The Vancouver Area Neighbourhood Deprivation Index (VANDIX): a census-based tool for assessing small-area variations in health status

Authors: Nathaniel Bell and Michael V. Hayes
Date: September-October 2012

From: Canadian Journal of Public Health
Publisher: Springer

Document Type: Report
Length: 3,195 words

Abstract:
Objective: The Vancouver Area Neighbourhood Deprivation Index (VANDIX) is a census-based measure of socio-economic status (SES). It was designed to serve as an accessible and representative proxy marker of population health status without requiring more extensive health data. This paper describes the structure and previous applications of the VANDIX for measuring relative variations in health outcomes in British Columbia, Canada.

Methods: The VANDIX was constructed from a 2005 survey of provincial medical health officers asking them to comment on the best census markers of health status in British Columbia. The VANDIX is based on the weighted summation of seven socio-economic variables from the census, including in order of weighted importance: proportion without high school completion; proportion without university completion; unemployment rate; proportion of lone-parent families; average income; proportion of home owners; and employment ratio.

Results: The VANDIX has been applied in numerous research and policy settings across the province against several distributions of health status, including self-rated health, injury and access to health care services. In each assessment, the VANDIX has shown that socio-economic inequities parallel health inequities.

Conclusion: SES is one of the most influential factors that shape population patterns of health outcomes. Census-based indicators of SES such as the VANDIX can serve as easily accessible and representative markers of population health status, and have application for policy, research and public health promotion.

Key words: Socio-economic factors; censuses; health status indicators; British Columbia

Population patterns of mortality, disease, injury and access to health services are widely known to be influenced by socioeconomic circumstances. (1-5) Summary measures of the distribution of social and economic characteristics taken from the census help us to identify systematic variations in the health status of populations. These measures also provide a means to inform policymakers, service providers and the public at large about relative inequalities in health status.

There is long-established and comprehensive research dedicated to the development of area-based measures of social class and other aspects of socio-economic position for public health research and surveillance both in Canada and abroad. (6-12) The Vancouver Area Neighbourhood Deprivation Index (VANDIX) is a census-based measure of socio-economic status that was constructed for the purpose of analyzing small-area distribution of health status within urban populations of British Columbia. (13) Specifically, the VANDIX was designed to serve as an easily accessible and representative proxy measure of the health status of the population at a more granular geographic scale than provincial health authority boundaries. The organization of the Vancouver Coastal and Fraser Health Authorities shown in Figure 1 created the impetus for this work, as

both administrative areas straddle the Vancouver Census Metropolitan Area (CMA), which severely affects attempts to understand the distribution of health status at an intra-region level. This limitation not only restricts the generation of valid data for testing hypotheses about population health, but also severely limits the ability to organize collective attention toward managing common health concerns.

The overriding issue when constructing the VANDIX was deciding how best to build cooperative links with decision-makers who could help frame an understanding of health disparities and advance a health equity agenda, and how to do so in a way that would allow for a more representative view of local health outcomes that was not constrained by the boundaries of the provincial health authorities. To address these challenges, we constructed the VANDIX from a survey of provincial medical health officers (MHOs). This was an effort to evaluate an empirical measure of health status based upon perspectives on the determinants of health held by individuals who have the professional responsibility to provide leadership in addressing issues relating to health disparities. Thus, the VANDIX is based on what public health experts believe are the best census markers of health status.

Constructing the VANDIX

The VANDIX was developed using the results of a 2005 survey circulated to the MHOs in British Columbia. The VANDIX incorporated 21 indicators covering material wealth, housing, demographic factors, mobility, education, employment and culture. The survey was approved by the Research Ethics Board of Simon Fraser University and distributed by BC's Provincial Health Officer. Each MHO was asked to comment on which of the 21 indicators they felt best characterized poor health outcomes throughout the province. Variables included in the survey were identified from a literature review according to their association with health outcomes, their representation of both social and material deprivation, and the ability to construct each indicator directly or indirectly using Canadian census data. Respondents were asked to rate the importance of each indicator for characterizing poor health outcomes using a five-point Likert Scale (strongly agree responses=5, agree responses=4, neutral responses=3, disagree responses=2 and strongly disagree responses=1). A total of 10 of the province's 27 MHOs returned a completed survey for a response rate of 37 %. Table 1 lists all 21 variables originally included in the survey.

