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(continued on reverse)

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Elements of Mobility as Predictors of Survival in Elderly Patients with Dementia: Findings from the Canadian Study of Health and Aging

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Abstract

In order to identify elements of mobility that predict survival in elderly people with dementia, we conducted a two-year follow-up of a cohort of dementia subjects from the population-based Canadian Study of Health and Aging. There were 749 prevalent cases of Alzheimer's disease and 208 prevalent cases of vascular dementia. Elements of mobility that predicted death during the two-year follow-up period included difficulty in dressing (OR = 2.08, 95% CI: 1.41–3.07), difficulty in getting about (OR = 1.69, 95% CI: 1.18–2.40), history of falls (OR = 1.43, 95% CI: 1.05–1.94), abnormal gait (OR = 1.61, 95% CI: 1.08–2.40) and abnormal motor strength (OR = 1.51, 95% CI: 1.07–2.15). Sociodemographic factors such as older age and male sex were also significant predictors of decreased survival. These associations are potentially useful to clinicians and health professionals by providing prognostic information to supply to families and suggesting areas in which interventions to improve survival might be focused.

***Key words**: dementia; mobility; predictors; survival*

Introduction

Old age is all too commonly a time of impaired neurologic function. In 1978, the annual cost of caring for patients with dementia in the United States, where dementia is the major debilitating condition of more than half the residents of nursing homes, was $12 billion, and the projected cost by the year 2030 is $30 billion (1978 dollars).[1] In Canada, prevalence estimates in 1991 suggested that 252,600 (8.0%) of all Canadians aged 65 and over met the criteria for dementia.[2] If the prevalence estimates remain constant, then the number of Canadians with dementia will rise to 592,000 by the year 2021.[2] In a 1998 study by Hux et al., the annual societal cost of care per patient with Alzheimer's disease (AD) in Canada ranged from $9,451 for mild disease to $36,794 (1996 Canadian dollars) for severe disease.[3]

Various institution- and community-based studies have indicated that survival is significantly reduced by AD and vascular dementia (VaD).[4–6] At present, the progressive course of dementia cannot be reversed,[7,8] and prognostic data are therefore important in the management of this condition and in the allocation of resources.[9] Several prognostic factors have been investigated: increasing age,[9–13] male sex,[6,9,10,13–15] functional disability (mobility),[6,8–10,16–19] severity of dementia,[4,5,8–11,14,15] age of onset,[8,9,11,12,16] educational level,[9,10,12,14,15] extrapyramidal signs (EPS)[11,20–22] and comorbidity.[1,5,8,14] Only age, sex and mobility have been shown consistently in the literature to be related to shorter survival, and since only mobility is modifiable, it is a vital prognostic factor in dementia.

Poor mobility is postulated to affect survival both by increasing the risk of falls and through secondary diseases related to immobility.[8] Patients with AD are known to be at considerable risk for falls and fractures compared with non-demented persons of the same age. Fractures tend to immobilize patients even further. Immobility then places them at risk for other potentially lethal events, such as pulmonary embolus and aspiration pneumonia.[8]

Unfortunately, past studies that have identified the value of mobility as a predictor of survival in dementia are hampered by methodologic complications

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TABLE 1
Review of studies with mobility as a prognostic indicator for survival in dementia

Author (year)	Size of study (*n*)	Years of follow-up	Type of dementia	Definition of mobility	Measure of association (95% CI)
Knopman et al. (1988)[17]	101	2	Alzheimer's disease (AD)	Blessed Dementia Rating Scale	OR = 2.2 (p = 0.03)
Walsh et al. (1990)[8]	126	6	AD	Wandering and falling	RR = 3.1 (1.4–6.6)
van Dijk et al. (1992)[19]	606	8	AD, Multi-infarct dementia (MID)	Stockton Geriatric Scale	OR = 1.7 (p < 0.05)
Bracco et al. (1994)[16]	145	9	AD	Blessed Dementia Rating Scale	HR = 2.11 (1.13–3.92)
Molsa et al. (1995)[6]	333	14	AD, MID	Disability graded on the need of help in daily activities	AD: RR = 1.15 (0.86–1.55) MID: RR = 2.32 (1.39–3.88)
Heyman et al. (1996)[10]	1036	7	AD	Blessed Dementia Rating Scale	HR = 1.09 (1.04–1.14)
Bowen et al. (1996)[18]	327	6.5	AD	Blessed Dementia Rating Scale	OR = 2.7 (1.7–4.5)
Aguero-Torres et al. (1998)[9]	223	7	All dementia	Katz Activities of Daily Living Scale	HR = 1.20 (1.09–1.33)

CI = confidence interval; OR = odds ratio; RR = relative risk; HR = hazard rate

(Table 1).[6,8–10,16–19] Many study populations consisted of subjects from geriatric and dementia clinics, psychiatric hospitals and nursing homes,[8,16,17,19] often with over-representation of advanced cases. The aim of all previous studies has been to detect predictors of disease prognosis,[6,8–10,16–19] and to our knowledge none has concentrated exclusively on investigating mobility. Most studies have restricted their scope to Alzheimer's disease,[8,10,16–18] and only one recent study has investigated all dementias.[9]

Finally, and most importantly, the definition of mobility has been poorly captured in almost all studies. A wide range of proxies for mobility, such as the Katz Activities of Daily Living (ADL) Scale,[9,23] the Blessed Dementia Rating Scale[10,16–19,24] and the Stockton Geriatric Rating Scale,[19,25] have been used. This is also the case outside the field of dementia.[26–31] None of these investigations, however, has brought together all of the important elements of mobility. An aggregation of these features that includes ADL, falls, walking, gait and motor system disorders would result in a powerful and instrumental definition of mobility. The combination of ADL measures and clinical variables would be unique in the study of mobility in dementia.

The high prevalence of dementia in older people, the rapid increase in the oldest sector of the population in industrialized countries and the lack of an effective treatment to reverse the disease underscore the need to identify factors related to favourable prognosis in dementia.[9] The aim of this study, a two-year evaluation of 957 subjects with dementia, was to identify elements of mobility that predict survival in elderly patients with dementia.

Methods

Setting and Participants

The study involved subjects from the Canadian Study of Health and Aging - Part 1 (CSHA-1). The CSHA-1 was a survey conducted across Canada in 1991–1992 to estimate the prevalence of dementia and its subtypes; details of the study methods have been reported elsewhere.[2] In brief, the survey included a representative sample of people aged 65 and over from community and institutional settings in all 10 provinces. Thirty-six cities and their surrounding rural areas were selected by cluster sampling;[32] roughly 60% of Canadians 65 and over lived in the sample areas.[2]

The community sample was obtained from the databases of the provincial health insurance plans, except in Ontario, where enumeration records were used. Of the 19,398 people on the community sample lists, 9,008 were eligible and agreed to participate.[2] The institutional sample comprised subjects in nursing homes, chronic care facilities and collective dwellings such as convents. It consisted of 1,817 subjects, of whom 1,255 were eligible and agreed to participate.[2]

For community participants, the survey had a two-phase design. In the first phase, individuals were interviewed in their homes after written consent had been obtained. The Older Americans Resources and Services ADL Scale was completed,[33] and a Modified

Mini-Mental State (3MS) examination was performed.[34] Individuals scoring 77 or less on the 3MS (maximum score = 100) were identified as potentially cognitively impaired and were invited to proceed to the second phase of the study, which involved a clinical assessment.[32] A random sample of those who scored higher than 77 was also invited to participate in the second phase in order to estimate the false-negative rate of the 3MS. Institutionalized subjects were evaluated in one phase, which included both the interview and the clinical assessment.

The clinical examination assessed the presence of cognitive impairment and provided a differential diagnosis of dementia.[2] The diagnostic criteria for dementia followed the third revision of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-III-R).[35] A diagnosis of Alzheimer's disease was based on the criteria of the National Institute of Neurological and Communicative Disorders and Stroke, and the Alzheimer's Disease and Related Disorders Association.[36] A draft of the 10th revision of the International Classification of Diseases was used to define subcategories of vascular and other dementias.[37]

The examination was in four parts. Clinical team members were unaware of the 3MS score obtained at the screening interview. First, a nurse administered the 3MS examination; tested hearing, vision and vital signs; recorded height, weight and medication use; and obtained the subject's cognitive and family history from a relative, using section H of the Cambridge Mental Disorders of the Elderly Examination (CAMDEX).[2,38] Second, a neuropsychologist evaluated psychometric test results in conjunction with the results of the CAMDEX and the 3MS examination administered by the nurse. Third, a physician reviewed the information collected by the nurse and examined the patient, performing a mental status assessment as well as physical and neurologic examinations. Finally, subjects suspected of having dementia or delirium were sent for hematologic and biochemical tests.[2]

Final diagnostic categories included no cognitive impairment (NCI), cognitive impairment without dementia (CI) and four general types of dementia: AD (probable and possible Alzheimer's disease), VaD (vascular dementia), other dementia and unclassified dementia.[32] Other dementias included those resulting from Huntington's chorea, Creutzfeldt-Jakob disease, Parkinson's disease, Pick's disease and head injury. The final diagnosis for each participant was reached in a consensus conference that integrated all available data on a particular individual and included the physician, study nurse, psychometrician and neuropsychologist who had examined the patient.

Consistency of diagnosis was assessed in two ways. First, there was a comparison of the diagnosis given with that obtained from a computer algorithm. Second, for 210 cases, a review of clinical chart data by a study physician from another centre was performed. The agreement between the computer classification and the final diagnosis was 97.6% for the distinction between dementia and non-dementia and 97.5% for the distinction between probable AD and other types of dementias.[32] The kappa index of agreement between the study diagnosis and the review diagnosis by the second physician was 0.70 for the classification of NCI, CI, AD and other dementias.[2]

The present investigation followed a cohort of 957 subjects: 272 community subjects with a diagnosis of AD and 77 with a diagnosis of VaD; and, of institutionalized subjects, 477 with AD and 131 with VaD. Subjects with a diagnosis of "other" and "unclassified" dementia were excluded from the study.

In 1993–1994, two years after the CSHA-1, the 18 study centres conducted a field study, known as the Maintaining Contact Study (MCS), to re-contact CSHA-1 participants. Basic health status, including vital status, was assessed at that time. The CSHA-2 study then followed in 1996–1997, and re-evaluated the individuals involved in CSHA-1. The vital status of each individual in the CSHA-1 cohort was assessed using MCS data from two years after the clinical examination in conjunction with CSHA-2 data. Information on the date of death was obtained through next-of-kin interviews and confirmed with the Provincial Registrar of Births and Deaths. At this time, 267 subjects with AD and 81 subjects with VaD had died.

Prognostic Factors

Mobility

The main predictor of interest in this study was mobility. Items and measures were selected from the clinical examination phase of the CSHA-1 based on five broad categories: ADL, walking, falls, motor system disease and gait. These elements formed an operational definition of mobility.[4,8–10,16–19,26,28,30]

The ADL category was represented by difficulties in dressing. This item was part of the CAMDEX section of the clinical assessment.[38] The CAMDEX interview was conducted by a study nurse with a relative, friend or caregiver who may or may not have been living with the subject. Nurses underwent a one-week training program in administration of the CAMDEX, which is both a valid and reliable measure.[2,38] Subjects were categorized as having, or not having, difficulties in dressing, which ranged from misaligned buttons to complete inability to dress themselves. Information on this variable was available for 926 of the 957 subjects. Walking and ability to get about were also assessed by the CAMDEX. Participants were classified as having, or not having, difficulties in getting about. Data on this variable were missing for 101 subjects.

Information on previous falls was obtained by the physicians through a clinical history involving the patient and/or family member. The physicians' clinical and physical assessments were standardized using training materials such as manuals and videotapes.[2] Information on history of falls was unavailable for 66 subjects. Motor

system strength and gait were assessed by physical examination. These variables were categorized as normal, abnormal or could not be examined. Gait pattern and motor strength could not be examined in 34% and 13% of individuals respectively.

Covariates

Because other factors, for example age and comorbidity, are also associated with mobility, they are classically defined covariates of the mobility–survival association and were adjusted for in the analyses. Sociodemographic covariates were collected during the clinical assessment phase of the study. Data for age, sex and residence were complete. Information on marital status was missing for eight individuals, and educational data were available for 795 of the 957 participants.

Further information was gathered on disease-related covariates, including dementia type, duration and severity, and cognitive function (3MS). Subjects were categorized as having a diagnosis of AD or VaD, and dementia severity was graded by physicians as mild, moderate or severe; severity data were missing for 11 subjects. The duration of dementia was taken as the age of onset of first memory symptoms (CAMDEX data) subtracted from age at clinical assessment. This information was available for 861 of the 957 participants. The 3MS examination to evaluate cognitive function was conducted during the clinical assessment phase, and the score was summarized into four categories (0–29, 30–49, 50–69 and 70–100); scores were missing for 98 subjects.

Data on comorbid conditions were collected using physician clinical histories and the CAMDEX. Subjects were categorized as having a positive or negative history of heart attack, stroke, Parkinson's disease and respiratory difficulties (asthma, bronchitis). For 39 subjects, data were missing on heart attack; for 121, on respiratory problems; for 47, on stroke; and for 23, on Parkinson's disease.

Statistical Methods

Descriptive univariate analyses and comparisons among all prognostic variables were conducted using simple distributions, Pearson correlations and chi-squared tests.[39] Bivariate comparisons between individual predictors and outcome status were made using chi-squared tests.[39] The effect of prognostic factors on survival was then further evaluated by unconditional logistic regression modelling.[40] This technique provided the best fitting and most parsimonious models to describe the relation between the dichotomous survival outcome and the set of independent mobility and covariate variables.[40] Age, sex, education and type of dementia were substantively included in the models.

Each mobility variable was then modelled independently of the others. Possible prognostic covariates were entered successively. The four variables related to comorbid conditions were entered as a group. This modelling approach was used for the analysis of all demented subjects and for separate analyses of community and institution dwellers. Regression was performed using the indicator method to account for missing data:[41–43] for each variable with missing values a missing-value indicator was created,[41,42] which took the value 1 wherever the original variable was missing and 0 elsewhere.[41,42] Statistical analyses were conducted using the SAS statistical software package.[44]

Mobility and several covariates were investigated as potential predictors of survival. Age was entered in the models as a continuous variable. Sex (male or female), residence (community or institution), education (< 8 years or 8+ years), dementia type (AD or VaD), difficulty dressing (yes or no), difficulty getting about (yes or no), history of falls (yes or no) and all comorbidity variables (yes or no) were evaluated as dichotomous. Finally, disease duration (< 2, 3–5, 6+ years), severity (mild, moderate, severe), 3MS score (0–29, 30–49, 50–69 and 70–100), gait (normal, abnormal, could not be examined) and motor strength (normal, abnormal, could not be examined) were evaluated as categorical variables.

Results

General Characteristics

Of the 957 study subjects, 749 had a diagnosis of AD and 208 of VaD. Mean age at clinical examination was 85.0 (standard deviation = 7.1) years. Table 2 lists the principal baseline characteristics of the sample, and Table 3 summarizes the baseline mobility and comorbidity data.

In further unadjusted analyses, several sociodemographic characteristics varied significantly between community and institution dwellers. Subjects living in institutions were older than subjects in the community ($p = 0.005$) and included a higher proportion of females ($p < 0.001$) and of severe cases of dementia ($p < 0.001$). However, no significant differences were observed in the proportion of more highly educated participants ($p = 0.265$) or in the proportion of AD versus VaD dementia ($p = 0.852$) as a function of residence.

