coast (M)	58	3462	1.37	1.06 – 1.78
George Town (M) - Part B	11	600	1.38	0.76 – 2.49
Brighton (M)	103	6859	1.50	1.23 – 1.82
Flinders (M)	16	587	1.84	1.13 – 3.01

(a) Total deaths among persons 25-74 for the period 1998-2000
(b) Mid-year estimated resident population in 1999, persons aged 25-74 years
(c) Age-sex standardised mortality ratio (all causes): Tasmania as the standard (100)
(d) Represents a combination of Launceston (C) – Inner, and Launceston (C) – Part B
(e) Represents a combination of Hobart (C) – Inner, and Hobart (C) - Remainder

Table 3: Correlations between socioeconomic disadvantage, geographic remoteness and social capital, and descriptive statistics for each measure [a, b]

	1	2	3	4	5	6	7	8
1 Socioeconomic disadvantage	1.0							
2 Geographic remoteness	0.03	1.0						
3 Political participation	-0.18	0.57***	1.0					
4 Trust in public and private institutions	0.06	0.11	-0.33**	1.0				
5 Social trust	-0.33**	0.28*	0.14	0.02	1.0			
6 Neighbourhood Integration	-0.20	0.21	-0.02	0.25	0.34**	1.0		
7 Neighbourhood Safety	-0.19	0.66***	0.47***	0.00	-0.03	0.19	1.0	
8 Neighbourhood Isolation	-0.13	-0.68***	-0.43***	-0.17	-0.15	-0.27*	-0.54**	1.0
Scale/Index mean (standard deviation) [c]	4.6 (1.9)	2.9 (1.8)	1.6 (0.3)	4.9 (2.4)	5.3 (2.0)	6.4 (2.3)	4.8 (2.3)	4.9 (2.2)
Median	5.0	2.4	1.6	4.6	5.3	6.7	5.1	4.8

(a) Based on 41 Statistical Local Areas
(b) *≤0.10, **≤0.05, ***≤0.01
(c) Scales measuring socioeconomic disadvantage and social capital were scored to range from 0-10. The political participation and geographic remoteness indexes have potential ranges from 0-7 and 0-12 respectively.

Table 4: Regression coefficients for all cause mortality for persons 25-74 years in 41 Statistical Local Areas in Tasmania, 1998-2000: effects of area-level variation, socioeconomic disadvantage, geographic remoteness, and social capital [a]

		β	β/se [b]
A	Intercept	-7.42	
	Statistical Local Area variation (Baseline model)	0.028	2.80
B	Intercept	-7.64	
	Statistical Local Area variation	0.018	2.57
	Area Socioeconomic disadvantage [c]	0.047	3.36
C	Intercept	-7.51	
	Statistical Local Area variation	0.027	2.70
	Geographic remoteness	0.031	1.35
D	Intercept	-7.48	
	Statistical Local Area variation	0.028	2.80
	Political participation	0.035	0.31
E	Intercept	-7.49	
	Statistical Local Area variation	0.026	2.89
	Trust in public and private institutions	0.012	0.86
F	Intercept	-7.47	
	Statistical Local Area variation	0.029	2.90
	Social trust	0.008	0.42
G	Intercept	-7.29	
	Statistical Local Area variation	0.025	2.78
	Neighbourhood integration	-0.021	-1.31
H	Intercept	-7.40	
	Statistical Local Area variation	0.028	2.80
	Neighbourhood isolation	-0.006	-0.35
I	Intercept	-7.32	
	Statistical Local Area variation	0.023	2.56
	Neighbourhood safety	-0.026	-1.73

(a) All models age and sex adjusted (fixed parameters)
(b) Values of β/se greater than ± 2 are significantly different from 0 at $p \leq 0.05$
(c) Scales measuring socioeconomic disadvantage and social capital were scored to range from 0-10. The political participation and geographic remoteness indexes have potential ranges from 0-7 and 0-12 respectively

Table 5: Regression coefficients for all cause mortality rates for persons 25-74 years in 41 Statistical Local Areas in Tasmania, 1998-2000: area-level variation and simultaneous adjustment for socioeconomic disadvantage and social capital (Model 1), plus geographic remoteness (Model 2) [a]

		Model 1 [b]		Model 2	
		β	β/se [c]	β	β/se
Intercept	A	--		-7.68	
Statistical Local Area variation		--	--	0.019	2.71
Socioeconomic disadvantage		--	--	0.045	3.21
Geographic remoteness		--	--	0.021	0.95
Intercept	B	-7.79		-7.75	
Statistical Local Area variation		0.018	2.57	0.019	2.71
Socioeconomic disadvantage [d]		0.050	3.33	0.048	3.20
Political participation		0.090	0.75	0.050	0.39
Geographic remoteness		--	--	0.015	0.56
Intercept	C	-7.68		-7.72	
Statistical Local Area variation		0.017	2.43	0.018	2.57
Socioeconomic disadvantage		0.046	3.29	0.044	3.14
Trust in public & private institutions		0.009	0.69	0.009	0.69
Geographic remoteness		--	--	0.021	1.00
Intercept	D	-7.87		-7.89	
Statistical Local Area variation		0.019	2.38	0.020	2.50
Socioeconomic disadvantage		0.059	3.69	0.057	3.56
Social trust		0.031	1.72	0.029	1.53
Geographic remoteness		--	--	0.016	0.73
Intercept	E	-7.53		-7.56	
Statistical Local Area variation		0.016	2.29	0.017	2.43
Socioeconomic disadvantage		0.045	3.21	0.042	3.00
Neighbourhood integration		-0.015	-1.07	-0.017	-1.13
Geographic remoteness		--	--	0.024	1.09
Intercept	F	-7.69		-8.00	
Statistical Local Area variation		0.017	2.43	0.016	2.29
Socioeconomic disadvantage		0.049	3.50	0.051	3.64
Neighbourhood isolation		0.008	0.50	0.038	1.73
Geographic remoteness		--	--	0.058	1.93
Intercept	G	-7.53		-7.54	
Statistical Local Area variation		0.014	2.33	0.011	2.20
Socioeconomic disadvantage		0.045	3.46	0.031	2.38
Neighbourhood safety		-0.024	-1.85	-0.066	-3.67
Geographic remoteness		--	--	0.096	3.43

(a) All models age and sex adjusted (fixed parameters)
(b) Data for Model 1-A were previously presented in Table 4
(c) Values of β/se greater than ± 2 are significantly different from 0 at $p \leq 0.05$
(d) Scales measuring socioeconomic disadvantage and social capital were scored to range from 0-10. The political participation and geographic remoteness indexes have potential ranges from 0-7 and 0-12 respectively