Our interest was to assess the variables felt by the majority of MHOs to most influence poor health outcomes against other indices and measures (described below). We administered a cut-off score of 31 to determine that the indicator received an overall "non-neutral" response (10 times a neutral response [value=3] + 1). Seven variables were identified from this process, including in order of weighted importance: the proportion of persons without high school completion; proportion of persons without a university degree; unemployment rate; proportion of lone-parent families; average income; proportion of home owners; and employment ratio.

The VANDIX is an additive index constructed from the summation of the standardized (z-score) values for each of the seven variables. Before summation, preference weights were assigned to each variable on the basis of the response frequency of MHOs' selection rankings regarding its influence as a determinant of health. The VANDIX weights were assigned by ordering each variable according to total response scores from all 10 MHOs. The variable that received the highest aggregate response score was assigned a ranking of 1, the next highest score was assigned a rank of 2, etc. The proportional weights were calculated by the following equation:

[w.sub.i] = n-[r.sub.j]+1/[SIGMA](n-[r.sub.j]+1)

where [w.sub.i] is the standardized proportional weight for the selected variable, n is the total number of variables in the index (n=7) and [r.sub.j] is the ordinal position of the variable. The preference weight assigned to each variable was obtained by dividing its ordinal position by 28, which is the sum of all ranking values. The seven weights in order of importance were 0.25, 0.214, 0.179, 0.143, 0.107, 0.714 and 0.035. Both "average income" and "home ownership" received identical scores from the MHOs, and so the final index assigned a rank of 2.5 to both indicators and a weight of 0.089 to ensure that all weights summed to 1.

The VANDIX was designed to be replicated using data available from the Canadian census. Canadian census data are accessible to anyone associated with an academic organization through Statistics Canada's Data Liberation Initiative (DLI). Under the DLI agreement, academic institutions pay a fixed fee that allows students, faculty and staff of Canadian universities to access DLI products. Variables used to build the VANDIX can be accessed using the Canadian Census Analyzer, which is an online electronic database distributed by the Computing in the Humanities and Social Sciences centre at the University of Toronto. The Census Analyzer is accessible from any university library's electronic index and database collections.

Table 2 outlines how each VANDIX data category was calculated using the data categories of the 2001 and 2006 Canadian census. The final score was created from the summation of each of the seven standardized and weighted variables, with positive weighted z-scores reflecting "greater disadvantage" or poorer health and negative scores representing "lesser disadvantage" or better health. The standardized z-scores of four variables--average income, university degree, employment ratio and home ownership--were multiplied by -1 before summation to maintain the association between positive z-scores and greater disadvantage. Once constructed, the final VANDIX score could be linked to spatially referenced census data using the unique identifier associated with each dissemination area, census tract or census subdivision for purposes of mapping,

geocoding or spatial analysis.

Uptake and use

The VANDIX has repeatedly reaffirmed the relation between both the social and economic environment and health status throughout British Columbia. It has been assessed against trends in individual perceptions of self-rated health, (13) and intentional and unintentional injury, (14-17) and it has been combined with ancillary geographic data to measure disparities in access to emergency medical care services. (18) Further uptake includes assessments by the Canadian Institute for Health Information as well as members of British Columbia's Interior Health Authority for evaluating variations in health status and local social service delivery. (19,20)

Methodological assessments of the VANDIX variables, the strength of agreement in MHO responses, the weighting scheme assigned to the variables, as well as the effect of the modifiable areal unit problem, have been also been tested. (13,21,22) In the initial assessment, we compared the effect size of the VANDIX score against a subset of data taken from the Canadian Community Health Survey (CCHS) Cycle 2.1 questionnaire on self-rated health with two additional Canadian deprivation indices: Frohlich and Mustard's socio-economic factor index (6) and Pampalon and Raymond's Deprivation Index for Health and Welfare Planning in Quebec. (10) The results from this assessment are shown in Figure 2. All three indices similarly produced a social gradient in health status within the Vancouver CMA when contrasted against self-rated health response scores from the CCHS. At the very minimum, the results supported the effectiveness of integrating into the construction of health indices the perspectives of decision-makers who could advance a health equity agenda, which is in contrast to the current preference for data-driven socio-economic indices (e.g., principal component analysis), a trend that largely emerged from past critiques (23,24) of the UPA8 constructed by Jarman et al. in the UK for allocating general practitioner resources.

