Angina and Socio-economic Status in Ontario

How Do Characteristics of the County You Live In Influence Your Chance of Developing Heart Disease?

Linda Feldman, RN, MScN

Colin McMullan, PhD

Tom Abernathy, PhD

ABSTRACT

Objective: To assist in the development of community heart health programming and policy development, the Central West Health Planning Information Network (CWHPIN) was asked by its partners to collaborate in obtaining information that might clarify the relationships between socio-economic status (SES) and heart disease among residents of Ontario, Canada. The purpose of this component of the project was to explore, at the county level, how much of the variation in *angina pectoris* (angina) could be explained by SES variables.

Study Design: Linear regression modeling was used to identify key predictors of angina hospitalization rates in counties Ontario-wide.

Results: Results of the linear regression modeling showed that SES variables (most notably education and occupation) were key predictors of angina, even when traditional risk factors (i.e., smoking, etc.) were included in the analysis.

Conclusion: This study demonstrates that, at the county level, socio-economic variables such as education and occupation have a significant relationship with rates of heart disease at the population level, even when including the traditional risk factors in the analysis.

La traduction du résumé se trouve à la fin de l'article.

Central West Health Planning Information Network (CWHPIN)

Correspondence: Colin McMullan, 10 George Street, Suite 301B, Hamilton, ON L8P 1C8, Tel: 905-570-9952 ext. 243, Fax: 905-570-0974, E-mail: mcmullanc@cwhpin.ca

Cardiovascular disease (CVD) is a leading cause of mortality throughout most of the world. This situation is true in Canada, where it is estimated that one in four (close to eight million) Canadians have some form of cardiovascular disease.¹ Cardiovascular disease was the leading cause of mortality (30.4%) in Ontario in 1996.² This burden of illness exacts a significant toll on the Canadian population in terms of disability and economic costs. As such, methods for ameliorating this burden remain a top public health priority.^{2,3}

Cardiovascular disease represents a broad category of conditions that affect the heart and circulatory system. The largest component of CVD is ischemic heart disease (IHD). IHD is a term applied specifically to the symptomatic narrowing of the coronary arteries by atherosclerotic changes.² IHD includes angina, which presents as chest pain resulting from decreased blood supply to the heart.⁴ Prolonged angina can lead to an acute myocardial infarct or heart attack (AMI). Hospitalization rates for angina, by county in Ontario (1992/93-1996/97), ranged from 154 to 535 per 100,000 (See Figure 1).

It is well accepted that factors such as physical inactivity, hypertension, smoking, diabetes, high blood cholesterol levels, and having a Body Mass Index (BMI) greater than 27, contribute to higher mortality and morbidity rates, but together, are able to explain only about 30% of the variance in CVD.⁵ Recently, strong evidence has emerged from work by a number of researchers⁶⁻⁸ that supports the argument that socio-economic status (SES) is an important independent risk factor in the etiology and progression of heart disease. The purpose of this paper was to discover the extent to which the variability in angina hospitalization rates could be explained by SES variables and lifestyle risk factors.

In Ontario, Public Health Units (PHUs) are required by the Ministry of Health and Long-Term Care (MOHLTC) to implement programs and initiatives designed to decrease deaths from heart disease. Currently, strategies suggested for reducing CVD relate primarily to traditional risk factors like smoking, a high fat diet, and physical inactivity. Further insight into which socio-economic risk factors and or combinations of risk factors influence local rates of illness is required. This evidence

may lead to further research and contribute new knowledge to support effective, broad-based heart health promotion programming and policy development.