The unadjusted proportion of individuals with difficulties in dressing and getting about differed significantly with respect to residence, as did the unadjusted proportion of subjects with past falls, gait problems and strength difficulties (all $p < 0.001$). A history of stroke and Parkinson's disease was found to be more common in institutionalized subjects ($p = 0.003$ and $p = 0.050$ respectively), whereas no significant differences in a history of heart attack ($p = 0.444$) or respiratory problems ($p = 0.150$) were observed between community and institution residence.

Correlation analysis of sociodemographic, mobility and comorbidity variables revealed a high Pearson correlation coefficient of 0.756 ($p < 0.001$) between disease severity and 3MS score. Because of a high occurrence of missing data for 3MS (10.2%) as compared with disease severity (1.1%), the 3MS variable was excluded from further analysis. Replacing severity with 3MS in the analyses yielded similar results.

TABLE 2
Baseline demographic and clinical characteristics of the study population: percent distribution of variables

Baseline characteristics		All subjects *n* = 957	Subjects by vital status at two-year follow-up		
			Alive *n* = 609	Dead *n* = 348	*p* value[a]
Age (years)	65–74	7%	8%	3%	< 0.001
	75–84	36%	38%	34%	
	85+	57%	54%	63%	
Sex	Male	30%	27%	34%	0.024
	Female	70%	73%	66%	
Residence	Community	36%	44%	24%	< 0.001
	Institution	64%	56%	76%	
Marital status[b]	Married	25%	24%	27%	0.237
	Single, divorced, widowed	75%	76%	73%	
Education (years)[b]	Elementary (0–7)	55%	55%	54%	0.703
	Higher (8+)	45%	45%	46%	
Dementia type	Alzheimer's disease	78%	79%	77%	0.382
	Vascular dementia	22%	21%	23%	
Duration of disease (years)[b]	0–2	30%	31%	27%	0.067
	3–5	40%	38%	46%	
	6+	30%	31%	27%	
Severity of dementia[b]	Mild	22%	25%	15%	< 0.001
	Moderate	38%	41%	35%	
	Severe	40%	34%	50%	
3MS score[b]	0–29	36%	31%	46%	< 0.001
	30–49	23%	22%	26%	
	50–69	30%	34%	22%	
	70–100	11%	13%	6%	

[a] Crude (unadjusted) ^{2} test
[b] These variables have some missing values, as explained in the Methods section.

Predictors of Survival

Unadjusted bivariate comparisons between individual predictors and outcome status revealed that survivors were significantly younger ($p < 0.001$) and were more likely to be female ($p = 0.024$), to live in the community ($p < 0.001$) and to have a milder dementia ($p < 0.001$) than those who died (Table 2). There was no significant difference between survivors and deceased in educational level ($p = 0.704$), duration of disease ($p = 0.067$) or type of dementia ($p = 0.382$). Evaluation of individual mobility variables indicated that survivors were less likely to have a history of falls ($p < 0.001$), difficulties in dressing ($p < 0.001$), difficulties in getting about ($p < 0.001$), gait problems ($p < 0.001$) and strength problems ($p < 0.001$) (Table3). There were no significant differences in comorbidity characteristics, including the proportion of participants with histories of stroke ($p = 0.060$), respiratory problems ($p = 0.231$) or Parkinson's disease ($p = 0.082$). However, a history of previous heart attack was found to be less likely in survivors after two years of follow-up ($p = 0.047$).

Regression Modelling

The effect of mobility and other prognostic factors on survival was further evaluated for all subjects by unconditional logistic regression modelling (Table 4). Models 1 through 5 provided the odds ratio (OR) and 95% confidence intervals (95% CI) for each mobility variable adjusted for age, sex, residence, education, dementia type, dementia severity and all comorbid conditions. In all five models adjusted for covariates, individuals with any type of mobility difficulty were at

TABLE 3
Baseline mobility and comorbidity characteristics of the study population: percent distribution of variables

Baseline characteristics		All subjects *n* = 957	Subjects by vital status at two-year follow-up		
			Alive *n* = 609	Dead *n* = 348	*p* value[a]
Mobility					
Difficulty dressing[b]	No	39%	48%	24%	< 0.001
	Yes	61%	52%	76%	
Difficulty getting about[b]	No	33%	39%	22%	< 0.001
	Yes	67%	61%	78%	
History of falls[b]	No	64%	68%	55%	< 0.001
	Yes	36%	32%	45%	
Gait	Normal	26%	32%	15%	< 0.001
	Abnormal	40%	40%	39%	
	Could not be examined	34%	28%	46%	
Motor system strength	Normal	56%	62%	46%	< 0.001
	Abnormal	31%	27%	37%	
	Could not be examined	13%	11%	17%	
Comorbidity					
History of heart attack[b]	No	86%	88%	83%	0.046
	Yes	14%	12%	17%	
History of respiratory problems[b]	No	82%	83%	80%	0.231
	Yes	18%	17%	20%	
History of stroke[b]	No	69%	71%	65%	0.060
	Yes	31%	29%	35%	
History of Parkinson's disease[b]	No	96%	94%	97%	0.078
	Yes	4%	6%	3%	

[a] Crude (unadjusted) ^{2} test
[b] These variables have some missing values, as explained in the Methods section.

significantly greater risk of death at two-year follow-up. The adjusted models further indicated that individuals who could not be examined for gait abnormalities were also at significantly increased risk of a poor outcome. Finally, the adjusted associations between death at two-year follow-up and older age, male sex and institutional residence were all statistically significant, confirming the results of the crude bivariate analyses.

Other baseline characteristics, including educational level, dementia type, dementia severity and all comorbid conditions except for heart attack history were not significantly related to survival after adjustment for all other variables. When duration of dementia was entered into all five models it was not significantly related to survival, and because of the high occurrence of missing values (10.0%), it was removed from further analysis. All five mobility variables were found to be significant ($p = 0.002$) when entered as a group into a model containing all other baseline variables. Assessment of standard errors in this model revealed no collinearity issues.[40]

Similar logistic regression models were constructed, separately, for community and institution dwellers. In the community sample, only older age, male sex, difficulty getting about and abnormal gait were significant predictors of shorter survival after adjustment for covariates (Table 5). Severity of dementia was only a significant predictor when severe cases were compared with mild cases, and VaD dementia was found to significantly predict poor survival in the three models that included the variables of strength, falls and difficulty getting about. In the institution sample, older age, male sex, difficulties dressing, difficulties getting about and abnormal motor strength were the strongest predictors of

TABLE 4
Predictors of death in dementia after two years of follow-up: unconditional logistic regression modelling of all subjects (*n* = 957)

	Model 1		Model 2		Model 3		Model 4		Model 5	
Predictor	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Age (years)	1.05	1.03–1.07[c]	1.05	1.03–1.08[c]	1.05	1.03–1.07[c]	1.05	1.03–1.07[c]	1.05	1.03–1.08[c]
Male vs female	1.79	1.29–2.49[c]	1.79	1.29–2.48[c]	1.78	1.28–2.46[c]	1.82	1.31–2.52[c]	1.78	1.29–2.47[c]
Residence										
Institution vs community	1.57	1.08–2.26[a]	1.87	1.32–2.66[c]	1.86	1.31–2.65[c]	1.71	1.19–2.45[b]	1.82	1.27–2.59[b]
Education										
Higher vs elementary	1.05	0.76–1.43	1.06	0.78–1.45	1.08	0.79–1.48	1.08	0.79–1.48	1.08	0.79–1.48
Dementia type										
Vascular vs Alzheimer's	1.10	0.73–1.66	1.15	0.76–1.73	1.14	0.76–1.72	1.10	0.73–1.65	1.05	0.69–1.61
Severity of dementia										
Moderate vs mild	1.01	0.66–1.54	1.20	0.79–1.82	1.17	0.78–1.76	1.18	0.78–1.78	1.17	0.78–1.76
Severe vs mild	1.12	0.68–1.83	1.44	0.89–2.31	1.52	0.96–2.42	1.37	0.86–2.20	1.45	0.91–2.33
Mobility										
Difficulty dressing	2.08	1.41–3.07[c]								
Difficulty getting about			1.69	1.18–2.40[b]						
History of falls					1.43	1.05–1.94[a]				
Gait (vs normal)										
Abnormal							1.61	1.08–2.40[a]		
Could not be examined							2.01	1.27–3.16[b]		
Motor strength (vs normal)										
Abnormal									1.51	1.07–2.15[a]
Could not be examined									1.36	0.85–2.17
Comorbidities										
Heart attack	1.57	1.05–2.35[a]	1.59	1.06–2.38[a]	1.55	1.04–2.31[a]	1.56	1.05–2.33[a]	1.61	1.08–2.40[a]
Respiratory problems	1.27	0.85–1.89	1.17	0.79–1.74	1.23	0.83–1.83	1.17	0.79–1.74	1.19	0.80–1.77
Stroke	1.08	0.75–1.56	1.04	0.72–1.51	1.04	0.72–1.51	1.01	0.70–1.46	1.02	0.70–1.48
Parkinson's disease	1.46	0.73–2.93	1.41	0.70–2.82	1.42	0.71–2.85	1.37	0.69–2.73	1.45	0.72–2.90

[a] 0.050 p 0.010
[b] 0.010 p 0.001
[c] $p < 0.001$

decreased survival (Table 6). Individuals who could not be examined for gait abnormalities were found to be at significantly increased risk of a poor outcome.

Discussion

Summary of Results

All elements of mobility were found to be significantly related to decreased survival, both before and after adjustment for other covariates. Inability to perform the examination to assess gait function also strongly predicted shorter survival. Older age and male sex consistently predicted shorter survival among all subjects and in separate analyses of institution and community dwellers. Education, dementia type, dementia duration and dementia severity were not significantly related to survival among all subjects, although VaD and severe dementia predicted poor survival in community dwellers alone. Finally, only one comorbid condition, heart attack history, was a significant predictor of death at two-year follow-up.

TABLE 5
Predictors of death in dementia after two years of follow-up: logistic regression models of community dwellers (*n* = 349)

	Model 1		Model 2		Model 3		Model 4		Model 5	
Predictor	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Age (years)	1.14	1.08–1.20[c]	1.14	1.08–1.21[c]	1.15	1.08–1.21[c]	1.14	1.07–1.20[c]	1.15	1.09–1.21[c]
Male vs female	2.54	1.40–4.61[b]	2.48	1.37–4.50[b]	2.66	1.46–4.84[b]	2.69	1.46–4.95[b]	2.55	1.40–4.64[b]
Education										
Higher vs elementary	0.86	0.48–1.55	0.86	0.48–1.55	0.89	0.50–1.60	0.84	0.46–1.51	0.87	0.49–1.57
Dementia type										
Vascular vs Alzheimer's	2.05	0.95–4.42	2.20	1.04–4.67[a]	2.18	1.03–4.60[a]	1.99	0.93–4.27	2.20	1.01–4.80[a]
Severity of dementia										
Moderate vs mild	1.21	0.65–2.25	1.31	0.72–2.40	1.29	0.71–2.34	1.36	0.75–2.46	1.37	0.76–2.49
Severe vs mild	3.26	1.13–9.40[a]	3.83	1.43–10.2[b]	4.00	1.52–10.5[b]	3.89	1.47–10.3[b]	3.81	1.44–10.1[b]
Mobility										
Difficulty dressing	1.67	0.85–3.28								
Difficulty getting about			1.89	1.02–3.49[a]						
History of falls					1.77	0.96–3.26				
Gait (vs normal)										
Abnormal							1.91	1.01–3.60[a]		
Could not be examined							1.98	0.66–5.93		
Motor strength (vs normal)										
Abnormal									1.24	0.60–2.53
Could not be examined									2.24	0.41–12.2
Comorbidities										
Heart attack	1.62	0.78–3.38	1.50	0.71–3.15	1.56	0.76–3.28	1.50	0.71–3.14	1.61	0.77–3.34
Respiratory problems	0.98	0.49–1.98	1.01	0.50–2.04	1.01	0.50–2.05	0.93	0.46–1.88	0.99	0.49–1.98
Stroke	0.73	0.35–1.55	0.70	0.33–1.46	0.71	0.34–1.48	0.68	0.33–1.43	0.70	0.33–1.47
Parkinson's disease	2.73	0.53–14.1	3.22	0.63–16.6	3.26	0.64–16.5	2.39	0.45–12.6	3.01	0.59–15.4

[a] 0.050 p 0.010
[b] 0.010 p 0.001
[c] $p < 0.001$

Characteristics and Limitations

This study had three main limitations. First, the cohort of dementia subjects was derived from a population-based survey and therefore included only prevalent cases of dementia. Cases with very rapid progression of disease were less likely to be included. Second, despite the large initial sample size, the separate analyses for community and institutional residence may have had limited power, and those results not found to be statistically significant need to be interpreted with caution. Third, the cohort may also have had insufficient power to detect a true difference in some variables that were uncommon in this population, such as individual comorbidity.

However, the sample included community and institution dwellers as well as AD and VaD cases, and the present findings are believed to be generalizable to prevalent dementia in a broad-based population. Information on mobility variables, covariates and vital status measures were accurately and precisely collected in order to minimize misclassification bias.[2] Finally, stringent sampling procedures and assessment of all known covariates aided in the reduction of selection and confounding biases.[2]

Comparison with Literature

The present study, indicating that mobility is an important predictor of survival in elderly people with dementia, is consistent with results from previous studies that have evaluated functional disability in dementia.[6,8–10,16–19] We observed that elements of mobility that included

TABLE 6
Predictors of death in dementia after two years of follow-up: logistic regression models of institutionalized subjects (*n* = 608)

	Model 1		Model 2		Model 3		Model 4		Model 5	
Predictor	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Age (years)	1.03	1.01–1.06[b]	1.04	1.01–1.06[b]	1.03	1.01–1.06[a]	1.03	1.01–1.05[a]	1.03	1.01–1.06[b]
Male vs female	1.56	1.04–2.33[a]	1.58	1.06–2.36[a]	1.55	1.04–2.33[a]	1.59	1.06–2.37[a]	1.56	1.04–2.33[a]
Education										
Higher vs elementary	1.18	0.80–1.73	1.17	0.79–1.72	1.20	0.82–1.77	1.22	0.83–1.80	1.22	0.83–1.80
Dementia type										
Vascular vs Alzheimer's	0.82	0.50–1.36	0.81	0.49–1.34	0.82	0.49–1.36	0.81	0.49–1.34	0.74	0.44–1.23
Severity of dementia										
Moderate vs mild	0.82	0.44–1.55	0.96	0.52–1.81	0.93	0.50–1.73	0.92	0.49–1.72	0.91	0.49–1.70
Severe vs mild	0.82	0.43–1.57	1.04	0.56–1.94	1.09	0.59–2.02	0.98	0.53–1.83	1.02	0.55–1.90
Mobility										
Difficulty dressing	2.12	1.28–3.51[b]								
Difficulty getting about			1.59	1.02–2.50[a]						
History of falls					1.38	0.97–1.98				
Gait (vs normal)										
Abnormal							1.29	0.74–2.23		
Could not be examined							1.75	1.00–3.05[a]		
Motor strength (vs normal)										
Abnormal									1.65	1.09–2.49[a]
Could not be examined									1.38	0.84–2.27
Comorbidities										
Heart attack	1.54	0.93–2.53	1.64	0.99–2.71	1.54	0.94–2.54	1.57	0.95–2.59	1.63	0.99–2.70
Respiratory problems	1.47	0.88–2.46	1.25	0.75–2.07	1.39	0.84–2.31	1.33	0.81–2.21	1.30	0.79–2.16
Stroke	1.25	0.81–1.93	1.24	0.81–1.92	1.23	0.80–1.91	1.21	0.78–1.87	1.18	0.76–1.82
Parkinson's disease	1.45	0.67–3.14	1.36	0.63–2.94	1.39	0.64–2.99	1.40	0.65–3.01	1.44	0.67–3.10

[a] 0.050 p 0.010
[b] 0.010 p 0.001
[c] $p < 0.001$

difficulty in dressing and getting about were important prognostic factors, confirming results from studies that have assessed these variables using ADL scales.[6,9,10,16–19] A history of falls was also found to predict poor survival. To our knowledge, falls were examined only in one prior investigation, by Walsh et al.,[8] which reported similar results in a hospital-based study of AD patients.