While the observations identified from the VANDIX strongly reinforce the view that social and economic inequalities parallel health inequalities, no area-based measure of deprivation or health status is without its limitations. First, the VANDIX has not yet been assessed against individual-level socio-economic data representative of all seven area-level variables because of the difficulty of replicating each variable outside of the census. Rather, its assessments have been used to draw attention to socio-economic conditions that tend to make whole populations healthier than others, which may not necessarily reflect the factors that lead some individuals to be healthier than others. However, as the VANDIX score has repeatedly demonstrated correlation with health outcomes both over time and by case mix, the VANDIX findings provide evidence of at least some type of causal process between socio-economic characteristics and health status. Furthermore, the much broader literature on the determinants of health points to the effect of area- or neighbourhood-level socio-economic conditions on health, even after adjustment for the characteristics of the individuals therein. (25-27) Although the development of comparable, individual-level variables representative of the VANDIX may further define how socioeconomic position reflects population health status, it is highly likely that such an effort would largely confirm rather than challenge findings from previous studies.

A second concern is that the VANDIX as a relative measure of health inequity is primarily reflective of the material conditions that are important for health, such as adequate income, housing or employment as opposed to the social factors that reflect dimensions of cohesion and fragmentation that similarly underpin disparities in health status. (28) An additional concern is that by combining measures of income, education, employment and family demographic structure into a single index, we run the risk of conflating or potentially nullifying the various social and economic pathways thought to modify health outcomes. This is an issue that may be further compounded by defining health status using geographic boundaries, which may not meaningfully reflect the scale of social processes. While valuing each of the seven variables with a specified weight reduces this potential limitation it does not necessarily reduce the "averaging out" effect that two or more measures may incur (e.g., high income with low university graduation among persons in skilled trades; low income with home ownership). Such a limitation, however, is universally problematic for area-based deprivation measures, as most, if not all, markers incorporate multiple constructs representative of income, poverty or wealth, or proxy measures of social or material status or class. The simplifying alternative is to employ income as a proxy marker of health status, given its strong relation with the unequal distribution of mortality rates. (29,30) Although income distribution is generally a fairly clear indicator to interpret and is widely found to parallel health status, reinforcing the perception that health status is merely a reflection of income distribution detracts from addressing the importance of social conditions of everyday life as the crucial pathway that leads to excess morbidity and mortality.

CONCLUSION

Assessing the health experiences of populations against social and economic variables carries information about the characteristics of the social environment that are determinants of health. This association has been repeatedly demonstrated by the VANDIX as well as other census-based socio-economic measures both in Canada and abroad. One of the prevailing strengths of these tools is the ability to produce a readily available and representative marker of health status that enables leaders and researchers engaged in health policy and promotion to obtain a broader understanding of the distribution of health status at an inter-regional scale. This strength is largely due to the availability, structure and representativeness of national censuses, which remain the principal data sources for drawing attention to this association. While the health patterns raised by these studies clearly have limitations because of the reliance on area-level data to define individual health experiences, the fact that this pattern is recurrent is evidence of some underlying causal processes within our socio-economic environment that are

fundamentally important in shaping health experiences. However, the value of the VANDIX, as well as other Canadian health measures, faces substantial challenges given the federal government's recent decision to abolish the mandatory long-form census for the 2011 census year. Such a change will undoubtedly affect our ability to rely on the census as a rich, centralized data source given the widespread apprehension that its representativeness, particularly among the more vulnerable and marginalized populations, has now been significantly reduced.

Acknowledgements: Funding for N. Bell is provided by a postdoctoral fellowship awarded by the Canadian Institutes of Health Research.

REFERENCES

(1.) Krieger N. Theories for social epidemiology in the 21st century: An ecosocial perspective. Int J Epidemiol 2001; 30(4):668-77.

(2.) Marmot MG. The Status Syndrome: How Social Standing Affects Our Health and Longevity. New York, NY: Henry Holt, 2005.

(3.) Wilkinson RG, Pickett KG. The Spirit Level: Why More Equal Societies Almost Always Do Better. London, UK: Allen Lane, 2009.

(4.) Syme SL. To prevent disease: The need for a new approach. In: Blane D, Brunner E, Wilkinson RG (Eds.), Health and Social Organization. London: Routledge, 1996.

(5.) Cubbin C. Socioeconomic status and injury mortality: Individual and neighbourhood determinants. J Epidemiol Community Health 2000; 54:517-24.

(6.) Frohlich KL, Mustard C. A regional comparison of socioeconomic and health indices in a Canadian province. Soc Sci Med 1996; 942:1273-81.

