ABSTRACT

Area-based markers of deprivation (e.g., postal codes) are commonly used to identify groups of people with low socioeconomic status (SES); the validity of this approach, however, remains unknown. In this study, we determined the accuracy of using income quintile groups calculated on the basis of the median family income of each forward sortation area (1996 Canadian census) to identify those living in poverty (i.e., annual family income of < \$12,620). The sensitivity and specificity of using the lowest income quintile to capture those in poverty were 26% and 83%, respectively (likelihood ratio (LR) of 1.49; 99% CI, 1.49 to 1.50). Among those in non-metropolitan and metropolitan areas, the LRs were 1.26 (99% CI, 1.26 to 1.27) and 2.01 (99% CI, 2.01 to 2.02), respectively. The use of postal codes as the only marker to identify people with low SES may result in substantial misclassification of personal poverty, particularly in non-metropolitan areas.

ABRÉGÉ

On utilise communément les indicateurs de dénuement fondés sur la zone (p. ex., le code postal) pour définir les groupes de gens dont le statut socio-économique (SSE) est faible, mais on ignore encore la validité d'une telle approche. Dans notre étude, nous avons déterminé le degré d'exactitude de l'emploi de quintiles de revenus calculés selon le revenu familial médian dans chaque région de tri d'acheminement (Recensement canadien de 1996) pour identifier les personnes vivant sous le seuil de pauvreté (revenu familial annuel <12 620 \$). La sensibilité et la spécificité de l'emploi du quintile de revenus inférieur pour identifier ces personnes étaient de 26 % et de 83 %, respectivement (rapport des vraisemblances (RV) de 1,49; IC 99 %, 1,49 à 1,50). Pour la population à l'extérieur des régions urbaines et en zone métropolitaine, les RV étaient respectivement de 1,26 (IC 99 %, 1,26 à 1,27) et de 2,01 (IC 99 %, 2,01 à 2,02). L'emploi du code postal comme seul indicateur des gens à faible SSE pourrait donc entraîner d'importantes erreurs de classement de la pauvreté individuelle, surtout à l'extérieur des régions urbaines.

Do Area-Based Markers of Poverty Accurately Measure Personal Poverty?

Don D. Sin, MD, MPH,¹ Larry W. Svenson, BSc,² S.F. Paul Man, MD¹

Poverty is a powerful determinant of inadequate access to quality care and poor health outcomes, particularly among those aged 65 years or less.^{1,2} Although personal income is a good marker of personal socioeconomic status (SES), in certain circumstances, this information may not be available.³ As a result, researchers have increasingly used area-based markers such as postal or zip codes as surrogates for personal SES in determining the impact of poverty on health outcomes as they are readily available in most large databases.^{4,5} The accuracy of this model rests on the assumption that people living in poverty reside in similar neighbourhoods. If there is significant heterogeneity in personal income levels within individual neighbourhoods, misclassification of socioeconomic position of residents may occur resulting in an "ecological fallacy." The direction and magnitude of this problem are difficult to predict; at the very least, residual effects of personal poverty will lead to an underestimation of the impact of SES on the outcomes of interest.⁶ The relationship between personal poverty (as measured by personal income) and regional poverty (as measured by area-based income) is not well known. With the increasing use of area-based markers to identify and control for the effects of poverty in Canadian health services research, it is important to determine the accuracy of using postal codes as a marker for personal poverty. In this study, we report on the relationship

between postal code-based marker of poverty and personal poverty using population-based data from Alberta, Canada.

METHODS

Data source

We searched through the Alberta Health Insurance Plan (AHIP) database to identify all residents in Alberta in 1996 who were covered under this plan. Because universal access to health care is protected by the Canada Health Act, very few residents were missed. The AHIP database contained sociodemographic information on 2,874,609 residents.

Markers of poverty

Alberta is one of two provinces in Canada that charge a small health care premium to its residents. The premiums are prorated according to the individuals' reported income from the previous year; those in poverty are exempted from these charges. Residents less than 65 years of age qualify for a government assistance that reduces (or in certain cases eliminates) their health care premiums if their personal annual adjusted taxable income is ≤ \$7,560 (or ≤ \$12,620 for families of two or more people). For dependants (i.e., children and young adults living at home), government subsidies for health care are determined by the combined adjusted annual income of their parents. The same rules governing premium subsidies that apply to adults also apply to children. Children whose parents have an annual combined income of ≤ \$12,620 receive government subsidies. Those receiving government subsidies represent approximately 15% of the entire population and are considered to be living in poverty.^{7,8}