METHODS

Data for this investigation were analyzed for Ontario's 49 counties, districts, and municipalities (Table I). The best Ontario-wide data sources available for this study were ecological measures at the county level. Data on angina hospitalization rates were obtained from the Institute for Clinical and Evaluative Sciences' (ICES) Atlas on cardiovascular health and services in Ontario.⁹ Data for traditional cardiovascular risk factors were obtained from the 1996 Ontario Health Survey (OHS). Our analysis included five traditional CVD risk factors: smoking, high blood pressure, physical inactivity, Body Mass Index (BMI) > 27 and diabetes. The choice of these factors was based primarily on their identification by ICES⁵ as the primary risk factors for cardiovascular disease and on the availability of data. We were unable to include information on cholesterol or dietary fat intake (also identified by ICES as key CVD risk factors) as the 1996 OHS did not include such data. SES

Figure 1. Angina morbidity rates in Ontario, 1996

variables were obtained from Statistics Canada's 1996 Census.

There remains little agreement as to precisely which measures best capture the concept of socio-economic status. For instance, although heart disease has been related to both ecological and individual SES measures, those used have been inconsis-

tent.^{6,10,11} However, measures of SES typically suggested in the health literature fall into the general areas of income (including income inequality), education, occupation and living conditions.^{10,11} Researchers¹⁰ have demonstrated that measures of SES are not interchangeable and the use of a variety of SES measures is recommended.

TABLE I

Variables and Data Sources

Variables	Categories	Data Sources	Years
Education	% Population over 15 years <Grade 9 (<GR 9 or Less than Grade 9) % Population over 15 years high school no graduation (>GR9<GR13 or Some High school) % Population over 15 years at least high school education (HIGHSCH or At Least High school) % Population over 15 years with Trade/Industrial certificate (w/trade cert.) Gini Concentration Ratio Education (GINI_EDU)	Statistics Canada Census	1996
Income	Average Household Income (AVEINCOM) Low Income Cut Off (LICO) economic families (LICO_ECO) LICO Unattached Individuals (LICO_UNA) LICO Private Dwellings (LICO_PRI) Gini Concentration Ratio Income (GINI_INC)	Statistics Canada Census	1996
Occupation/ Employment	% Labour force 15+ years & female (LABFEMA) % Labour force with Agricultural career (LABAGRIC) % Labour force with Managerial career (LABMANAG) % Labour force with Manufacturing career (LABMANUF) Unemployment Rate persons 15-24 years (UNE15_24) Unemployment Rate persons 25+ years (UNE25_+) Gini Concentration Ratio Occupation (GINI_OCC)	Statistics Canada Census	1996
Living Conditions	% Own Dwellings with costs > 30% income (OWNER30%) % Rent Dwellings with costs > 30% income (RENTED30%) % Household Owner Dwellings (OWNERHOU) Average Dwelling Value (AVERVALU) % Female Sole Support Parent Dwellings (FEMPAREN) % Households Sole Support Parent (SOLEPARE)	Statistics Canada Census	1996
Cardiovascular Morbidity	Age/sex adjusted Angina Hospitalization Rates per 100,000 population aged 20 yrs & over by County in Ontario (ICD-9 codes 411.0, 413.0)	Basinski A. Hospitalization for cardiovascular medical diagnosis. In: Cardiovascular Health & Services in Ontario, An ICES Atlas, 1999, Chapt. 2; page 33.	1992/93-1996/97
Cardiovascular Lifestyle Risk Factors	Smoking (Occasional plus daily) Physical Inactivity (% Inactive) Hypertension (Do you have high BP?) BMI greater than 27	Ontario Health Survey	1996

TABLE II

**Pearson Correlation (Parametric)
Between 18 Log-transformed Census
Variables and Dependent/Outcome
Variables**

Census Variable	Angina Morbidity
Average dwelling value	-0.666 **
% Less than Gr 9	0.403 **
% Some high school	0.567 **
% High school grad	-0.597 **
Trade/Industrial cert	0.654 **
% Agricultural career	0.237 n/s
% Managerial career	-0.389 **
% Manufacturing career	-0.087 n/s
% Female labour force	-0.498 **
Unemployment rate 15-24 yrs	0.454 **
Unemployment rate 25+ yrs	0.321 *
Average Income	-0.570 **
Owner Households	0.391 **
Own 30% or > costs	-0.363 *
Rent 30% or > costs	0.096 n/s
Gini Income	0.063 n/s
Gini Education	0.457 **
Gini Occupation	0.193 n/s