The role of abnormal gait, although predictive of poor outcome in this study, has been controversial in the literature. Studies on gait and EPS in Alzheimer's disease by Stern et al.[22] and Lopez et al.[21] differed as to the importance of EPS in predicting mortality. We found, however, that the inability to examine gait is more predictive of death than abnormal gait itself. This was not remarked upon in previous studies, but may have been due to subjects' inability to stand up for the examination and may have been a marker of their general status[45].

Motor strength was strongly related to survival, but its role was never examined in past investigations. Studies outside the field of dementia have indicated the importance of motor strength as a component of mobility.[26–31] The closest proxy to motor strength investigated in the dementia literature is cachexia, which was shown both by Evans et al.[46] and Nielsen et al.[47] to be associated with poor survival.

Sociodemographic factors, including older age and male sex, significantly predicted poor outcome in this study. These results are consistent with the majority of studies that have investigated these variables.[4,6,9–11,13–15,18,19]

Furthermore, we observed that participants residing in institutions were at higher risk of death at two-year follow-up than community dwellers. Only Jagger et al.[14] have previously analyzed this relation, and they found similar results. Educational level was not significantly related to survival in our study. This confirmed the results of four previous papers that examined education in Alzheimer's disease,[10,12,16,18] but not those of Stern et al.[15] Moreover, Hier et al.[12] demonstrated a significant relation between lower educational attainment and survival in VaD. Our findings may be attributable to the limited sample of VaD patients in our study.

We observed that dementia severity is not predictive of poor outcome in all subjects, although severe dementia was found to be significantly related to survival in community dwellers. A positive relation between severity of disease and survival has been reported in some studies (mostly community-based[8,10,14,17,18,46]) but not in others (mostly institution-based[4,11,16,48]). These findings and our own may be related to the skewed distribution of disease severity in institutionalized individuals. A lack of mild cases in institutions may have resulted in insufficient power to detect a significant association between severity and survival. This hypothesis was supported in our analyses by the low proportion of mild cases of dementia in institutions as compared with the community.

Our finding of no significant relation between dementia type (AD or VaD) and survival was consistent with several studies.[1,9,12,13] However, the community survey of Molsa et al.[6] showed that VaD carried a less favourable survival prognosis than AD. This was also evident in our separate analysis of community participants. Possibly, in these older age groups the differences in disease-specific causes of death tend to be minimal,[9] although it was unclear why this should not hold true for community participants.

Of the comorbid conditions assessed in this study, a history of heart attack was significantly associated with survival. This result is consistent with several previous investigations,[5,6,14,18,19] although the two studies by van Dijk et al.[5,19] both showed that stroke, respiratory disease and Parkinson's disease were also significant predictors of mortality. Our lack of such findings may be attributable to the low prevalence of some of these diseases and the limited sample size.

Implications and Conclusions

This study of dementia has shed light on the important elements of mobility that afford longer survival in patients with AD and VaD. Because the progressive course of dementia is not reversible, the results may be of value in providing prognostic information for families and health professionals. The elevated associations found here are important for clinicians to consider in discussions with patients and their families. Furthermore, because mobility is a modifiable factor, the study may help pave the way for targeting future interventions aimed at reducing or eliminating morbidity and mortality related to dementia.

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A Deprivation Index for Health and Welfare Planning in Quebec

Robert Pampalon and Guy Raymond

Abstract

Given that one of the goals of public health policy in Quebec and Canada is to reduce social inequalities in health and well-being, it is surprising, to say the least, that most information systems in this field make no mention of people's socio-economic characteristics. The present article proposes an index to reflect the material and social dimensions of deprivation as this concept has been developed by Peter Townsend and other authors. The article describes the method used to create the index, which uses census data and tools developed by Statistics Canada to match postal codes with enumeration areas. Examples are provided of the use of the index in information systems covering three aspects of health and well-being in Quebec: deaths, hospitalizations and births. The value of the information provided by this index in planning health and social services is demonstrated.

Key words: *births; deprivation; geography; hospitalization; mortality; Quebec; social inequalities*

Introduction

The association between social inequalities and differences in people's health and well-being is now well known, and the struggle against inequalities has become a major public health policy issue throughout the world,[1,2] in Canada[3,4] and in Quebec.[5,6] The strategies put forward in the Quebec policy for health and welfare[5] include improving living conditions, such as level of education and income; providing support in people's environments (home, school and workplace); and working with groups that are considered vulnerable from the standpoint of their health and well-being.

Except for the general surveys on health and social issues that have been conducted recently,[7] measuring social inequalities in health and welfare has always posed some problems in Quebec. These problems are due to the lack of socio-economic data in the main information systems used to determine the health and well-being of the population and to assess its consumption of health and social services, such as long-term care, home support and youth and children's services. Such information is lacking in the databases used to track deaths, hospitalizations and tumours in Quebec, and it is also absent from the database of the Quebec health insurance plan.

To get around these difficulties, researchers have turned to an ecological approach: to compensate for the lack of data on individuals, they substitute data on geographic areas such as neighbourhoods or CLSC (local community service centre) districts and analyze these data to determine the presence of socially based inequalities in health.[8–12] This approach undeniably provides some valuable information, but it does have limitations. The populations of the areas analyzed are often not very homogeneous. This kind of analysis is used only for large urban centres, and it has no explicit conceptual reference, or at least no unique one.

We therefore intend to propose a deprivation index that has explicit conceptual foundations, that can be incorporated into databases in the health and social services sector, and that can be used to track those inequalities in health and well-being that are associated with deprivation. In particular, we intend to describe the way the index is constructed and, by way of examples, to illustrate the possibilities that it offers for analyzing inequalities and for planning health and social service interventions. We begin with a short description of the concept of deprivation and how it has been measured around the world. We then show how we have adapted this concept to the Quebec context and provide a few examples of its use. Last, we suggest how the index could contribute to health and social service policies and programs.

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The Concept of Deprivation

The term "deprivation" emerged in Britain in the 1980s from a long tradition of analyzing social inequalities in health. Peter Townsend[13] saw deprivation as "a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which the individual, family or group belongs." This disadvantage may occur at various levels, for example, with regard to food, clothing, housing, education or work. In fact, a person is considered deprived to the extent that he or she falls below the level attained by the majority of the population or below what is considered socially acceptable.

Peter Townsend distinguishes two forms of deprivation: material and social. The first involves deprivation of the goods and conveniences that are part of modern life—for example, a car, a television or a neighbourhood with green space. Social deprivation refers to relationships among individuals in the family, the workplace and the community. According to Townsend, material deprivation should be distinguished from "poverty," which is more related to lack of the resources—especially the financial resources—needed to acquire modern goods and commodities. Social deprivation, on the other hand, is more closely related to the concept of "social capital,"[14] reflecting certain characteristics of social organization, such as isolation or cohesion, individualism or co-operation, mutual assistance and trust.

Both of these forms of deprivation are closely linked with public health and welfare. They are related to mortality in the general population[15,16] and to premature mortality (either general or due to ischemic heart disease or other causes related to tobacco use).[17] They vary with all forms of morbidity, from cancer[18] to restriction of activities,[19] and from respiratory diseases and diabetes[20] to tooth decay.[21] Material and social deprivation are also associated with mental health, such as short-term and long-term use of psychiatric services[22–25] and criminal behaviour.[26] Finally these forms of deprivation may be used as a guide in managing public health services, especially in the area of medical resources.[27,28]

Measuring Deprivation

Many studies of deprivation (chiefly material deprivation) rely on two particular deprivation indices, one developed by Townsend[13] and the other by Carstairs and Morris.[29] Both indices involve four variables, three of which are the same in both cases: unemployment, lack of a car and overcrowded housing. The fourth variable in the Townsend index is home ownership; in the Carstairs index, it is lower social class. In the construction of these indices, the four variables are standardized and normalized, each variable being given an equal weight.

A third index, called the Under-privileged Areas (UPA) score, was developed by Jarman et al.[30] and is extensively used in deprivation studies. (Incidentally, it is also used in determining remuneration for physicians in Britain.) The UPA score comprises eight variables, including the four already mentioned and four more: the proportion of single-parent families, children under age 5, retired persons living alone and recent immigrants. The weight given to each of these variables in constructing the index differs according to the perception that physicians have of that variable's impact on their workload. A comparative analysis of the three indices[31] has shown that the first two correlate more closely with a set of health indicators than does the third.

Lastly, studies of deprivation sometimes use other kinds of indices or numerous individual variables, including income, education level, marital status and residential mobility as well as those already mentioned.[13,22,31]

These measures have been derived essentially from national census data on small geographic areas such as wards and enumeration districts in Britain,[16–18,20,29] "small area market statistics" in Sweden[28] and meshblocks in New Zealand.[32] The measures can then be transposed into individual records in population surveys[26] and surveys of specific client groups,[20,22,23] or they can be used in ecological analyses.[16–18,27,29] In such analyses, these small areas are usually grouped into larger, arbitrary statistical aggregates (such as quintiles or deciles) according to their level of deprivation, from lowest to highest.

What is important when creating such measures is to choose a basic geographic unit that is as small as possible and as homogeneous as possible in its socio-economic characteristics. The size of the social inequalities in health and well-being that will be observed and the accuracy of the observations will depend greatly on the basic geographic unit chosen. In Britain, for instance, it has been shown that basing analyses on enumeration districts (average population of about 500), rather than on wards (average population of over 5,000), reduces errors in classifying individuals, leads to higher correlations between social inequalities and health, and results in more stable funding of medical services from one census to the next.[27,33,34]

Data and Methods

Basic Geographic Unit

Our basic geographic unit, the *enumeration area* (EA), was chosen for two reasons. First, this is the smallest geographic unit for which census data are available in Canada. The average EA has a population of 750. Second, the postal code conversion file can be used to establish a link between information on EAs and the geographically based information, classified by 6-character postal codes, available in the health and welfare databases maintained in Quebec.[35]

Not all of the EAs in Quebec were used in the analysis. The EAs in Nunavik and the Cree territories of James Bay were excluded because of the poor quality of their census data. All EAs with fewer than 250

inhabitants (fewer than 68 households) were eliminated, because this is the minimum size of EA for which Statistics Canada produces income figures. Many of the EAs thus eliminated have no inhabitants and are classified as unorganized areas. Also, most of those EAs that consist of health and social service institutions, such as hospitals, psychiatric facilities, homes for the aged and rehabilitation centres, were eliminated since any group institution with 75 beds or more constitutes an EA, according to the census rules.[36] The 9,058 EAs that remained and were included in the present analysis represent about 96% of the total population and of all households in Quebec.

The equivalence that the postal code conversion file establishes between the 6-character postal code areas and the EAs is not perfect. Slightly less than 6% of the postal code areas cover more than one EA. For these areas, the EA was randomly and proportionally assigned, according to the population of each EA living in the same postal code area. This population figure comes from the Statistics Canada file for weighting the population by postal codes.[37]

Indicators

The deprivation index combines six indicators chosen for the following reasons: their relation to a large number of health and welfare issues; their association with one of the two forms of deprivation (material or social); and their availability by EA in the Canadian census data. The six indicators and the mnemonics that we have used for them are as follows: the proportion of persons who have no high-school diploma (SCOLAR); the ratio of employment to population (EMPLOI); average income (REVMOY); the proportion of persons who are separated, divorced or widowed (S_D_V); the proportion of single-parent families (F_MONO); and the proportion of people living alone (SEULES). All of these indicators except for the proportion of single-parent families have been adjusted according to the age and sex of the population so as to highlight the economic and social conditions of the persons concerned.[32] In order to normalize the distribution, it was necessary to convert some of the indicators (REVMOY, S_D_V and SEULES) to their logarithms and one (F_MONO) to its square root.

Combining the Indicators

In general, there are two ways to combine indicators: the additive approach, with weighting, which has been used to create deprivation indices in Britain,[13,29,30] and the factorial approach, which has been used to develop various socio-economic indices[38–40] and, more recently, a deprivation index in New Zealand.[32] We opted for the factorial approach because the weight assigned to each indicator is not determined arbitrarily on the basis of the perceptions of the researcher or of a group of professionals (for example, general practitioners),[30] but is determined from the statistical relationships that exist among the indicators within the geographic area in question. More specifically, we used principal component analysis (a form of factor analysis), applying a Varimax rotation and retaining only those components whose eigenvalues exceeded 1.00. Two of the components that we analyzed satisfied this criterion, and it was from these two components and their cross-tabulations that we developed the deprivation index (Table 1).

TABLE 1
Principal components among indicators included in the deprivation index by enumeration area (*n* = 9058)

Indicator	Component 1	Component 2
Persons with no high-school diploma (SCOLAR)	-0.89	-0.01
Employment/population ratio (EMPLOI)	0.80	-0.27
Average income (REVMOY)	0.86	-0.25
Persons living alone (SEULES)	-0.13	0.82
Separated, divorced, and widowed persons (S_D_V)	-0.16	0.86
Single-parent families (F_MONO)	-0.14	0.76
Explained variance	37%	36%
Cumulative variance	37%	73%

NOTE: The above values are the saturations between the indicator and the component. They are interpreted like correlation coefficients.

Source: 1996 Canadian census

Each of the two components accounts for slightly more than one third of the variations in the six indicators considered, for a total of 73%, and the two are sharply differentiated in their meaning. The first component reflects variations in education, employment and income in Quebec and thus tends to emphasize the material aspect of deprivation. The second component reflects variations in the indicators associated with the social aspect of deprivation—the proportions of widowed, separated and divorced persons, of single-parent families and of persons living alone.

To test the validity of this model for Quebec as a whole, we repeated the same principal component analysis for four distinct areas in Quebec: the Montreal Census Metropolitan Area (CMA), the other CMAs in Quebec (Quebec City, Sherbrooke, Hull, Chicoutimi-Jonquière and Trois-Rivières), the Census Agglomerations (CAs) of Quebec (cities with 10,000 to 100,000 inhabitants) and, finally, Quebec's small towns and rural areas. In every case, we found the same factorial structure, with the two principal components accounting for 72–75% of the variation in the indicators for the CMAs and CAs and 62% of the variation in the indicators for small towns and rural areas.

Grouping the Enumeration Areas

To ensure a certain statistical accuracy in the analysis of inequalities in health and welfare, we had to combine

the EAs into sufficiently large groups while ensuring that these groups were homogeneous in terms of material and social deprivation. The EAs were therefore grouped according to their factor scores, which represent the importance of each component in each EA, and a conventional method[16,18,27,29] was followed. For each component, the factor scores were ranked from least to most deprived EA, and then the resulting distribution was divided into quintiles, according to the size of the population of each EA. Thus, quintile 1 represents the least deprived segment of the population of Quebec, and quintile 5 represents the segment that is most deprived.