(7.) Carstairs V, Morris R. Deprivation and mortality: An alternative to social class? Community Med 1989; 11(3):210-19.

(8.) Langlois A, Kitchen P. Identifying and measuring dimensions of urban deprivation in Montreal: An analysis of the 1996 census data. Urban Studies 2001; 38(1):119-39.

(9.) Morris R, Carstairs V. Which deprivation? A comparison of selected deprivation indexes. J Public Health Med 1991; 13(4):318-26.

(10.) Pampalon R, Raymond G. A deprivation index for health and welfare planning in Quebec. Chronic Dis Can 2000; 21(3):104-13.

(11.) Salmond C, Crampton P, King P, Waldegrave C. NZiDep: A New Zealand index of socioeconomic deprivation for individuals. Soc Sci Med 2006; 62(6):1474-85.

(12.) Townsend P, Phillimore P, Beattie A. Health and Deprivation: Inequality and the North. London: Croom Helm, 1987.

(13.) Bell N, Schuurman N, Oliver L, Hayes MV. Towards the construction of place-specific measures of deprivation: A case study from the Vancouver metropolitan area. The Canadian Geographer 2007; 51(4):444-61.

(14.) Bell N, Schuurman N, Hameed SM. A multilevel analysis of the socio-spatial pattern of assault injuries in Greater Vancouver, British Columbia. Can J Public Health 2009; 100(1):73-77.

(15.) Bell N, Schuurman N, Hameed SM. Are injuries spatially related? Join-count spatial autocorrelation for small-area injury analysis. Inj Prev 2008; 14(6):34653.

(16.) Bell N, Schuurman N, Hameed SM. A small-area population analysis of socioeconomic status and prevalence of severe burn/fire-related injury in British Columbia, Canada. Burns 2009; 35(8):1133-41.

(17.) Bell N, Simons RK, Lakha N, Hameed SM. Are we failing our rural communities? Motor vehicle injury in British Columbia, Canada, 2001-2007. Injury 2011; (August 10 [Epub ahead of print]).

(18.) Schuurman N, Bell N, Hameed SM, Simons R. A model for identifying and ranking need for trauma service in non-metropolitan regions based on injury risk and access to services. J Trauma 2008; 65(1):54-62.

(19.) Crabbe A. Mapping deprivation for the small city, rural context: A Kamloops-Thompson case study. Small Cities Imprint 2011; 3:40-51.

(20.) Canadian Institute for Health Information. Using Deprivation Indices to Measure Health Disparities and Inform Policy. Canadian Public Health Association Centennial Conference, 2010, June 14, 2010, Toronto, ON.

(21.) Bell N, Schuurman N, Hayes MV. Using GIS-based methods of multicriteria analysis to construct socio-economic deprivation indices. Int J Health Geographics 2007; 6:17.

(22.) Schuurman N, Bell N, Dunn J, Oliver L. Deprivation indices, population health and geography: An evaluation of the spatial effectiveness of indices at multiple scales. J Urban Health 2007; 84:591-603.

(23.) Carr-Hill R, Sheldon R. Designing a deprivation payment for general practitioners: The UPA(8) Wonderland. BMJ 1991; 302:393-96.

(24.) Davey-Smith G. Second thoughts on the Jarman Index--claims being made for the underprivileged area score are unproved. BMJ 1991; 302:359-60.

(25.) Diez Roux AV, Merkin SS, Arnett D, Chambless L, Massing M, Nieto FJ, et al. Neighborhood of residence and incident of coronary heart disease. N Engl J Med 2001; 345(2):99-106.

(26.) Oliver LN, Hayes MV. Neighbourhood socio-economic status and the prevalence of overweight Canadian children and youth. Can J Public Health 2005; 96(6):415-20.

(27.) Krishnan S, Cozier YC, Rosenberg L, Palmer JR. Socioeconomic status and incidence of type 2 diabetes: Results from the Black Women's Health Study. Am J Epidemiol 2010; 171(5):564-70.

(28.) Townsend P. Deprivation. J Social Policy 1987; 16:125-46.

(29.) Graham H, Kelly M. Health Inequalities: Concepts, Frameworks and Policy. London: NHS Health Department Agency, 2004.

(30.) Wilkinson RG, Pickett KG. Income inequality and population health: A review and explanation of the evidence. Soc Sci Med 2006; 62:1768-84.