Premium assistance is governed by a more lenient set of rules for seniors (≥ 65

1. Division of Pulmonary Medicine, Department of Medicine, University of Alberta, Edmonton, AB
2. Public Health Sciences, University of Alberta; and Health Surveillance Branch, Alberta Health and Wellness

Correspondence and reprint requests: Dr. Don D. Sin, 2E4.29 Walter C. Mackenzie Centre, University of Alberta, Edmonton, AB T6G 2B7, Tel: 780-407-6151, Fax: 780-407-6384, E-mail: don.sin@ualberta.ca

years of age) such that 65% of seniors qualify for assistance.⁸ Therefore, to reduce the heterogeneity of the study population, we excluded seniors from our analysis. We also excluded residents who were considered "Treaty Indian" because under the Indian Act, the Canadian Federal Government pays for the premiums of all First Nations people. We categorized the remaining population into two groups based on whether or not residents received government subsidies for health care premiums.

Postal code-based marker of socioeconomic status

We linked the AHIP data set with the 1996 official Canadian census data to calculate the median income for each neighbourhood area corresponding to the first three digits of the resident's postal code (i.e., forward sortation areas). Through this process, we identified 136 unique forward sortation areas (FSA); 2 FSAs were excluded because these areas did not contain any income data, leaving 134 FSAs for analysis. Approximately 2,500 to 8,000 residents reside in each of the FSAs.⁹ We then divided the neighbourhoods into five equal categories (quintiles) according to the reported median family income of each FSA.⁹

Metropolitan versus non-metropolitan

Alberta has two large metropolitan health care regions with > 500,000 people (i.e., Capital Health Authority and Calgary Regional Health Authority Regions). Using this information, we divided the population according to whether or not they resided in one of these large metropolitan centres. We did this because in cities there are distinct enclaves where persons in poverty reside in close proximity to each other, which may result in less heterogeneity of personal income within large city postal districts than in non-metropolitan regions.¹⁰

Statistical analysis

All categorical variables were compared using a χ^2 test, while continuous variables were compared using Student's *t* test. We generated receiver operating curves to visualize the sensitivity and specificity of using the lowest postal code-based income quin-

	Poverty No. (% of total)	Non-Poverty No. (% of Total)	P
No.	418,316	2,047,481	–
Age (years)			
(interquartile range)	26 (11, 43)	31 (15, 43)	<0.001
Age ≤ 18 years of age	129,880 (31.1)	593,170 (29.0)	<0.001
Female	221,306 (52.9)	994,099 (48.6)	<0.001
Metropolitan	245,271 (58.6)	1,229,553 (60.1)	<0.001
Postal Code-Based Income Quintiles (Q)*			
Q1 (lowest)	107,124 (25.6)	351,209 (17.2)	<0.001
Q2	106,206 (25.4)	406,358 (19.9)	<0.001
Q3	85,988 (20.6)	412,608 (20.2)	<0.001
Q4	74,420 (17.8)	425,888 (20.8)	<0.001
Q5 (highest)	44,578 (10.7)	451,418 (22.1)	<0.001

* Income quintiles were determined on the basis of the reported median annual personal income of postal code districts. Quintile 1 consisted of postal districts that had the lowest median reported personal income, while quintile 5 had the highest income.
Number in parentheses indicates percent of total for each category unless otherwise indicated.
The percentages for income quintiles do not add up to 100% due to rounding.

Groups	Sensitivity %	Specificity %	LR
Metropolitan	16.2	92.0	2.01
Non-metropolitan	39.0	69.2	1.26
< 18 years of age	26.8	82.0	1.49
≥ 18 years of age	25.1	83.1	1.49
Men	27.0	82.4	1.54
Women	24.4	83.0	1.46

Abbreviation: LR, likelihood ratio (which is sensitivity/(1-specificity))

tile as a proxy for personal poverty. Statistical significance was indicated by a *P* value of less than 0.01 in all analyses. All analyses were two-tailed in nature and conducted using SAS, version 7.0 (Cary, NC).

RESULTS

In 1996, there were 2,874,609 residents in Alberta. We excluded 408,812 (14% of the population) because they were seniors or had a "Treaty Indian" status. Therefore, the study population consisted of 2,465,797 people aged 0 to 64 years (median age 30, interquartile range 15 to 43); 29% of residents were under the age of 18, 49% of the population were female and 60% resided in a metropolitan centre.