Lastly, the two sets of quintiles (for material and social deprivation) were cross-tabulated, for a total of 25 cells. We could then see which population segments were not deprived according to either of these measures, which ones were deprived according to one but not the other and which ones were deprived according to both. For example, the cell in which quintile 1 for component 1 intersects quintile 1 for component 2 represents the population segment that is most privileged both materially and socially; the cell for quintile 5 for both components represents the segment that is the most deprived.

Health and Welfare Indicators

The deprivation values were entered into three information systems, covering deaths, hospitalizations and births. Various measures were then produced by quintiles and cross-tabulated deprivation quintiles. Some of the measures were general, such as life expectancy at birth, the standardized mortality ratio (SMR) for the years 1995–1997 and the hospitalization rate adjusted for population age and sex and for the level of resource use (APR-DRG: classification and weighting system for short-term patients) for the year 1997/98. In the case of the SMR, chi-squared tests were used to determine the significance of any differences between the values by quintiles and cross-tabulated quintiles and the values for Quebec as a whole.[41]

The other measures were more specific and were designed to test the sensitivity of the index by associating it with problems known to be largely determined by material and social living conditions.[7,17,24,25,42,43] These measures were as follows: standardized mortality ratio for premature deaths (at ages 35–74) due to tobacco use, adjusted rate of hospitalization for mental illness and two measures regarding births—the fertility rate for teenage girls (< 20 years old) and the birth rate of infants with low birth weight (< 2500 g) among all women in Quebec for the years 1995–1997.

For most of the deaths, hospitalizations and births analyzed (89–96%), a corresponding deprivation value was obtained (Table 2). For the remaining events no deprivation value was obtained, either because the associated EA had been excluded for being too small or because the postal code in the database was invalid (less than 3% of the events had invalid postal codes).

Results

In Quebec the geographic pattern of deprivation was very distinct (Table 3), and the patterns for material and social deprivation showed both similarities and dissimilarities. Material deprivation was especially high in small towns and rural areas, dropped off in the suburbs of the larger cities and then rose again in the urban core. In contrast, social deprivation was a largely urban reality, increasing steadily from the suburbs into the downtown metropolitan areas. This pattern is fairly similar to the results of Quebec health and social surveys concerning people's satisfaction with their social life.[44,45]

TABLE 2
Deaths, hospitalizations and births by type of database record: numbers and percentages of records for which deprivation values were/were not obtained

	Deprivation value obtained		No deprivation value obtained				TOTAL	
			Excluded EAs		Invalid postal codes			
Database record	*n*	%	*n*	%	*n*	%	*n*	%
Deaths	121,217	89	11,415	8	3,892	3	136,524	100
- tobacco use[a]	10,928	94	506	4	191	2	11,625	100
Hospitalizations	716,668	92	40,907	5	19,731	3	777,306	100
- mental illness[b]	38,074	92	2,198	5	1,184	3	41,456	100
Births	239,786	95	9,215	4	3,111	1	252,112	100
- mothers < age 20	10,891	91	828	7	197	2	11,916	100
- weight < 2500 g	14,250	96	505	3	166	1	14,921	100

[a] Cancers of the lips, mouth, pharynx, esophagus, trachea, bronchi and lungs; bronchitis, emphysema and obstruction of airways in persons age 35 to 74. ICD-9: 140 to 149, 150,161,162,491,492, 496.
[b] Various psychoses and neuroses. ICD-9: 290 to 316.

Sources: Deaths database 1995–1997; Med-Echo database 1997/98; births database 1995–1997

TABLE 3
General characteristics of the population by deprivation quintile: number, age group and selected places of residence, Quebec, 1996

Deprivation quintile	Population (*n*)	Age group		Place of residence		
				Montreal CMA		Small towns and rural areas (%)
		0–17 years (%)	65+ years (%)	Montreal Island (%)	Suburbs (%)	
Material						
1	1,367,798	23.4	10.3	35.3	30.3	2.3
2	1,367,859	24.1	10.1	21.5	30.7	8.2
3	1,367,281	23.6	11.2	20.8	25.6	16.9
4	1,367,943	23.4	12.3	23.5	17.9	31.1
5	1,367,081	23.8	13.3	24.6	7.0	47.8
Social						
1	1,367,522	28.8	7.1	10.4	31.0	32.8
2	1,366,503	26.5	9.3	10.0	26.6	31.6
3	1,368,213	24.0	11.6	19.9	20.7	26.2
4	1,367,708	20.9	14.2	36.9	19.0	12.6
5	1,368,016	18.1	14.9	48.4	14.2	3.0
Material and social						
1 and 1	315,221	29.4	5.8	28.3	45.3	1.6
5 and 5	325,770	20.3	15.0	50.9	2.9	2.9
Quebec	6,837,962	23.7	11.4	25.1	22.3	21.3

Source: 1996 Canadian census

To sum up, the population segment with the highest indices of both material and social deprivation (quintile 5 in both cases) was found in the downtown areas of larger cities, while material deprivation was highest in small towns and rural areas of Quebec and social deprivation was highest in urban areas.

As Table 3 also shows, this pattern partly reflects the demographic features of the population. The people who were most deprived both materially and socially (quintiles 5 and 5) were slightly older than their more fortunate fellow citizens (quintiles 1 and 1), because of marked differences in their degree of social deprivation, which seemed to increase along with population age.

However, the differences due to age were much less than those associated with the various social indicators in our deprivation index (Table 4). For people aged 65 and over, there were between two and three times as many in quintile 5 for both types of deprivation as in quintile 1 (15% versus 5.8%), but for people living alone (all ages) the corresponding ratio was 9:1 (20.2% versus 2.2%) and for single-parent families it was 5:1 (34.1% versus 6.9%). The discrepancies in education level, employment and income were also quite large and existed beyond any differences in the demographic profiles of the deprivation groups.

The use of principal component analysis (with Varimax rotation) produced material and social dimensions of deprivation that were relatively independent from a statistical perspective. The correlation was 0.00 between the factor scores for the two principal components and 0.03 between the quintiles established from these factor scores. This is why the variations among quintiles shown in Table 4 were large for some variables and small or non-existent for others. The variations were large when these variables were used to define the component and small when they were not. Low education level, for example, increased with material deprivation but not with social deprivation. This observation is important when interpreting the relations between health and well-being indicators and deprivation.

Life expectancy at birth decreased consistently with material deprivation among both men and women (Table 5), but this pattern did not hold for social deprivation among women. In total, the least deprived men in Quebec (quintiles 1 and 1) can expect to live almost 9 years longer than the most deprived (quintiles 5 and 5). The difference in life expectancy among the corresponding groups of women was slightly less than 3 years. The pattern is similar for general mortality but not at all similar for premature death due to tobacco use (Table 6), which increased continuously with both material and social deprivation among men and women.

The hospitalization rate also increased with material deprivation among both sexes (Table 7). It varied with social deprivation as well but in a different way, first decreasing as people's social deprivation worsened, then increasing steadily, though very slightly. The pattern for

TABLE 4
Mean values[a] of indicators composing the deprivation index, by deprivation quintile, Quebec, 1996

Deprivation quintile	SCOLAR (%)	EMPLOI (%)	REVMOY ($)	SEULES (%)	S_D_V (%)	F_MONO (%)
Material						
1	18.1	66.0	30,045	8.9	9.9	13.2
2	28.8	60.8	23,280	8.7	10.5	14.7
3	36.1	56.8	20,907	9.7	11.0	15.9
4	43.1	52.7	18,703	10.5	11.5	17.4
5	53.3	43.1	15,624	11.0	12.1	19.0
Social						
1	35.8	59.6	23,475	3.5	6.5	7.2
2	36.1	57.4	22,792	5.6	8.6	10.9
3	35.7	56.3	22,161	8.1	10.5	14.5
4	35.8	54.9	21,067	12.1	12.8	19.2
5	35.9	51.4	19,068	19.4	16.5	28.4
Material and social						
1 and 1	17.2	68.2	32,684	2.2	6.2	6.9
5 and 5	51.5	38.7	13,958	20.2	18.3	34.1
Quebec	35.9	55.9	21,712	9.7	11.0	16.0

[a] Means for the enumeration areas covered by the deprivation index
Source: 1996 Canadian census

LEGEND
SCOLAR: proportion of persons who have no high-school diploma
EMPLOI: ratio of employment to population
REVMOY: average income
S_D_V: proportion of persons who are separated, divorced or widowed
F_MONO: proportion of single-parent families
SEULES: proportion of people living alone

TABLE 5
Life expectancy at birth by deprivation quintile, Quebec, 1995–1997

Deprivation quintile	Males (years)	Females (years)	TOTAL (years)
Material			
1	78.5	84.9	81.9
2	76.4	84.0	80.4
3	75.5	83.7	79.7
4	75.3	83.6	79.5
5	73.7	82.5	77.9
Social			
1	76.5	82.0	79.0
2	76.7	83.6	80.0
3	76.5	84.6	80.7
4	75.8	84.2	80.2
5	73.4	82.9	78.4
Material and social			
1 and 1	79.7	83.7	81.8
5 and 5	71.0	81.1	76.0
Quebec	75.8	83.7	79.8

Source: Deaths database, 1995–1997

hospitalization for mental illness was quite different, increasing continuously with both forms of deprivation among men and women. The same kind of increase was found in fertility rates among teenage girls and birth rates of infants with low birth weight (Table 8).

Discussion

The size of the inequalities that our deprivation index revealed—especially as regards premature death due to tobacco usage, hospitalization for mental illness, fertility in teenage girls and births of infants with low birth weight—shows that this deprivation index is especially sensitive to the material and social conditions in which people live.

The approach used to develop the index is not totally new. Six-digit postal codes have been used previously in Canada to introduce an income measure into death records,[46–48] and some differences in life expectancy and mortality due to several causes have been identified thereby. However, our approach does differ from past efforts in several respects.

First of all, it is based on a clearly established concept of deprivation that comprises two dimensions confirmed by our principal component analysis: material deprivation (including an income measure) and social deprivation.

TABLE 6
Standardized mortality ratios for general mortality and premature mortality due to tobacco use,[a] by sex and deprivation quintile, Quebec, 1995–1997

Deprivation quintile	General mortality (SMR)[b]						Tobacco mortality (SMR)[b]					
	Males		Females		TOTAL		Males		Females		TOTAL	
Material												
1	0.81	***	0.89	***	0.85	***	0.67	***	0.73	***	0.71	***
2	0.96	***	0.98		0.96	***	0.98		0.96		0.97	
3	1.03	**	1.00		1.01	*	1.02		1.00		1.01	
4	1.03	***	1.01		1.02	***	1.09	***	1.08	*	1.08	***
5	1.14	***	1.08	***	1.12	***	1.19	***	1.16	***	1.18	***
Social												
1	0.92	***	1.07	***	1.01		0.85	***	0.88	**	0.90	***
2	0.92	***	0.99		0.97	***	0.86	***	0.88	**	0.89	***
3	0.94	***	0.93	***	0.94	***	0.96		0.88	**	0.94	**
4	1.00		0.97	***	0.98	***	1.01		1.01		0.99	
5	1.18	***	1.05	***	1.09	***	1.30	***	1.26	***	1.23	***
Material and social												
1 and 1	0.68	***	0.88	***	0.77	***	0.53	***	0.69	***	0.60	***
5 and 5	1.37	***	1.17	***	1.26	***	1.63	***	1.47	***	1.52	***
Quebec	1.00		1.00		1.00		1.00		1.00		1.00	

[a] See Table 2
[b] SMR (standardized mortality ratio) differs from the Quebec value (1.00) at $p < 0.001$***; $p < 0.01$**; $p < 0.05$*.
Source: Deaths database, 1995–1997

TABLE 7
General hospitalization rates[a] and rates of hospitalization for mental illness,[b] by sex and deprivation quintile, Quebec, 1997/98

Deprivation quintile	General hospitalization (%)			Hospitalization for mental illness (%)		
	Males	Females	TOTAL	Males	Females	TOTAL
Material						
1	10.3	11.1	10.7	0.60	0.80	0.70
2	12.2	12.8	12.5	0.76	1.01	0.89
3	12.6	13.3	13.0	0.81	1.09	0.95
4	13.1	13.7	13.5	0.93	1.10	1.02
5	14.2	15.1	14.7	1.01	1.29	1.15
Social						
1	12.2	13.9	13.2	0.62	0.86	0.74
2	11.7	13.2	12.6	0.67	0.88	0.77
3	12.4	12.8	12.6	0.76	0.93	0.85
4	12.8	13.0	12.9	0.91	1.13	1.03
5	13.9	14.2	13.9	1.19	1.46	1.33
Material and social						
1 and 1	9.3	11.2	10.4	0.45	0.63	0.55
5 and 5	15.9	16.7	16.2	1.49	1.72	1.61
Quebec	12.5	13.2	12.9	0.82	1.05	0.94

[a] Rates per 100 population
[b] See Table 2
Source: Med-Écho database, year 1997/98

TABLE 8
Fertility rates in teenage girls[a] and rates of birth of infants with low birth weight[b] for all women, by deprivation quintile, Quebec, 1995–1997

Deprivation quintile	Fertility (%)	Low birth weight (%)
Material		
1	0.58	5.07
2	1.09	5.35
3	1.53	5.89
4	1.95	6.19
5	2.65	7.12
Social		
1	0.92	5.22
2	0.94	5.54
3	1.30	5.93
4	1.93	6.28
5	3.11	6.74
Material and social		
1 and 1	0.26	4.72
5 and 5	4.71	8.19
Quebec	1.56	5.94

[a] Births to women less than 20 years of age per 100 women aged 15–19
[b] Births of infants weighing less than 2500 grams, per 100 live births
Source: Births database, 1995–1997

Our results show that within Quebec the two dimensions do not necessarily co-exist: an area can very well be deprived materially but not socially, and vice versa. Our results also show that each of these forms of deprivation can have its own distinct impact on health and that this impact is increased when the two forms are found together. The impact can also vary with sex and with the health and welfare indicator considered. Thus it is useful to distinguish between these two forms of deprivation.

Another difference in our index is that it uses data for enumeration areas rather than census tracts to estimate people's degree of deprivation. Studies done in Quebec[49] and elsewhere[27,33,34] show that the smaller the reference area, the more likely the population will be homogeneous, the more classification errors will be avoided and the more major discrepancies in health will be revealed. A recent Manitoba study[50] shows that average household income for EAs is just as good a predictor of mortality, hospitalization and other health problems as the household income reported in the census. Thus there appears to be an advantage in using EAs as the reference area in this kind of study.

However, some studies[51,52] have shown that geographic measures, no matter how small, are not individual measures and that it could be somewhat risky to substitute one for the other. A geographic measure is an aggregate of individual and environmental features, which, separately and jointly, have an impact on the health of a population.[53,54] Geographic measures, therefore, provide a general estimate of such an impact without having to disentangle the specific contribution of these individual and environmental features.

A final difference in our approach is that it offers a model of deprivation that covers the vast majority of the territory and population of Quebec rather than just a sample or a part of it and is thus valid everywhere, regardless of area of residence. The model can therefore help to provide a more complete knowledge of inequalities in health and welfare within the population. It can also help to plan programs in a manner consistent with the resources available to the individual communities throughout the jurisdiction concerned. This is a definite advantage for a health and social services system like Quebec's, in which many programs have large regional and local intervention components.

Indeed, the deprivation index presented in this paper offers many possibilities for planning and implementing health and social service programs. Here are a few of them.