** Correlations are significant at the 0.01 level (2-tailed test of significance).

* Correlations are significant at the 0.05 level (2-tailed test of significance).

n/s = non-significance M = marginal significance (i.e., 0.05-0.07)

TABLE III

**Angina – Summary Table of Angina
Pectoris Modeling**

Model Summary	5 Variable 'Proposed' Model
R	0.752
R ²	0.565
Adjusted R ²	0.514
S.E. of estimate	0.087
F	11.16
Significance	0.000

Less Than Gr9 T=3.01, P=0.004
Some High school T=3.07, P=0.004
Managerial T=1.61, P=0.114
Gini Education T=-2.599, P=0.013
Trade/Industrial T=3.93, P=0.000

It was deemed important to use a variety of SES measures in order to explore the various meanings, components, and correlations between variables. Based upon: 1) an extensive literature review, and 2) the availability of data at the county level, 23 variables from an initial list of 45 SES indicators were selected as appropriate for inclusion in the analysis. SPSS (version 10.0) was used for the analyses.

Descriptive analyses

Because the distributions of both outcome (dependent) and predictor (independent) variables suggested some level of asymmetry, geometric transformations (i.e., natural log Base 10 transformations) were used to aid in linearizing relationships. The Pearson (parametric) correlation technique

TABLE IV

5 SES Variables and 5 Lifestyle Variables

Model Summary					
R	R Square	Adjusted R Square	Std. Error of the Estimate		
.809	.654	.563	8.268E-02		
ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	.491	10	4.908E-02	7.180	.000
Residual	.260	38	6.835E-03		
Total	.751	48			
Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-7.310	3.718		-1.966	.057
Less than grade 9	1.201	.471	1.116	2.552	.015
Some high school	2.069	.678	.709	3.054	.004
Managerial occupation	.410	.249	.293	1.644	.108
Gini education	-7.437	3.177	-1.238	-2.341	.025
Trade certificate	.520	.268	.341	1.943	.059
High blood pressure	.132	.303	.057	.435	.666
BMI > 27	-.220	.594	-.068	-.371	.713
Physical inactivity	-.278	.912	-.038	-.305	.762
Smoking	1.137	.525	.393	2.164	.037
Diabetes	-4.514E-03	.220	-.003	-.020	.984

was applied to examine associations between the outcome and predictor variables. Variables were selected for further study if they were found to be significantly associated at the 0.01 or 0.05 confidence level (2-tailed).

Multivariable regression analyses

Variables that emerged as exhibiting an association to the angina rates were included in an initial crude regression model. A subset of 15 predictors that had regression coefficients with *t* values of at least ± 1.0 ,¹² were selected for further examination. The selected variables were then adjusted for the inclusion and impact of lifestyle risk factors. Those predictors that continued to meet the guideline (± 1.0 *t*) were selected from the adjusted model and modeled further. The lifestyle variables were then added to the model. In the final model, all predictors met the more stringent guideline of ± 1.5 *t*. The variables in the final model were removed, one at a time, to assess their relative importance.

Given the nature of the SES variables, it is possible that there would be some strong correlations (collinearity) between the independent variables. Diagnostics such as tolerance and variance inflation factor were examined to assess the stability of inter-correlations and, thus, the stability of regression coefficients. Collinearity diagnostics were assessed during the initial and "final" models. The variables included were not extensively plagued with collinearity concerns.

RESULTS

Bivariate relationships

Initial explorations revealed that 15 of the original 23 SES census variables appeared to play a role in explaining angina hospitalization rates. Those that showed no association were eliminated from further testing (Table II).

