

SHORT REPORT

Confounding by socioeconomic position remains after adjusting for neighbourhood deprivation: an example using smoking and mortality

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Area based measures of socioeconomic deprivation are often used as proxies for personal socioeconomic position. But sometimes people of high socioeconomic position live in deprived areas, and vice versa.^{1 2} This means that adjusting for area deprivation (only) may leave residual confounding for any exposure-outcome association in which socioeconomic position is strongly implicated.³ The purpose of this paper is to report an example in which residual confounding by personal socioeconomic position remains after adjusting for neighbourhood deprivation. We are not aware of previous empirical findings. More generally, we also examine the issue of residual confounding by socioeconomic position when adjusting for just one individual socioeconomic factor (education or income) compared with adjusting simultaneously for a large range of socioeconomic factors. Our empirical example is the association of tobacco with adult mortality in a large study that includes multiple measures of personal socioeconomic position.

METHODS AND RESULTS

We used a New Zealand census mortality cohort of 758 367 men and 798 828 women aged 25 to 74 years at the 1996 census followed up for mortality for three years to compare mortality in current and never smokers (see <http://www.wnmeds.ac.nz/nzcms-info.html> for details). We used a New Zealand specific measure of neighbourhood socioeconomic deprivation, constructed using proportions of people at the 1996 census with/in: no telephone access; no car access; receipt of a means tested benefit; unemployment; low household income; single parent families; nil qualifica-

Key points

- Socioeconomic position is a potential confounder of many exposure-outcome associations.
- Residual confounding by socioeconomic position is likely to remain after controlling for just one measure of socioeconomic position, such as an area based measure of socioeconomic deprivation or a single individual socioeconomic factor like income.
- Adjusting the smoking-mortality association for a neighbourhood measure of deprivation captured only half of the total confounding by a full range of socioeconomic factors.
- Researchers seeking to control for confounding by socioeconomic position should ideally control for many socioeconomic factors.

tions; non-tenured homes; and household crowding.⁴ The specification of other socioeconomic covariates is detailed in the footnote to table 1. Rate ratios were measured using Poisson regression (SAS version 8.2).

Full adjustment for both neighbourhood deprivation and a range of personal socioeconomic factors reduced the excess rate ratio of the smoking-mortality association by 26% for men and by 19% for women (table 1, model 4). Controlling for just neighbourhood socioeconomic deprivation only brought about half of this reduction (model 2a). Adjusting

Table 1 Rate ratios of 25–77 year old all cause mortality for current smokers compared with never smokers, adjusted for: (1) baseline of age and ethnicity; (2) baseline plus one socioeconomic factor (deprivation, income, or education); (3) baseline plus deprivation, income, and education simultaneously; and (4) model 3 plus car access, housing tenure, and labour force status

Poisson regression model	Rate ratios for current compared to never smokers (95% confidence intervals)		Percentage reduction of excess rate ratio (that is, rate ratio–1) compared with baseline model	
	Men	Women	Men	Women
Tobacco smoking: current compared with never				
(1) Baseline model—adjusting for just age and ethnicity	2.10 (2.01 to 2.20)	2.06 (1.95 to 2.17)	–	–
(2) Adjusting additionally for just one socioeconomic factor:				
(2a) Model 1, plus neighbourhood socioeconomic deprivation	1.97 (1.88 to 2.06)	1.95 (1.85 to 2.06)	12	10
(2b) Model 1, plus equalised household income	1.98 (1.89 to 2.07)	1.98 (1.87 to 2.09)	11	8
(2c) Model 1, plus highest educational qualification	2.05 (1.96 to 2.15)	2.01 (1.90 to 2.12)	5	5
(3) Adjusting simultaneously for deprivation, income, and education	1.88 (1.80 to 1.97)	1.89 (1.79 to 2.00)	20	16
(4) Adjusting fully for all socioeconomic factors*	1.81 (1.72 to 1.89)	1.86 (1.76 to 1.97)	26	19

The New Zealand index of small area socioeconomic deprivation (NZDep96) was used to measure neighbourhood deprivation (see Methods). Equalised household income (five level categorical variable) was calculated by summing the incomes of all people in the household, and equalising for economies of scale (number of adults and children in household) using the New Zealand specific Jensen index. Highest educational qualification was obtained directly from census data (nil, school, post-school). *In addition to the variables listed in the table, the fully adjusted model also includes census data on: household car access (nil, 1, ≥2), housing tenure (freehold, rental and other), and labour force status (employed, unemployed, non-active).

Policy implications

Many exposure-outcome relations are likely to be over-estimated due to residual confounding by socioeconomic position if only one socioeconomic factor is adjusted for.

for just income (model 2b) or just education (model 2c) only brought about 20% to 50% of the reduction observed in the full model.

COMMENT

Neither indices of neighbourhood socioeconomic deprivation nor single individual socioeconomic factors fully characterise socioeconomic position. With regard to deprivation indices, our example used a New Zealand index of socioeconomic deprivation constructed for very small areas (population about 100). Where deprivation indices are constructed for larger groupings of people (resulting in more measurement error of personal socioeconomic position) the problem of residual confounding is likely to be greater than that shown here.

This threat of residual confounding is likely to be particularly important in two situations. Firstly, when the exposure of interest is strongly patterned by socioeconomic position. Such patterning is a growing feature in many societies as health messages to modify behaviour are preferentially taken up by people of higher socioeconomic position. Secondly, small effect sizes are particularly prone to uncontrolled confounding. For example, a British study that adjusted for (only) area deprivation reported small excess risks of congenital anomalies and low birth weight in populations living near landfill sites.⁵ As the authors stated, residual confounding by socioeconomic position was a possible reason for their findings.

The relative importance of area based and personal measures of socioeconomic position will differ depending on many factors, including the composition of the area based measure, the size of its catchment population, the degree of residential segregation in the wider society, and the particular exposure-disease relation. The disentangling of the separate and complementary contributions of contextual and individual socioeconomic position to health is the subject of ongoing research. The point we wish to make here is that as both individual and contextual social factors are important for health, and multiple individual socioeconomic factors are important for health, researchers ideally need to control for multiple measures of socioeconomic position—not just neighbourhood deprivation—to minimise the threat of residual confounding by socioeconomic position. Where this is not possible it may be wise to assume that adjustment for

deprivation alone captures perhaps only half (or less) of the full confounding by socioeconomic position.

CONTRIBUTORS

Tony Blakely had the idea for the paper, and led the interpretation and write up. Darren Hunt conducted some of the analyses, and contributed to the interpretation and write up. Alistair Woodward contributed to the interpretation and write up. Authorship order was assigned on the basis of relative importance of contribution.

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Summary statistics New Zealand security statement

The NZCMS is a study of the relation between socioeconomic factors and mortality in New Zealand, based on the integration of anonymised population census data from Statistics New Zealand and mortality data from the New Zealand Health Information Service. The project was approved by Statistics New Zealand as a Data Laboratory project under the Microdata Access Protocols in 1997. The datasets created by the integration process are covered by the Statistics Act and can be used for statistical purposes only. Only approved researchers who have signed Statistics New Zealand's declaration of secrecy can access the integrated data in the Data Laboratory. (A full security statement is at <http://www.wnmeds.ac.nz/nzcms-info.html>.) For further information about confidentiality matters in regard to this study please contact Statistics New Zealand.

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