First of all, we consider it important to conduct an extensive analysis of inequalities in all aspects of the public's health and well-being. Our deprivation index can be used for this purpose, and we have begun a detailed analysis not only of mortality and hospitalization rates but also of malignant tumours, consumption of medical services, consumption of services for young victims of abuse and neglect and for old people living in their own homes. This analysis will allow a preliminary assessment of inequalities in health and well-being associated with deprivation, monitoring of these inequalities and consideration of them when public policies and programs are being developed.

The deprivation index can also be used to support regional and local interventions. Since this index is a geographic measure, based on census data, it can be used to derive a profile of deprived communities at the regional and local levels and determine exactly where such communities are located in Quebec. Because the index can also be entered into client files that record use of services, it can be used to establish deprivation profiles for different target client groups at the regional and local levels. Through comparison of the deprivation profile for the population as a whole with profiles of specific groups of clients, the rate of penetration of health and social services within the deprived population of Quebec can be estimated. We have already started such a project concerning the services provided by CLSCs in the province.

Lastly, our index can simplify the task of measuring population needs in order to allocate resources among regions and local communities. Currently, needs for health and social services are measured in Quebec,[55,56] elsewhere in Canada[57–59] and elsewhere in the world[60,61] according to two parameters: the population's age and its social and health-related characteristics. Two distinct methods are used for this purpose, one for each parameter. Our deprivation index will allow analysts to apply the

same method to measure both types of needs, taking a provincial consumption profile and projecting it onto the regional or local level.

In short, the index offers considerable opportunities both for acquiring new information about health and social service needs and for planning policies and programs to meet them. This is true not only in Quebec but also elsewhere in Canada because the tools required to construct the index are available.

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A Comparison of Methods for Measuring Socio-economic Status by Occupation or Postal Area

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Abstract

Seven methods of estimating socio-economic status (SES) were compared, including four based on data specific to individuals (Blishen, Pineo-Porter, British Registrar General, Hollingshead) and three based on the average characteristics of the postal code area in which people live (income alone, education alone, income and education combined). Data from the files of 151 patients undergoing in vitro fertilization were used. The four individual scales were highly correlated among themselves (Spearman's correlation coefficient between 0.6 and 0.9) but only moderately correlated with the measures based on postal code (Spearman's correlation coefficient between 0.2 and 0.3).

***Key words**: in vitro fertilization; Ontario; postal codes; socio-economic status*

Introduction

Socio-economic status (SES) has long been a prime predictive variable in epidemiologic studies. People of lower socio-economic status have lower life expectancy and higher mortality rates from almost all causes of death,[1] and a variety of morbidities are variably associated with SES. As an explanatory variable in health studies, SES has been used to derive health policy recommendations[2] and to infer public health implications of dietary needs in different social strata.[3] In addition, SES has long been an important factor in many studies in the social sciences.

In a lengthy review of the use of SES in epidemiology, Liberatos et al.[1] pointed out that most measures are based upon three related dimensions: occupation, education and income. A ranking of occupational classes is often employed because occupation is considered to be a reliable indicator of relative standing in industrial societies. It is not surprising, then, that many scales and indices for assessing SES, such as that described by Pineo et al.,[4] rely on the social prestige of subjects' occupations as a major indicator.

For studies in which detailed personal questionnaires are not available for all subjects, the accurate measurement of SES is problematic. Educational level and income are particularly difficult to ascertain in administrative or medical data sets, since such data are rarely collected. For population or administrative data in which occupation, education and income are unknown, census surveys are sometimes used, estimating the income and education of individuals on the basis of their neighbourhood average. The existence of a variety of occupational scales and other proxy measures is an indication of the extent of this problem.

Although occupation can be considered an important sole estimator of social class and status for several types of investigations, for other studies it is desirable to estimate SES comprehensively by including measures of education and income. Occupation or neighbourhood-indexed census data, then, must often suffice to estimate education and income. The use of data imputed by assuming individual information from ecologic census data linked to postal codes is a common method of estimating SES in the absence of more specific and detailed records. Collins et al.[5] were one group who used this method of extracting income and other demographic information from Canadian postal codes. The impressive levels of documentation, digitization and accessibility of the Statistics Canada data retrieval and compilation systems make the use of census data for SES estimation an attractive technique.

In order to validate the application of any one method of SES estimation for larger studies using a similarly specialized population, we conducted this study to measure the extent of agreement between seven measures of

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socio-economic status, using, as did Collins et al.,[5] a population of clinically infertile individuals undergoing in vitro fertilization (IVF) treatment.

Methods

Data from the administrative files and patient charts of the IVF clinic at the London Health Sciences Centre in London, Ontario, were extracted for 200 randomly selected patients (out of a possible total of 3,373 patient files). This set was to be used as part of a quality control study for a larger study of IVF, which includes postal codes as a proxy measure for SES. Therefore, this smaller study was undertaken to assess the validity of that method with respect to other SES measures available in the literature.

The data extracted included the self-reported occupations of both the patients and their spouses as well as their home postal codes. Only patients with complete records of postal codes and occupations were included; 151 had complete information.

SES Estimation

Seven methods of SES estimation were selected from the medical and anthropological literature for their popularity in infertility studies or in larger Canadian public health studies. Four are direct measures from individual-level data (referred to here as Blishen, Pineo-Porter, Hollingshead and British), and three other methods use postal code information. Unfortunately, the coding of self-reported occupations to refer to established categories of these SES methods was subjective, relying on the investigators' discretion as to how best to categorize patients' occupations. This subjectivity was partially addressed through trichotomization of all scales (discussed in greater depth later) to more generously allow for potential concordances.

A scale for ranking occupations developed by Blishen et al.[6] has been popular in Canadian public health studies. The Blishen scale assigns SES codes to the occupations listed in the *1981 Canadian Classification and Dictionary of Occupations*. The scale's developers derived indicators of prevailing education and income levels for each occupational category. Income indicators were based upon the pooled median employment income for all paid labour force participants in each occupation; education level was based upon the proportion of people with higher education in that occupational category. The original authors pointed out that the validity of assuming concordance between occupational prestige and socio-economic prestige is questionable, given that the latter is, in fact, a composite measure of the three dimensions of education, income and occupational prestige. Instead they offered an SES score derived from a linear regression involving the Pineo-Porter prestige scores described below, thus, in their words, making "minimal use of occupational prestige." A list of many common occupations and their corresponding SES scores is available in the original reference.

The Pineo-Porter method[4] attaches prestige scores to 16 occupational categories and is the basis for the Blishen method. The Pineo-Porter method was intended, in part, to be an evaluative test of the 1971 census codes.

What is referred to here as the "British method" is similar to the Wilson-Barona method[7] and uses the British Registrar General's levels of social class. These levels are summarized in the research of Benzeval et al.[2] There are obvious concerns resulting from cultural differences between British and Canadian societies. It is nevertheless assumed that a profession benefiting from a degree of prestige in one culture will experience a comparable degree in the other.

The Hollingshead method,[8] used by Newton et al.,[9] defines each occupation as being in one of nine categories, the ninth being at the highest SES level.

The last three SES estimation methods all use information on education, income and the product of education with income, derived from characteristics associated with postal code area. For the data in this study, Statistics Canada was able to provide such information by enumeration area, which subtends a smaller area than the postal code. However, only the postal codes of subjects were available in the data set, so a "best match" enumeration area was chosen for each postal code. The best match is defined by Statistics Canada as the enumeration area with the highest number of surveyed addresses within that postal code or, for rural areas, the enumeration area in which the main post office resides. Street addresses were not employed.

The first of the postal code methods used education data obtained from the 1996 census, which consisted of the number of individuals surveyed within an enumeration area who had completed each of six educational levels, in ascending order of prestige: less than grade nine education, at least some high school, a trade certificate or other diploma, other non-university education, some university or the completion of a university degree. An integral SES score was computed using a weighted sum of these variables (with weights equal to the number of people reporting each level of highest education obtained), divided by the total number of families surveyed in each enumeration area.

Income data from the census—the average family income for each enumeration area—was the second postal code method. Cases in which average income was reported as zero were assumed to represent unco-operative jurisdictions and were therefore excluded from this study. In order to make statistical comparisons with the other methods of SES measurement, which are referenced against national averages, the income data were similarly trichotomized: the national 1996 Canadian census data for average family income were divided into three levels, each containing somewhat equal numbers of surveyed individuals. The divisions are imprecise because the Statistics Canada data used were themselves pre-divided into income ranges.

TABLE 1
Agreement between methods of estimating socio-economic status (SES)[a] according to kappa score and 95% confidence interval (CI)

	Pineo-Porter		British		Hollingshead	
SES method	κ	95% CI	κ	95% CI	κ	95% CI
British	0.553	0.439–0.668				
Hollingshead	0.065	-0.029–0.159	0.233	0.118–0.349		
Postal code— income	-0.012	-0.091–0.066	0.11	0.008–0.212	0.06	-0.083–0.203
Postal code— education	0.096	-0.034–0.226	-0.026	-0.143–0.091	-0.051	-0.123–0.022

[a] SES based on highest occupational score between two spouses

Since the Blishen method assumes, with justification, an estimation of SES as a linear combination of the two variables of education and income, it is useful to test another simple combination of the two: their product. This was the third postal code method used. A weighted average with coefficients matching those of the Blishen linear equation would garner a response similar to that described by the Blishen method, as would a power series expansion. However, since the data are reduced to an ordinal discrete type, a simple multiplicative product serves as an approximation.

Statistical Methods

Contingency tables were constructed to compare the results from each of the seven measurements with each other. The data were reduced to ranked integral SES scores, and Spearman coefficients were computed to determine the extent of correlation between the seven methods. Each method generates scales of differing ranges, but they were all trichotomized to "low," "medium" and "high" SES for one of the two analyses of this study. When the data were so categorized, kappa statistics were computed to evaluate the degree of agreement between the various methods. This trichotomization was performed to assuage any concerns that might arise about subjectivity in coding along strict categorical parameters.

For the Blishen method, the cut-offs that determined the medium SES range were defined as the mean Blishen score for the general population plus or minus 1.5 standard deviations. The trichotomization of the Pineo-Porter scores was accomplished by grouping similar prestige categories. Since, in all cases, the dollar value of farms or businesses was not available in the patients' files, small business owners and farmers were universally assumed to belong to the medium SES category when the Hollingshead method was applied. Given that the original Hollingshead reference is more than 20 years old, the subjective coding procedure was modified to represent the modern monetary values of comparable businesses.

The primary analysis assumes that household status reflects the SES of the "highest" occupation in that household, thus benefiting from the highest income and education of the two spouses. This allows a traditional homemaker, whose score is low on some scales, to be more accurately recorded as of the same SES (prestige, standard of living, social opportunities, etc.) as his or her, presumably better employed, spouse.

Two secondary analyses were conducted on an exploratory level. For each SES measurement type, an arithmetic mean was computed of the patient's score and the spouse's score. That mean was then considered to be the SES estimation for the household. As well, to test the possibility that the various methods may agree on the scoring of one sex's traditional occupations more than on the other's, data from each sex were separated and tested independently.

Results

The kappa scores for agreement are given in Table 1 and the Spearman coefficients for ranked correlations in Table 2. No kappa scores appeared in comparisons with the Blishen method due to a dearth of low SES measures according to that method.

In general, the kappa scores were of moderate size. The greatest scores were predictably given by comparisons between the British and Pineo-Porter methods. This is not surprising since the Pineo-Porter method was derived in part from the British Registrar's prestige scale.

Of greater interest is the relation between the postal code methods and the others. Both the kappa and correlation scores were low for these comparisons.

Findings from the secondary analyses were generally consistent with those of the primary analyses. The highest degree of agreement overall was demonstrated in the comparison of men only with men. The results of the secondary analyses are not included here.

Discussion

The postal code methods did not estimate SES in the same way as did other occupation-based methods. The highest scores for this comparison, in terms of both agreement and correlation, were observed when men were compared only with men. This implies that

TABLE 2
Correlation between methods of estimating socio-economic status (SES)[a] according to Spearman's correlation coefficient (r_s) and *p* values

	Blishen		Pineo-Porter		British		Hollingshead	
SES method	r_s	*p* value	r_s	*p* value	r_s	*p* value	r_s	*p* value
Pineo-Porter	0.60742	0.0001						
British	0.61494	0.0001	0.88977	0.0001				
Hollingshead	0.70132	0.0001	0.61745	0.0001	0.59927	0.0001		
Postal code—income	0.19259	0.0178	0.26621	0.001	0.30312	0.0002	0.19336	0.0174
Postal code—education	0.21914	0.0069	0.19142	0.0186	0.22038	0.0065	0.23214	0.0041
Product of income X education	0.22477	0.0055	0.26539	0.001	0.29967	0.0002	0.23930	0.0031

[a] SES based on highest occupational score between two spouses

household SES, ostensibly measured by the postal code methods, is more closely approximated by men's occupations than by women's, at least in this data sample. If the finding is not artefactual, the reasons for it may have to do with issues of sex relations, religion or affluence. It is marginally related to the finding of Collins et al.[5] that the male's profession in their Canadian sample was statistically more likely than the female's to influence a couple's decisions regarding reproductive services and technologies. According to their data, among couples seeking infertility services, only 1.7% of the men were unemployed as compared with 15.9% of the women. Sauer et al.[10] found an almost identical rate of unemployment among Californian IVF women, supporting the supposition that the financial status of IVF households is best estimated by the male spouse's income.

The composite method involving the product of census-based income and education, reflective of Liberatos' insistence that SES embody both financial and pedagogical wealth,[1] is encouraging in that all its correlation scores were greater than those computed for census education alone, and greater than most of those for census income. However, a superior method of combining the two measures may be desirable. A linear combination of the two, as in the Blishen method, would be possible if the given census data were not categorically presented but were, in fact, representative of individual households rather than averages of enumeration areas.

Krieger et al.'s very thorough analysis[11] of the general limitations of most kinds of SES estimation methodologies identifies a poignant facet of this particular population: SES will vary over time. Krieger's suggestion that SES measures be performed at different points in time would be well applied in this case, since an IVF couple's preparations for impending pregnancy may include alterations to their lifestyle, such as employment status.

A further important consideration when evaluating these results is that the IVF population examined may be characterized by much less SES variability than the populations from which the tested measures were derived. This is borne out by the lack of low SES scores for men obtained by the Blishen method. How this difference would skew the results is uncertain, but it may imply that many of the SES methods are quite inapplicable to such a specialized population. Under such an assumption and with the limitations of the given data in mind, the neighbourhood-averaging approach implicit in the various postal code methods may indeed be the most heuristically valid method of the seven investigated in this study.

The dearth of low SES scores for men may have broad implications. Since IVF for certain common etiologies of infertility is paid for by the provincial health insurance program in Ontario, one might not expect income to be a factor that distinguishes IVF men from men in the general provincial population. This is a simplistic view, since SES purports to measure, in addition to income, factors associated with prestige and education. These latter factors may indeed significantly influence a couple's decision to seek IVF services, perhaps even more so than income alone. This polarization in IVF men's SES levels, at least according to the Blishen method, also may be simply indicative of the need of those who seek IVF for a higher degree of household wealth, implying that selective funding policies of the provincial health insurance program are putting a large financial burden on individual patients, thus inadvertently altering the demographic profile of IVF consumers.

A further consideration when examining these results is the lack of completely comparable definitions of "low," "medium" and "high" SES. For the postal code income method, for example, these delineations were defined on the basis of the national income distribution; no such externally referenced delineation is possible for the education method. This would perhaps underestimate the kappa scores, but would not affect the Spearman correlation coefficients.