Linear regression modeling

Before *adjusting* for the impact of the traditional risk factors, five SES predictors (the percentage of the population with some high school; the percentage of the population with less than grade nine; the Gini coefficient* for education; the percentage of the population with a trades certificate; and the percentage of the population engaged in a managerial occupation) were found to meet the pre-set criterion for final model inclusion of ± 1.5 *t*, and accounted for approximately 51% (51.4%) of the variation in angina hospitalization rates (Table III).

The model was then run again *including* the five traditional CVD risk factors (i.e., smoking, hypertension, diabetes, physical inactivity and BMI > 27) with the five SES

* The Gini coefficient is a measure of inequality based on the Lorenz curve. The Gini coefficient ranges from 0 to 1, with 0 representing perfect equality, 1 total inequality. The Gini coefficient for education essentially indicates the distribution of educational attainment levels in a community. For example, communities with a high proportion of the population with less than grade nine, and a low proportion with post-secondary education, would have a higher degree of inequality (i.e., values closer to 1).

variables. Of the traditional risk factors considered, only smoking emerged as a significant contributor to the model (Table IV). The other four risk factors (i.e., diabetes, BMI > 27, physical inactivity and high blood pressure) were removed from the model.

The remaining six variables combined to explain 60% of the variation in angina hospitalizations in Ontario. The percentage of the population with some high school emerged as the strongest predictor, followed by: the percentage of the population that smokes; the percentage of the population with less than grade nine education; the measure of educational inequality; the percentage of the population with a trades/industrial certificate; and finally, the percentage of the population engaged in a managerial capacity (Table V).

DISCUSSION

The regression modeling revealed that hospitalization rates for angina were higher in Ontario counties where education levels were lower, a higher proportion of the population smoked, there was greater educational inequality, and fewer residents had a managerial career. Measures of educational levels emerged as key predictors in the model, even when traditional risk factors were included. This does not imply a causal relationship between angina morbidity and the five SES predictors, only that there is a strong statistical association.

Education has been one of the most widely used measures of SES in epidemiological studies,^{6,9} and the relationship between education and CVD has been demonstrated.^{11,13-15} Educational measures (particularly, 'the highest level of education obtained') are considered to be one of the strongest, most reliable measures of cardiovascular health.¹⁵ Unlike occupation and income, levels of educational attainment tend to remain quite stable over time. In addition, questions regarding educational levels tend to have a high response rate (unlike income). Finally, because educational level is relatively fixed after young adulthood, it is unlikely to be influenced by poor health.⁶ Our study supports the findings of these (and other) authors.

In addition to level of educational attainment, our investigation also revealed that educational inequality (Gini coefficient for education) was an important pre-

TABLE V

"Final" Proposed Model (5 SES Predictors and 1 Lifestyle Variable)

Model Summary						
R	R Square	Adjusted R Square	Std. Error of the Estimate			
.806	.650	.600	7.907E-02			
ANOVA						
	Sum of Squares	df	Mean Square	F	Sig.	
Regression	.488	6	8.132E-02	13.007	.000	
Residual	.263	42	6.252E-03			
Total	.751	48				
Coefficients						
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	
	B	Std. Error	Beta			
(Constant)	-8.255	2.599		-3.176	.003	
Less than grade 9	1.230	.423	1.143	2.912	.006	
Some high school	2.169	.624	.743	3.475	.001	
Managerial occupation	.380	.219	.272	1.735	.090	
GINI education	-7.867	2.867	-1.309	-2.744	.009	
Trade certificate	.506	.224	.332	2.265	.029	
Smoking	1.117	.349	.386	3.200	.003	

dictor of Ontario-wide angina hospital separation rates at the county level in Ontario. In some ways, this finding mirrors the debate surrounding the question as to whether it is absolute or relative levels of income that lead to gradients in health status. While Muller¹⁶ observed that education was a more robust predictor of mortality than income inequality, Jerrett¹⁷ found that, of 17 indicators of social status, income inequality had the largest effect on premature mortality. With respect to hospital separation rates for angina, our results would suggest that both absolute (educational level attained) and relative (Gini coefficient for education) measures might be important predictors. If indicators of educational levels are indeed the most important and reliable predictors of SES, researchers should explore the issue of whether it is the absolute or the relative level of education that matters.