Nathaniel Bell, PhD, [1] Michael V. Hayes, PhD [2]

Author Affiliations

[1.] Department of Surgery, University of British Columbia, Vancouver, BC

[2.] School of Public Health and Social Policy, and Department of Geography, University of Victoria, Victoria, BC

Correspondence: Michael V. Hayes, PhD, HSD Rm B202E, University of Victoria, Victoria, BC V8W 2Y2, Tel: 250-853-3108,

E-mail: mhayes@uvic.ca

Conflict of Interest: None to declare.

Caption: Figure 1. Relative distribution of socio-economic status for the Vancouver Central Metropolitan Area (CMA) as measured using the VANDIX at two spatial extents: a) census dissemination areas and b) local health area (LHA) boundaries. Administrative boundaries of the Vancouver Coastal and Fraser Health Authority are illustrated in section c)

Table 1. The 21 Variables That Provincial MHOs Were Asked to Characterize Regarding Their Link With Health Outcomes in BC

Material Wealth

1. Average income
2. Average dwelling value

Mobility

1. Moved in the last year
2. Moved in the last 5 years

Demographic Information

1. Elderly >65 living alone
2. Living alone
3. Single-parent family
4. Separated/divorced/widowed
5. Children under the age of 5
6. Family size >5 persons

Education

1. High school completion
2. University completion

Housing

1. Single-detached housing
2. Home ownership
3. Proportion of renters
4. Residence in an apartment

Employment

1. Employment ratio
2. Unemployment rate
3. Females in the labour force

Cultural

1. Non-Canadian citizen
2. First language non-official

Table 2. The Seven Individual Variables Used to Construct the VANDIX and Their Calculation Steps

Component	Census Variable
No high school completion *	NoCert--Without high school graduation certificate
Percentage of residents without high school completion	EduPop--Total population 20 years and over by highest level of schooling
University completion * ([dagger])	UniCert--University having certificate or diploma
Percentage of residents with a university degree	EduPop--Total population 20 years and over by highest level of

	schooling
Unemployment rate Unemployment rate of population aged 15 years and over	Unemployed
Proportion of lone-parent families Percentage of lone-parent families among all census families	LonePar--Total lone-parent families by sex of parent and no. of children TotFam--Total no. of census families by family structure and number of children
Average income ([dagger]) Average 2000 total income $	AveInc--Average 2000 total income $ among population 15 years and over by sex and presence of income
Home ownership ([dagger]) Proportion of persons owning their home	HomeOwn--Total owners of occupied private dwellings TotDwell--Total number of occupied private dwellings
Employment ratio ([dagger]) The ratio of those 15 years and over working or seeking work to the total population	Participation rate

Component	Calculation
No high school completion * Percentage of residents without high school completion	Percentage without high school degree=100 x (NoCert/EduPop)
University completion * ([dagger]) Percentage of residents with a university degree	Percentage with university degree=100 x (UniCert/EduPop)
Unemployment rate Unemployment rate of population aged 15 years and over	No change
Proportion of lone-parent families Percentage of lone-parent families among all census families	Percentage of lone-parent families=100 x (LonePar/TotFam)
Average income ([dagger]) Average 2000 total income $	No change
Home ownership ([dagger]) Proportion of persons owning their home	Percentage of home owners = 100 x (HomeOwn/TotDwell)
Employment ratio ([dagger]) The ratio of those 15 years and over working or seeking work to the total population	No change

* The 2006 Census questionnaire on education partitioned survey responses into three age blocks (15-24, 25-64, 65+).

([dagger]) Standardized z-score of the index variable multiplied by -1 prior to summation to ensure higher scores=greater deprivation.

Figure 2. VANDIX, Socio-economic Factor Index (SEFI) and Deprivation Index for Health and Welfare Planning

in Quebec (DIHWPQ) indices constructed for the Vancouver Central Metropolitan Area at the dissemination area (DA) census geography and contrasted against the percentage of population reporting "fair or poor self-rated health" as recorded from the CCHS Cycle 2.1 questionnaire on self-rated health

	VANDIX	SEFI	DIHWPQ
SES 1	4.0%	5.5%	5.2%
SES 2	8.0%	6.5%	7.5%
SES 3	8.6%	9.6%	8.7%
SES 4	9.8%	9.7%	10.1%
SES 5	17.3%	15.7%	15.1%

Note: Table made from bar graph.

Gale Document Number: GALE|A503264195