Conclusion

In general, the degree of agreement between the methods of SES measurement was moderate, though there was high correlation among all methods except the postal code ones. The specialized nature of the IVF patient community may, in fact, invalidate the application of popular SES methods to comparable infertility studies. Indeed, all occupation-based SES methods may be more limited, by virtue of their respective degrees of sensitivity, when applied to such a homogeneous group. The use of census data via the postal code methods may therefore still be a viable method of SES estimation for internal comparisons only, but not necessarily for comparisons with larger reference populations, whose greater variability makes traditional approaches more appropriate. However, depending on the comparisons being made, the use of postal code estimations may be useful to demonstrate the impact of SES on access to specialized medical procedures such as IVF, provided that there is more heterogeneity in the sample population.

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Estimation of Youth Smoking Behaviours in Canada

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Abstract

This study estimated the prevalence of current smoking and smoking initiation among Canadian youth. Logistic regression was used to relate socio-demographic predictors to the occurrence of the smoking indicators among youth (15–24 years) in the 1994/95 National Population Health Survey (NPHS). Models were then applied to provincial youth populations in the 1996/97 NPHS and the 1996 census of Canada. Model-generated estimates were compared with direct estimates obtained from NPHS data. The models accurately predicted provincial rates of current youth smoking for 1994/95. When applied to the 1996/97 NPHS, the current smoking models performed reasonably well, but were less predictive when applied to 1996 census data. Modelling of youth smoking initiation was not successful. This suggests that although simple estimation models of youth smoking can be derived, these models may not be portable across different populations or time periods.

Key words: *population health surveys; small area estimation; smoking; tobacco control; youth*

Introduction

Smoking is an important and preventable cause of death and illness.[1,2] Among Canadians, smoking causes 45,200 deaths annually;[3] it is a major cause of respiratory disease, cancer and circulatory disease;[4–9] and it contributes enormous burdens to Canadian society in terms of lost economic productivity and health care expenditure.[10,11] Despite considerable public health effort, rates of cessation in the general and youth populations are low, particularly among regular smokers.[1] Smoking initiation occurs primarily among adolescents,[1] and Canadian youth smoking rates appear to have been on the rise during the past few years.[12,13] Programs that prevent the uptake of tobacco use by youth are therefore of considerable importance to public health.

To design effective tobacco control programs, current data on the incidence and prevalence of youth smoking are required. Population-based health program planning often requires smoking estimates that are specific to the particular region. General surveys such as the National Population Health Survey (NPHS) in Canada[14] are designed to provide reliable estimates for a relatively large geographic area, such as an entire country or province. Health planning efforts generally target smaller areas, such as local health regions or units. Direct surveys of these smaller area populations can be expensive, and alternative techniques are required to obtain estimates of health indicators.

Traditional strategies used to obtain small area statistics include synthetic, multiple regression and combined estimation approaches, and these methods have been used to estimate rates of disability, cause-specific mortality and unemployment in small areas.[15–20] Such techniques assume that strong and stable associations exist between socio-demographic variables and health-related characteristics in a population.[16]

Synthetic estimation involves the application of stratum-specific estimates of the health behaviour (e.g. smoking rates) to the population of the small area defined by the same socio-demographic strata.[15,16] Multiple regression approaches to estimation use geographic subunits (e.g. counties, provinces) as the unit of analysis. Data from population-based surveys are used to develop a regression equation that relates area-level

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characteristics to rates of the health behaviour. Values for the small areas are then substituted into the regression equation to determine the prevalence/incidence of the health behaviour.[19] Combined approaches to small area estimation incorporate both synthetic and regression properties.[17] A common version of this approach involves determining national rates for subgroups by means of regression analysis and then applying these rates to the population distribution of the small area.[18]

The primary objectives of the present study were to use a regression approach along with data from the 1994/95 and 1996/97 NPHS[14,21] and the Canada Census of Population (census)[22] to develop mathematical models that would estimate the prevalence of current smoking and incidence (initiation) of daily smoking among different populations of youth in Canada in 1996. The predictive capability of the models was evaluated on the basis of pre-specified criteria using direct estimates from the 1996/97 version of the NPHS.[21] If successful, this approach will eventually permit the estimation of youth smoking behaviours for a small area, based entirely upon demographic data that are available routinely from the population census. As a starting point, this estimation and evaluation was done at the provincial level, with further work planned for smaller area populations if the process worked successfully.

Methods

Overview

A regression approach to estimation was used. Youth aged 15–24 who participated in the 1994/95 NPHS (n = 2,597) formed the study population for model development. Logistic regression equations were derived to relate socio-demographic predictors to the occurrence of smoking outcomes of interest in this study population. Individuals were the unit of analysis, and standardized survey weights were incorporated into the modelling process. Eight separate multivariate regression models were fitted for each outcome. Individual predicted logits were back-transformed to predicted probabilities of the smoking outcome, given the relations between socio-demographic characteristics and smoking indicated by each model. Individual probabilities were then applied to population counts for strata similarly defined by the categories of the predictor variables, to determine prevalence (current smoking) and incidence (new daily smoking) estimates for each province of Canada in 1996. Population strata counts were obtained first from the 1996/97 NPHS (n = 9,601) and then the 1996 census. To evaluate the models, the model-generated estimates for each province were compared with direct estimates obtained from the 1996/97 NPHS.

Current Smoking Outcome

The first smoking indicator examined was the prevalence of current smoking, derived from question SMOK-Q2 (current smoking status) on the 1994/95 NPHS. Current smoking is the most comprehensive indicator of the prevalence of smoking[23] and includes daily and non-daily smoking of cigarettes. This outcome was defined as the proportion of the population aged 15–24 that smoked daily or occasionally. The analogous variable at the individual level, which was used for the regression models, categorized individuals as either "currently smoking" (daily or occasionally) or "not at all."

Smoking Initiation Outcome

The second smoking indicator was the incidence (or uptake) of daily smoking, defined as the proportion of the population that became daily smokers in the previous year. This was also a derived outcome variable (questions SMOK-Q2 [current smoking status] and DVSMKY94 [number of years smoking]).[14] Youth were categorized as "new/incident daily smokers" if they had been smoking daily for one year or less.

Predictors of Youth Smoking

The goal of this project was to develop methods for small area estimation that could be applied in any region of Canada for which census data were available. Thus the socio-demographic factors used as predictors were included only if they were available in both versions of the NPHS (1994/95 and 1996/97) and in cross-tabulated form from the 1996 census. Different combinations of the following predictor variables were available: age, sex, language, education and unemployment. Each of the predictor variables was dichotomized in order to simplify the cross-tabulations. For the logistic regression models, province was included as an independent variable in order to control for any provincial effects. All possible combinations of variables were considered in the selection of models for estimation. Five models that included only main effect terms were promising and were thus selected for presentation (models 1–5, Table 1). Three additional models (models 6–8) including interaction terms that were postulated a priori were also considered.

Estimation

For each of the eight models, logistic regression was used to model relations between the predictor variables and the outcome of interest and to generate maximum likelihood parameter estimates. With respect to the first study outcome (current smoking), for example, the logit of the probability that an individual currently smokes given his or her socio-demographic characteristics (e.g. age, sex, province) was estimated. Predicted probabilities were then calculated by back-transformation for each combination of socio-demographic characteristics and province. Under the assumption that all individuals with certain characteristics had equal probabilities of the outcome, the probabilities were applied to the socio-demographic structure of the youth populations. Population strata counts were obtained first from the 1996/97 NPHS and then the 1996 census.

TABLE 1
Description of variables and models

Variable/model	Description
Dependent variables	
Prevalence of current smoking[a]	Proportion of current smokers (daily or occasional) in the population
Incidence of daily smoking[b]	Proportion of persons who began smoking daily in the previous year
Predictor variables[c]	
Age	15–19 and 20–24
Sex	Male and female
Language	English and/or French and other
Unemployment	Looking for work and all other labour force characteristics
Education	Not currently attending school and currently attending school
Models	
Model 1	Age, sex, province
Model 2	Sex, language, province
Model 3	Age, sex, unemployment, province
Model 4	Age, sex, education, province
Model 5	Age, sex, unemployment, education, province
Model 6	Age, sex, unemployment, age by unemployment, province
Model 7	Age, sex, education, age by education, province
Model 8	Age, sex, unemployment, education, age by unemployment, age by education, province

[a] In the regression models current smokers were compared with non-smokers.
[b] In the regression models new daily smokers were compared with all other respondents.
[c] All variables are dichotomized.

Model Validation

Direct estimates of both study outcomes (with associated 95% confidence intervals [CI]) were calculated for each province from the 1996/97 NPHS. Model-generated estimates were then compared with the direct estimates. There was an a priori assumption that the models were reasonable if the modelled provincial estimates were in approximately the same rank order as the direct provincial estimates and if the mean of the absolute differences between the modelled and direct estimates was small (near zero) relative to the estimates themselves. If both of these criteria were met, this would indicate that the modelling process resulted in reasonably accurate estimates. Spearman correlation coefficients[24] and associated two-tailed p values were also calculated to quantify correlations between provincial rankings obtained by direct and model estimation.

Results

General Patterns of Association

Parameter estimates obtained from the logistic regression modelling process were determined for both study outcomes. Unemployment and lower levels of education were found to be consistently associated with current smoking. For smoking initiation, age was the most consistent predictor. Education and unemployment were significantly associated with smoking initiation only in models that included both predictors simultaneously. These two predictors were positively correlated (higher education, higher unemployment), since full-time students were classified as unemployed within these data sources. Terms that described the interaction between age and both unemployment and education were not significantly associated with either study outcome.

Current Smoking

Provincial estimates of current smoking outcome (both direct and model-estimated) are shown in Table 2. These models relied upon stratum-specific population distribution figures from the 1996/97 NPHS. Direct estimates varied from 27.9% in Ontario to 40.1% in Quebec, and when Quebec was excluded the range of point estimates was quite small (27.9–33.6%). Model-generated estimates were in approximately the same order as the direct estimates, except for New Brunswick and Alberta, for which each of the eight models consistently ranked differently from the direct estimates. With respect to the second validation criterion, the mean of the differences between direct and model-generated estimates was smallest for models 4 and 7. For illustration and reference, Table 3 shows the beta coefficients and associated 95% CI derived for logistic regression model 4. Model 4 was considered the "best"

TABLE 2
Direct and model-generated estimates of the prevalence of current smoking among Canadian youth aged 15–24 in 1996 (estimates generated using stratum-specific population from the 1996/97 NPHS)

Province	Direct and model-generated estimates and provincial ranking															
	Direct		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
	% (95% CI)	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank
Nfld	33.6 (26.1–41.1)	3	32.3	5	32.7	5	22.8	4	32.2	5	24.9	4	23.0	4	32.3	5	25.3	4
NS	31.0 (23.4–38.6)	6	29.7	7	28.8	9	21.1	7	31.0	7	23.3	7	21.4	7	30.9	7	24.2	6
PEI	33.6 (25.2–42.0)	2	34.2	4	35.1	4	22.2	5	32.3	4	24.4	5	22.4	5	32.4	4	24.8	5
NB	30.7 (23.7–37.7)	7	34.4	3	35.3	3	25.5	3	33.0	3	27.1	3	25.7	3	33.1	3	27.6	3
Que	40.1 (34.9–45.3)	1	39.6	1	39.2	1	30.4	1	40.3	1	32.8	1	30.7	1	40.3	1	33.6	1
Ont	27.9 (26.6–29.2)	10	27.6	10	27.9	10	20.1	10	26.5	10	21.4	10	20.4	10	26.5	10	22.0	10
Man	31.5 (27.4–35.6)	5	37.2	2	37.3	2	25.6	2	35.4	2	27.7	2	25.9	2	35.3	2	28.3	2
Sask	30.4 (23.0–37.8)	8	31.2	6	31.5	6	21.5	6	31.6	6	23.8	6	21.7	6	31.6	6	24.2	7
Alb	31.9 (25.1–38.7)	4	29.6	8	30.1	7	20.2	9	30.0	8	22.4	9	20.5	8	29.9	8	22.9	9
BC	29.2 (23.1–35.3)	9	29.3	9	29.2	8	20.5	8	29.1	9	22.3	8	20.8	9	29.1	9	22.9	8
Correlation of ranks with direct estimates (*p* value)			0.67 (0.03)		0.66 (0.04)		0.58 (0.08)		0.67 (0.04)		0.66 (0.04)		0.60 (0.07)		0.67 (0.03)		0.62 (0.06)	
Mean of the absolute differences			1.7		1.9		9.0		1.4		7.0		8.7		1.4		6.4	

TABLE 3
Parameter estimates[a] from logistic regression model used to estimate the prevalence of current smoking (model 4)

	Intercept	Age	Sex	Education
Baseline level		15–19	Males	Not attending school
Beta (95% CI)	-1.384 (-1.666– -1.102)	-0.045 (-0.234–0.144)	0.148 (-0.021–0.317)	0.926 (0.737–1.116)

[a] Although considered in the model, parameter estimates are not presented for individual provinces.

of these two models because it is was parsimonious; it shows that the coefficients for age and sex were not statistically different from zero, and education was modestly associated with current smoking.

Table 4 presents direct and model-generated estimates of current smoking, but this time based upon stratum-specific population distributions from the 1996 census. The model-generated estimates followed a similar pattern to those estimated directly using the 1996/97 NPHS, although the strength of the correlation between the direct and model-generated estimates was not as strong.

Smoking Initiation

Direct and model-generated estimates of the incidence (or uptake) of daily smoking are shown in Table 5 (based on 1996/97 NPHS data) and Table 6 (based on the 1996 census). This outcome was quite rare, varying from 1.1%

TABLE 4
Direct and model-generated estimates of the prevalence of current smoking among Canadian youth aged 15–24 in 1996 (estimates generated using stratum-specific population from the 1996 census of Canada)

Province	Direct and model-generated estimates and provincial ranking																	
	Direct		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
	% (95% CI)	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank
Nfld	33.6 (26.1–41.1)	3	32.9	5	33.3	5	25.2	4	30.0	6	25.9	4	25.4	4	30.1	6	26.3	4
NS	31.0 (23.4–38.6)	6	29.3	9	29.5	10	23.7	6	29.1	7	24.7	7	23.9	6	29.0	8	25.2	7
PEI	33.6 (25.2–42.0)	2	34.3	4	35.1	4	24.2	5	30.1	5	24.8	6	24.4	5	31.0	5	25.9	5
NB	30.7 (23.7–37.7)	7	35.1	3	35.4	3	27.7	2	33.7	3	28.9	3	28.1	2	33.8	3	29.5	3
Que	40.1 (34.9–45.3)	1	39.7	1	41.6	1	32.2	1	37.9	1	41.6	1	32.5	1	37.9	1	34.0	1
Ont	27.9 (26.6–29.2)	10	27.7	10	31.3	9	21.7	8	26.4	10	22.6	10	22.0	9	26.5	10	23.1	10
Man	31.5 (27.4–35.6)	5	37.3	2	39.9	2	27.4	3	35.6	2	29.1	2	27.7	3	35.6	2	30.0	2
Sask	30.4 (23.0–37.8)	8	31.6	6	32.8	7	23.2	7	31.9	4	25.1	6	23.5	7	31.9	4	25.6	6
Alb	31.9 (25.1–38.7)	4	29.9	7	32.0	8	21.5	10	29.1	8	23.0	8	21.7	10	29.1	7	23.5	8
BC	29.2 (23.1–35.3)	9	29.9	8	33.3	6	21.7	9	28.6	9	22.9	9	22.0	8	28.3	9	23.5	9
Correlation of ranks with direct estimates (*p* value)			0.57 (0.09)		0.43 (0.21)		0.51 (0.14)		0.49 (0.15)		0.54 (0.11)		0.51 (0.14)		0.49 (0.15)		0.61 (0.06)	
Mean of the absolute differences			1.7		2.8		7.1		2.4		5.9		6.9		2.4		5.4	

to 4.7% in the 10 provinces (direct estimates). In general and for both data sources, the direct and model-generated estimates were poorly correlated, and the mean differences between modelled and direct estimates were large relative to the proportions of youth who were initiating smoking.