There are a number of possible explanations as to why income did not emerge as a significant predictor for angina morbidity in our investigation. With respect to the link between income and CVD, Raphael⁸ notes that a cause does not always lead directly to an outcome, but rather may lead to an increase in the probability that an outcome will occur. Further, it is important to remember that income is not particularly stable over time. There also exist issues surrounding the census measurement of income, including the fact that some people simply refuse to answer this question in the census and some may give inaccurate responses.

The findings are limited by the level and availability of data. The inclusion of addi-

tional variables (e.g., gender, ethnicity, dietary factors, etc.) might have altered the outcomes. The results are also limited by the scale of measurement (ecological) and by the fact that some towns and neighbourhoods within counties may not share all of the socio-spatial characteristics of the region.¹⁸ Although the use of area-based measures is subject to aggregation bias or "ecological bias", they may be able to tap characteristics of an area in which people live that cannot be measured at the individual level. In fact, empirical evidence to date suggests that underestimation of effects (due to SES heterogeneity of the neighbourhood), and not overestimation, may be more likely.¹⁹ As such, the results are generalizable only to the Ontario population.

CONCLUSION

This study demonstrates that socioeconomic variables are able to account for a significant proportion of the variation in hospitalization due to angina among counties in Ontario. Once again, however, while significant relationships exist, the exact nature of these relationships remains unknown. While there is an association between angina morbidity and SES, we cannot infer causation from this association.

In our investigation, education and occupation levels emerged as key predictors of heart disease. Policies and strategies that address workplace health and the socioeconomic context in which people live may also serve to decrease the inequalities in CVD risk factors and provide a healthier

(physically and mentally) community environment. These broader social policies need to occur within a context that continues to address the traditional CVD risk factors, particularly smoking. Coordinated action on both fronts may be necessary in order to reduce disparities in CVD across the province. This suggests the need to address the barriers (i.e., the current focus on lifestyle/behavioural factors in the province's Mandatory Guidelines) preventing PHUs in Ontario from addressing some of the broader societal determinants of health.²⁰ Finally, while it was beyond the scope of this paper to address the issue of whether or not Ontarians with lower educational or income levels are less likely to receive, or take advantage of, preventive services, our findings would seem to suggest that there may be value in targeting preventive heart health programs to areas characterized as high risk, by the SES measures discussed in this paper.

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RÉSUMÉ

Objectif : Pour favoriser l'élaboration de programmes et de politiques communautaires de santé cardiovasculaire, les partenaires du réseau Central West Health Planning Information Network (CWHPIN) ont cherché à obtenir des données pour clarifier la relation entre le statut socio-économique (SSE) et les cardiopathies chez les résidents de l'Ontario. Ce volet du projet visait à analyser, à l'échelle des comtés, la mesure dans laquelle les écarts dans la prévalence des angines de poitrine s'expliqueraient par les variables SSE.

Méthode : Des modèles de régression linéaire ont permis de déterminer les principaux prédicteurs des taux d'hospitalisation pour angine dans les comtés de tout l'Ontario.

Résultats : Les modèles de régression linéaire ont montré que les variables SSE (surtout le niveau d'instruction et la profession) étaient des prédicteurs clés des angines, même compte tenu des facteurs de risque classiques comme le tabagisme.

Conclusion : L'étude démontre qu'à l'échelle des comtés, il existe un lien significatif entre certaines variables socio-économiques (notamment le niveau d'instruction et la profession) et le taux de cardiopathie dans la population, même lorsque l'analyse tient compte des facteurs de risque classiques.