Table I illustrates the comparison between residents who lived and did not live in poverty. Residents in poverty were more likely to be younger and female and to live in non-metropolitan areas than those not in poverty. Although those in

poverty were also more likely reside in impoverished neighbourhoods, there was significant heterogeneity in the distribution of these residents across various income quintiles.

The sensitivity and specificity of using the lowest income quintile of postal code districts to identify those in poverty were 26% and 83% respectively, which resulted in a likelihood ratio (LR) of 1.49 (99% confidence interval, CI, 1.49 to 1.50). The use of lowest income quintile to identify those in poverty was better among metropolitan dwellers producing a sensitivity of 16%, specificity of 92% and LR of 2.01 (99% CI, 2.01 to 2.02). Among those living in non-metropolitan areas, the sensitivity, specificity and the LR were 39%, 69%, and 1.26 (99% CI, 1.26 to 1.27; Figure 1) respectively.

Table II shows the sensitivities and specificities of using lowest family income quintile derived from postal codes and Census Canada to identify residents with

poverty stratified according to age and gender. Neither gender nor age materially modified the relationship between personal and area-based poverty.

DISCUSSION

Our study produced some important observations. First, we found that there was only a weak association between personal poverty and postal code-based marker of poverty in Alberta. The use of the lowest family income quintile based on postal-code districts and Census Canada data had a sensitivity of only 26% and a specificity of 83% for identifying residents in poverty, which suggests that there is significant heterogeneity of personal income within postal code districts. Use of postal code-based data for poverty alone may, therefore, lead to biased estimates of the impact of poverty on the process of health and outcomes.

Second, we observed that the association between personal and postal code-based poverty was weaker in non-metropolitan areas than in metropolitan regions. This is consistent with previous data showing that residents of low income cluster together in “ghettos” and inner city enclaves within

large metropolitan centres;¹¹ In contrast, smaller cities and towns do not have such distinct enclaves resulting in greater heterogeneity of personal income in individual neighbourhoods. This has implications not only for health services researchers but also for health policy-makers because income disparities within neighbourhoods are an important predictor of increased morbidity and mortality independent of absolute income levels.^{11,12}

Our findings are consistent with a recent report by Demissie et al.¹³ They demonstrated that among children in Montreal, there was only a weak correlation between individually collected income status and those obtained through census tract data (correlation coefficient of 0.39). They also showed that use of other markers of personal SES had a similar relationship with census-obtained data. We extend their data by demonstrating that the relationship between personal and area-based marker of SES is even weaker in non-metropolitan regions.

A current debate exists concerning the components of poverty that result in poor health outcomes. Several studies have demonstrated that disparities in health status between the rich and the poor are asso-

ciated with differences in self-management abilities, poor coping skills and psychosocial profile across SES. Under this paradigm, personal markers of SES rather than area-based SES are more important predictors of health outcomes.^{14,15} Other studies, however, have shown a strong relationship between health care access and outcomes.² Since poor neighbourhoods have fewer clinics, physicians and other health care professionals, the area in which patients reside may be an important component to suboptimal outcomes.^{16,17} Area-based measures in this context would contribute valuable information to health services research and to our understanding of the effects of poverty on health outcomes. Both area-based and personal markers of poverty should therefore be used to evaluate the effects of poverty, particularly in non-metropolitan regions.

Several limitations of this study should be addressed. Although the database we used allowed us to accurately identify residents living in poverty, we were not able to differentiate across various income categories among residents not living in poverty. However, previous studies have shown that the differences in health outcomes between those of high and medium SES are small, making this separation less important.¹⁸ Because postal and zip codes cover several hundred households, the findings of this study may not be generalizable to area-based markers that cover only a small number of households.¹⁹ The optimal population size for categorizing residents for income status is not well known and there is little evidence to suggest that markers that cover a smaller number of individuals perform better than those that cover larger populations.¹³ Furthermore, our findings may not be generalizable to the elderly population since we excluded seniors from the study. Because income distribution is less pronounced in the elderly than in the non-elderly, the association between area-based markers and personal poverty would be even weaker in this population.¹⁰

In summary, our study suggests that use of postal codes to identify people of low poverty may lead to a substantial misclassification of personal poverty status. Although area-based markers may be use-

ful in controlling for health effects of neighbourhoods, when feasible, personal income data should also be used to adequately evaluate the role of personal poverty on health outcomes of patients, particularly among those living in non-metropolitan areas. Failure to do so may lead to significant residual confounding by personal poverty, and at worst, may result in "ecological fallacy."

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