Temporal Considerations

In Table 7, estimates and rankings from the best model in Table 2 (i.e. model 4) are presented along with direct estimates and rankings from the 1994/95 and 1996/97 NPHS. Direct estimates in 1994/95 and 1996/97 changed at least slightly in most provinces and quite substantially in New Brunswick and Manitoba. Similarly, the provincial rankings changed between the two NPHS survey years: 1996/97 model-generated estimates and ranks were consistent with those directly obtained from the 1994/95 NPHS and less strongly associated with the1996/97 direct ranks.

Discussion

In this study we attempted to estimate the prevalence and initiation of youth smoking in Canada using existing data from the NPHS and the Canadian census. A regression estimation approach was used. Analyses focused upon the derivation of estimates of youth smoking at the provincial level, and these were compared with direct estimates of youth smoking that were thought to be fairly stable and accurate.

There were a number of criteria established for the estimation process before this study was conducted. For a model to be acceptable, we felt that it had to produce accurate estimates. Second, the techniques used for estimation had to be fairly simple, as we felt they would be applied by personnel with basic statistical and spreadsheet training. The techniques themselves involved use of area-specific socio-demographic information from the census, in cross-tabulated form, in order to generate estimates of youth smoking. This meant that the predictors included in the models were limited to those available in the census, and that any model developed would ideally

TABLE 5
Direct and model-generated estimates of the incidence of daily smoking among Canadian youth aged 15–24 in 1996 (estimates generated using stratum-specific populations from the 1996/97 NPHS)

Province	Direct and model-generated estimates and provincial ranking																	
	Direct		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
	% (95% CI)	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank
Nfld	2.8 (0.4–5.2)	5	1.9	8	1.9	8	2.0	7	1.9	8	3.1	8	2.0	8	2.0	8	2.9	7
NS	3.6 (0.4–6.8)	4	3.7	3	4.0	2	1.3	10	3.7	3	5.7	3	3.9	3	3.6	3	4.7	3
PEI	1.6 (0.4–2.8)	8	4.0	2	3.8	3	4.1	2	3.9	2	6.4	2	4.2	2	4.0	2	6.1	2
NB	4.7 (1.4–8.0)	1	1.6	9	1.5	9	1.7	8	1.6	9	2.3	10	1.7	9	1.6	9	2.1	10
Que	4.3 (1.7–6.9)	2	2.9	4	3.0	4	2.9	3	2.9	4	4.3	4	3.0	4	2.9	4	3.9	4
Ont	2.1 (1.7–2.5)	7	2.3	7	2.3	6	2.4	6	2.3	7	3.1	7	2.4	7	2.3	7	2.8	8
Man	1.4 (0.4–2.4)	9	2.5	5	2.5	5	2.6	4	2.4	5	3.9	5	2.6	5	2.4	5	3.5	5
Sask	3.7 (0.7–6.7)	3	6.3	1	6.3	1	6.5	1	6.4	1	10.0	1	6.6	1	6.4	1	9.1	1
Aal	2.7 (0.3–5.1)	6	1.5	10	1.5	10	1.5	9	1.5	10	2.4	8	1.6	10	1.5	10	2.2	9
BC	1.1 (0.0–2.6)	10	2.3	6	2.3	7	2.4	5	2.3	6	3.6	6	2.4	6	2.3	6	3.3	6
Correlation of ranks with direct estimates (*p* value)			-0.01 (0.99)		-0.02 (0.96)		-0.15 (0.68)		-0.14 (0.70)		-0.23 (0.52)		-0.01 (0.99)		-0.14 (0.70)		-0.04 (0.91)	
Mean of the absolute differences			1.4		1.4		1.7		1.4		2.2		1.5		1.4		2.0	

be parsimonious. Finally, it was hoped that the final models would be portable (i.e. applicable to different Canadian populations of youth both geographically and across time).

Parameter estimates for models of current smoking were derived from the 1994/95 NPHS data. When the latter estimates were applied to random subsets of socio-demographic data for youth in that survey, they performed almost perfectly (data not shown), as would be expected given that the models were generated from the 1994/95 data set. When they were applied to socio-demographic data taken from the 1996/97 NPHS, the models performed reasonably well, but not perfectly. Performance declined further when these same models were applied to 1996 socio-demographic data from the census. As seen in Table 7, the model-generated estimates based on the 1996/97 NPHS data tended to be more similar in magnitude and rankings to the direct estimates from 1994/95 than those of 1996/97. This casts doubt on whether even the best of the predictive models was portable across time.

Population distributions of the socio-demographic factors considered in the models were relatively stable and would not, themselves, account for the observed temporal variations in youth smoking. This indicates that associations between the predictors and smoking changed over time, or that one or more explanatory variables that were not considered in the models were unstable. Thus, in general, the socio-demographic variables available for use were not sufficient to accurately predict youth smoking behaviours and changes in these behaviours.

For current smoking, although the models performed reasonably well according to both validation criteria, performance was inconsistent by province. Models that included unemployment (models 3, 5, 6 and 8) tended to underestimate the prevalence of current smoking. One would expect the employment status of individuals in this age group to be inaccurate, particularly as most youth are not viewed as being in the traditional labour force. Models that included education (but not unemployment—models 4 and 7) provided estimates that were more accurate than those that considered solely age and sex (model 1). Inclusion of the age-by-education interaction term did

TABLE 6
Direct and model-generated estimates of the incidence of daily smoking among Canadian youth aged 15–24 in 1996 (estimates generated using stratum-specific populations from the 1996 census of Canada)

Province	Direct and model-generated estimates and provincial ranking																	
	Direct		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
	% (95% CI)	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank
Nfld	2.8 (0.4–5.2)	5	1.8	8	1.9	8	1.9	7	1.8	8	2.6	8	1.9	8	1.8	8	2.3	8
NS	3.6 (0.4–6.8)	4	3.8	3	4.0	2	1.3	10	3.8	2	5.2	3	4.0	3	3.8	3	4.6	3
PEI	1.6 (0.4–2.8)	8	3.9	2	3.7	3	4.0	2	3.7	3	5.5	2	4.1	2	3.8	3	5.0	2
NB	4.7 (1.4–8.0)	1	1.5	9	1.5	10	1.5	8	1.5	9	2.1	10	1.6	9	1.5	9	1.9	10
Que	4.3 (1.7–6.9)	2	2.8	4	3.2	4	2.9	3	2.8	4	3.7	5	3.0	4	2.8	4	3.4	5
Ont	2.1 (1.7–2.5)	7	2.3	6	2.5	6	2.3	5	2.2	6	3.0	7	2.4	6	2.3	6	2.7	7
Man	1.4 (0.4–2.4)	9	2.5	5	2.6	5	2.5	4	2.4	5	3.8	4	2.6	5	2.4	5	3.5	4
Sask	3.7 (0.7–6.7)	3	6.3	1	6.5	1	6.5	1	6.4	1	9.5	1	6.6	1	6.4	1	8.7	1
Alb	2.7 (0.3–5.1)	6	1.5	10	1.6	9	1.5	9	1.4	10	2.2	9	1.5	10	1.5	10	2.0	9
BC	1.1 (0.0–2.6)	10	2.2	7	2.5	7	2.3	6	2.2	7	3.2	6	2.3	7	2.2	7	3.0	6
Correlation of ranks with direct estimates (*p* value)			-0.04 (0.91)		0.02 (0.96)		-0.12 (0.75)		0.08 (0.83)		-0.15 (0.68)		0.03 (0.93)		0.08 (0.83)		-0.15 (0.68)	
Mean of the absolute differences			1.4		1.5		1.7		1.4		2.1		1.5		1.4		1.9	

not improve the estimates. (Here, accuracy and its improvement refer to the degree to which direct and model-generated estimates were similar in rank and magnitude.)

Modelling of the second youth smoking indicator (initiation of daily smoking) was not successful. In general, there was a poor correlation between the rank order of the provincial estimates obtained directly and the model-generated rank estimates. Because the outcome was quite rare, there was also considerable variability in the direct estimates as indicated by their relatively large confidence intervals.

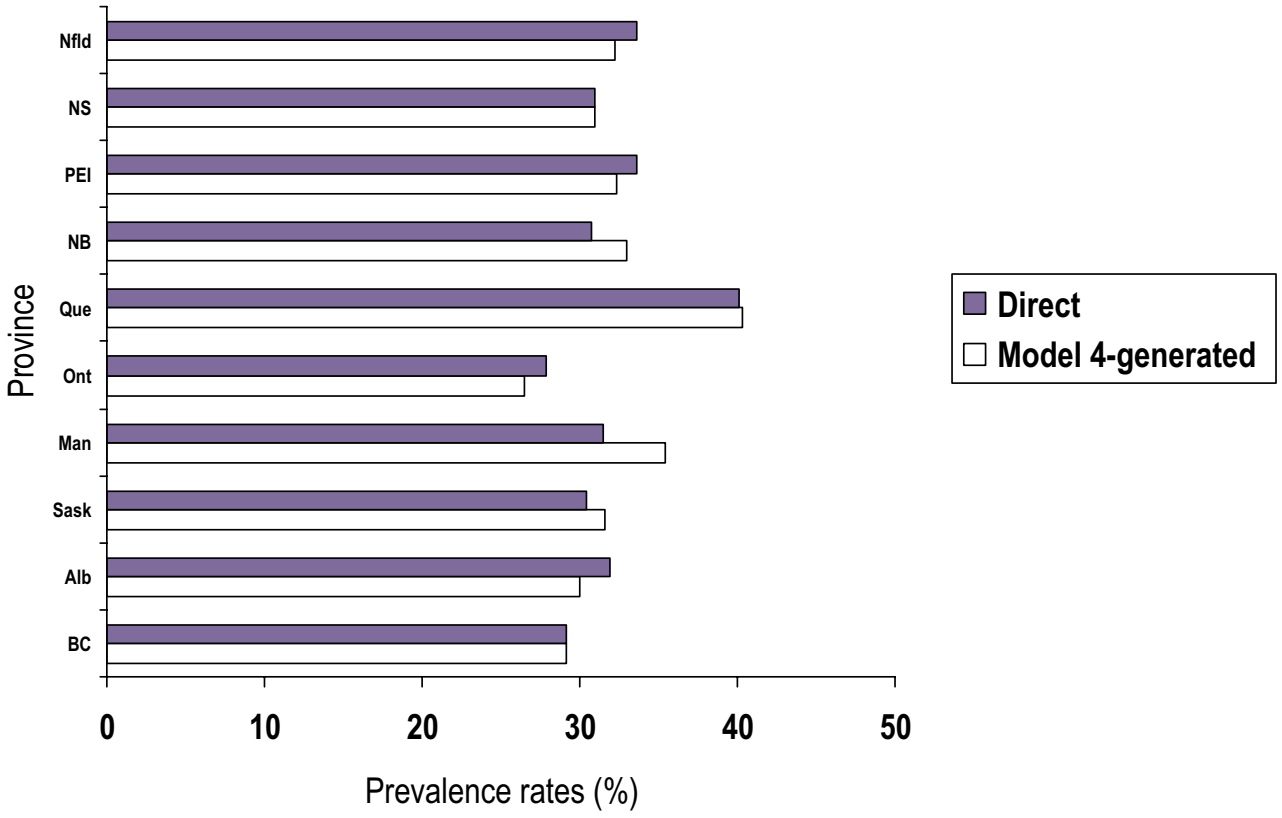
The study was limited by the sample sizes available in the two versions of the NPHS (2,597 and 9,601 for the 1994/95 and 1996/97 versions respectively). Direct estimates of smoking and the predictive models were less stable in some provinces than was anticipated. This also meant that additional subanalyses (within various age/sex strata, for example) were not possible, and that a split-data approach to model development and validation could not be undertaken. On a population level, the lack of interprovincial variation in the two smoking indicators complicated the estimation process. Similarly, for many of the eight models considered in our analysis, there was little variation between provinces in the underlying distributions of salient predictors. This also contributed to our difficulties in developing stable, predictive models.

To illustrate these last points, Figure 1 provides a visual summary of the provincial rates obtained of current smoking, estimated both directly from the 1996/97 NPHS and then by application of model 4 to the stratum-specific population from that survey. The direct and model-generated estimates were generally quite close, but this figure shows the inherent difficulty in using province-level data to perform small area estimation. With the exception of Quebec, there was actually only minor variation between the provinces in the prevalence of current smoking. It is possible, and even likely, that within-province variations in rates of youth smoking actually exceeded the variations observed between the provinces. The modelling procedures and their

TABLE 7
Comparison of model 4-generated estimates/rankings and direct estimates/rankings from the 1994/95 and 1996/97 NPHS for the prevalence of current smoking

Province	Model 4-generated from 1996/97 NPHS		1994/95 direct		1996/97 direct	
	Estimate (%)	Rank	Estimate (%)	Rank	Estimate (%)	Rank
Nfld	32.2	5	32.7	5	33.6	3
NS	31.0	7	29.1	9	31.0	6
PEI	32.3	4	34.7	4	33.6	2
NB	33.0	3	35.0	3	30.7	7
Que	40.3	1	39.1	1	40.1	1
Ont	26.5	10	27.6	10	27.9	10
Man	35.4	2	37.4	2	31.5	5
Sask	31.6	6	31.6	6	30.4	8
Alb	30.0	8	29.7	7	31.9	4
BC	29.1	9	29.5	8	29.2	9
Correlation of ranks with direct estimates (*p* value)			0.96 (< 0.0001)		0.67 (0.04)	
Mean of the absolute differences			0.5		0.2	

FIGURE 1
Comparison of direct and model 4-generated estimates of current smoking prevalence among Canadian youth aged 15–24 in 1996 (from the 1996/97 NPHS)



imputations may have performed better had they been derived from smaller areas than provinces.

Existing studies that have used synthetic, regression and combined estimation approaches have met with mixed success, and our results are consistent with this. For example, MacKenzie et al.[15] applied data from the United States National Health Interview Survey to local area data from the US census to estimate a variety of health indicators. Local estimates were then validated using a large, population-based telephone survey to generate "gold standard" values. Synthetic and regression estimates were found to approximate the gold standard results for some health-related variables, but not for others. There was no consistency with respect to the types of variables that produced accurate and poor approximations. Spasoff et al.[16] used synthetic and regression estimation to perform similar procedures with the 1990/91 Ontario Health Survey and the 1986 Canadian census. Again, small area estimation did not perform well in approximating gold standard estimates.

The findings observed in both of these studies were attributed to limitations in the design of the evaluations. The latter included flawed choices of gold standards and inaccurate sources of data on which to base estimation models. Our experience suggests that, in contrast to the results of these efforts, simple estimation models of youth smoking can be derived. However, these models may not be portable across different populations and time periods, and it is perhaps unrealistic to expect that complex behaviours like youth smoking can be predicted solely on the basis of socio-demographic factors and simple estimation approaches. More sophisticated analytic methods (such as the newer Empirical Bayes approaches[20]) may be required, or else the conceptualization of models must involve use of predictors that are not made available routinely through the census.

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The Prevalence of Diabetes in the Cree of Western James Bay

David AL Maberley, Will King and Alan F Cruess

Abstract

Diabetes prevalence and general demographic data for individuals with diabetes were evaluated in the Cree of Moose Factory, Ontario. Individuals with diabetes were identified through a retrospective review of the diabetes registry as well as of outpatient and inpatient records. The crude prevalence of diabetes was 62 (95% confidence interval: 54–72) per 1,000. The direct age-standardized prevalence of diabetes was 103 per 1,000 for the entire population (95% confidence interval: 89–118 per 1,000, standardized to the 1991 Canadian population). The estimated rate of diabetes in the Canadian population is approximately 5%. The average age of individuals with diabetes in the community was 53 years; the average duration of diabetes was 8.2 years. Most of the population with diabetes were female (64%) and were using anti-hypertensive medications (64%). This study presents diabetes prevalence data for the population of Moose Factory, Ontario, that indicate a higher prevalence than in both the Canadian population and other Cree populations in the region.

Key words: *aboriginal; adult; diabetes mellitus; Indians, North American; non-insulin dependent diabetes; Ontario; prevalence*

Introduction

The overall prevalence of self-reported diabetes among Canadian adults (aged 18–74) was approximately 5.1% in the Canada Health Survey.[1] Diabetes in North American Indians has become more prevalent over the past 50 years,[2] and certain native Canadian populations now suffer from a significantly higher prevalence of diabetes than the general Canadian population.[3–6]

The prevalence of diabetes varies markedly from population to population, although it is difficult to compare prevalence data between studies because of major differences in methods. Young et al.'s 1990 review of the geographic distribution of diabetes in aboriginal Canadians provides an overview of regional differences in prevalence figures.[7] This study demonstrated that the highest age-standardized diabetes rates were in the Atlantic region and the lowest rates were among the Inuit. The Algonkian speakers of the Northeast, who include the Cree of James Bay, have among the highest diabetes prevalence of all native groups in Canada.

Although few data exist for the Cree of western James Bay, Brassard et al.'s study of the Cree population of Quebec found the age-standardized prevalence of diabetes to be high in comparison with the Canadian population as a whole.[8] This elevated prevalence in the Cree may indicate recent, accelerated changes in lifestyle and diet that have occurred in these communities over the past 50 years.[9,10]

The objective of this paper is to evaluate the crude and age-standardized prevalence of diabetes in the community of Moose Factory, Ontario, and to compare these figures with those of other Canadian aboriginal populations.

Methods

The communities of western James Bay include Moose Factory, Moosonee, Attawapiskat, Kashechewan, Fort Albany, Peawanuk and New Post. The regional population is approximately 11,000 and is very stable, with little migration in or out. The inhabitants are predominantly Cree, one of several tribes that make up the Algonquin peoples.[11,12] Moose Factory is the largest community in the region and is located on an island in the mouth of the Moose River. The Cree inhabitants of Moose Factory over the age of 15 number 1,900.

Weeneebayko General Hospital, in Moose Factory, is the only hospital in the region. Health care for the population of Moose Factory is provided in this hospital or at an outpatient family medicine clinic that is based at the hospital.

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Travel to the communities of western James Bay is primarily by air. A rail line does reach Moosonee, but there is no access road into the region from the south. All the communities of western James Bay can be considered "remote:" there is little contact from non-native populations, and traditional hunting and gathering practices are still maintained.

The data for this study were collected during a review of both the Weeneebayko Hospital's diabetes registry and all patient charts in the Moose Factory Outpatient Clinic. At the time the data were compiled, in June 1998, all known individuals with diabetes were cared for through this clinic. Thus there was no possibility of missing subjects who were receiving medical care elsewhere. Inpatient records were reviewed to confirm the diagnosis of diabetes in individuals whose diagnostic laboratory data were not available in the outpatient charts.

Data from the chart review were collected through the hand searching of patient files. A diagnosis of diabetes was confirmed after consideration of fasting blood glucose studies taken during the course of routine medical care at the Moose Factory medical clinic. The attending physicians at the clinic use standard World Health Organization (WHO) criteria to determine the diagnosis of diabetes. Specifically, a diagnosis of diabetes was assigned if patients' fasting blood glucose levels were above 7.8 mmol/L or oral glucose tolerance test levels were greater than 11.1 mmol/L.[13] All laboratory studies were performed at the Weeneebayko Hospital Laboratory. For the glucose tolerance test, blood sugar levels were measured two hours after glucose load. Individuals with high random glucose tests were re-examined with fasting blood glucose tests at the outpatient clinic.

There is a very low prevalence of type I (insulin-dependent) diabetes in the Quebec Cree.[9] During the course of this study, only one individual with type I diabetes was identified in Moose Factory. For this reason, all data presented are for individuals with type II (non-insulin-dependent) diabetes. Individuals with gestational diabetes or secondary diabetes were excluded from this study. Non-Cree people with diabetes were also excluded.

Basic demographic and medical history data for the cohort with diabetes were recorded during the chart review. Age and duration of diabetes were recorded as of January 1, 1998. Where physicians' notes did not document the onset of diabetes, this point was defined as the date of the oldest laboratory value meeting the WHO criteria for diabetes. Treatment status was recorded as the regimen an individual was receiving for the majority of the five-year period preceding January 1998. Hypertension was defined as present if a patient was taking medications to control his or her blood pressure. Macrovascular complications of diabetes were defined as a history of stroke with sequelae, or myocardial infarction as documented by electrocardiography.

Data were also collected for routine blood tests. Many individuals did not have extensive laboratory profiles over the course of their diabetic history; however, an attempt was made to standardize the laboratory results in a manner that would make these values somewhat meaningful. For all individuals, laboratory values were recorded from tests that were performed as close as possible to a point two years after each individual's diagnosis of diabetes. These values were chosen to provide some indication of the diabetic metabolic status that exists in this community during the early stages of diabetes.

Descriptive statistics were calculated using the SPSS statistical program. The direct age-standardized prevalence for Moose Factory was calculated using 1991 Canadian census data for individuals over the age of 15.[14] Confidence intervals (CIs) for estimates of type II diabetes prevalence were calculated using the binomial distribution.[15]

This study was conducted with approval from the Weeneebayko General Hospital Board, the hospital's Chief Executive Officer and the Chief Medical Officer. The Hospital Board includes two representatives from each Cree community that receives medical care through the hospital. The study protocol was also approved by the Queen's University Health Sciences Human Research Ethics Board. All data were initially presented in an open forum in Moose Factory.

Results

Based on estimates supplied by the Health Planning Office of the Weeneebayko Hospital, the total Cree population of Moose Factory in 1997 was 2,819, with 1,900 individuals over 15 years of age.[16]

From the chart review, 174 individuals were identified as having diabetes. There were no individuals under age 15 with diabetes. The crude prevalence of diabetes for the entire population was 62 (95% CI: 53–72) per 1,000. The crude prevalence for individuals over age 15 was found to be 92 (95% CI: 79–105) per 1,000 [Table 1].

To evaluate the effect of a person's sex on the prevalence of diabetes, sex-specific values were calculated for males and females over the age of 15 (Table 1). The male and female prevalences were 67 (95% CI: 51–83) per 1,000 and 115 (95% CI: 95–135) per 1,000 respectively for those over age 15. The highest prevalence of diabetes was among women between the ages of 55 and 64, of whom 48% were found to have diabetes.

Because the Moose Factory Cree have a larger proportion of their population under the age of 35 than the Canadian population, direct age-standardization was performed using 1991 Canadian census data with individuals over the age of 15 as the referent population.[14] The direct age-standardized prevalence of diabetes among individuals over age 15 in Moose Factory was 131 (95% CI: 116–146) per 1,000. When all ages were considered, the age-standardized prevalence was 103 (95% CI: 92–114).

TABLE 1
Age-specific prevalence of diabetes by sex, Moose Factory population, 1998

Age (years)	Males		Females		Both sexes
	Prevalence per 1,000	Crude numbers	Prevalence per 1,000	Crude numbers	Prevalence per 1,000
15–24	11.9	3/251	7.9	2/253	9.9
25–34	14.9	4/268	43.8	11/251	28.9
35–44	56.8	10/176	120.2	25/208	91.1
45–54	184.9	22/119	166.7	21/126	175.5
55–64	272.7	12/44	483.3	29/60	394.2
65–74	131.5	5/38	265.3	13/49	206.9
75–84	285.7	6/21	411.8	7/17	342.1
85+	0.0	0/6	307.7	4/13	210.5
All ages	67.2	62/923	114.6	112/977	91.6
Standardized rate[a] (per 1,000) for ages 15 and up = 130.85 (95% CI: 115.7–146.0)					

[a] Age-standardized rates for Moose Factory subjects were calculated using the Canadian population distribution from the 1991 census as the standard.

Demographic features of the full cohort are presented in Table 2. Data were not available for all subjects on each variable; for all variables, data were available for approximately 90% of subjects.

The average age of individuals with diabetes in Moose Factory was 53, and the average duration of diabetes was eight years. Sixty-four percent of all those with diabetes were women, and 64% were taking anti-hypertensive medication(s). Most subjects were being treated with oral hypoglycemics, and 14% had suffered a myocardial infarction or stroke (Table 2). With an average body-mass index (BMI) of 32.4 kg/m^2, this population with diabetes would be considered markedly obese (obesity defined as a BMI above 27).

The average hemoglobin A_{1C} for the Moose Factory population with diabetes was found to be 0.10—considered to indicate poor control for individuals with diabetes. The average serum cholesterol was 5.25 mmol/L, a level that corresponds to "borderline risk," while the average blood urea nitrogen and serum creatinine levels for the cohort were within the normal range for the Weeneebayko Hospital Laboratory.

Discussion

For the general Canadian population, the estimated prevalence of diabetes is approximately 50 per 1,000.[1] The present study demonstrates a significantly higher prevalence of diabetes in the Cree of James Bay, Ontario. In the community of Moose Factory, the crude prevalence of diabetes was found to be 62 per 1,000 overall, and 92 per 1,000 for individuals over age 15. Direct age-standardization provided a prevalence estimate of 131 per 1,000 in James Bay, Ontario. These figures are significantly higher than for the James Bay Cree of Quebec, among whom Brassard et al. found the crude prevalence of diabetes to be 27 (95% CI: 24–30) per 1,000 and the age-adjusted prevalence to be 66 (95% CI: 59–73) per 1,000 for those over age 20 (Table 3).[8]

The differences in diabetes prevalence between these two related populations do not appear to be connected to sampling differences because both studies identified subjects through physician-diagnosed registries that used similar diagnostic criteria. The higher diabetes prevalence found in the present study may represent actual differences between the Ontario and Quebec study populations.

The increasing Westernization of North American aboriginal populations has resulted in striking dietary and lifestyle changes over the past 50 years.[17] Brassard et al.'s study showed a marked geographic gradient in the prevalence of diabetes, such that more isolated communities were somewhat protected from the disease. The elevated diabetes prevalence in Moose Factory may indicate that this community is less remote than those examined by Brassard et al. In fact, Moose Factory is quite a developed community, with fast-food vendors, restaurants and department stores allowing increased access to Western dietary choices. The degree of Westernization in Moose Factory is similar to that of Chisasibi, Quebec; however, the inclusion of many more isolated communities in the Quebec estimate may have resulted in an overall lower prevalence. As well, the fact that sampling occurred a decade earlier suggests that the Quebec communities, as a whole, were less Westernized at the time of Brassard's study than Moose Factory is

TABLE 2
Basic demographic data for Moose Factory population

Demographic variable	Subjects (with data)	Average number (continuous variables) or percentage (discrete variables)	Standard deviation
Total number of subjects	174		
Average age of subjects	174	53 years	15 years
Average duration of diabetes	170	8.2 years	6.4 years
Number of males/females	174	36% / 64%	
Treatment regimen (diet/oral/insulin)	171	28% / 53% / 19%	
Hypertensives/Normotensives	169	64% / 36%	
Stroke or myocardial infarction (ever/never)	155	14% / 86%	
Average hemoglobin A_{1C}	166	10%	3%
Average body-mass index	155	32.4 kg/m^2	4.9 kg/m^2
Average serum cholesterol	155	5.25 mmol/L	1.10 mmol/L
Average blood urea nitrogen	164	5.24 mmol/L	1.74 mmol/L
Average serum creatinine	165	64.8 mmol/L	19.9 mmol/L

TABLE 3
Direct age-standardized prevalence of diabetes for different Canadian populations

Region	Tribe/culture	Age range for standardization	Standard population	Direct age-standardized prevalence (95% CI)
Moose Factory, Ontario (present study)	Cree	15+	1991 Canadian	13.1% (11.5 –14.6)
James Bay, Quebec[8]	Cree	20+	1986 Canadian	6.6% (5.9–7.3)
Sandy Lake, Ontario[22]	Ojibwa/Cree	10+	1991 Canadian	26.1% (22.9–29.3)
Southwestern Ontario[3]	Oneida/Chippewa/Muncey	5+	1985 Canadian	14.7% (12.7–16.7)
Southwestern Ontario[3]	Caucasian	5+	1985 Canadian	2.2% (1.6–2.8)
Moose Factory, Ontario (present study)	Cree	All ages	1991 Canadian	10.3% (9.2–11.4)
Atlantic region[7]	Algonkian	All ages	1985 Canadian	8.7% (8.1–9.3)
Ontario[7]	Algonkian/Iroquoian	All ages	1985 Canadian	7.6% (7.3–7.9)
Sioux Lookout, Ontario[22]	Ojibwa/Cree	All ages	1986 Canadian	6.7% (4.6–8.7)

now. A very recent survey of the Quebec Cree population indicates that the crude prevalence of diabetes has increased over the past 10 years to more closely approximate the values presented in this study.[18]

Young et al.'s overview paper from 1990 presents age-standardized data for different native language groups based on the 1985 Canadian intercensal population estimate. The lowest rates of diabetes in the Canadian native population were found in the Northwest Territories, and the highest rates were noted in the Ontario and Atlantic regions.[12] As with the work of Brassard et al., a definite geographic gradient was observed. Lower diabetes prevalence figures were noted in more northerly latitudes and in more isolated regions.

To compare the diabetes prevalence figures found in this study with other North American Indian populations is complicated. Research methods vary greatly from study to study. Different population selection techniques, diagnostic criteria and standardized populations make for difficult comparisons of prevalence figures. Table 3 presents studies of native Canadian peoples that have incorporated age-standardized prevalence figures for diabetes using Canadian census data for standardization. To facilitate comparison, the direct age-standardized

results of this study are presented for both the complete population and for individuals over age 15. When age-standardized prevalence figures were available for the entire population, the "all ages" figures were uniformly lower. This is due to the association between age and an increased prevalence of type II diabetes.

Studies of specific native populations of Ontario, Alaska and Arizona have demonstrated lower diabetes prevalence rates than in the Ontario Cree population of James Bay.[19–21] In contrast, higher recorded prevalence figures were found in the Ojibwa-Cree community of Sandy Lake, Ontario.[22] Interestingly, for the tribes that demonstrated age-adjusted prevalence figures in the 100 per 1,000 range (Table 3), there was a marked homogeneity of heritage—the Chippewa, Cree, Ojibwa and Oneida are all part of the same language group (Algonkian).

The summary statistics for diabetes in Moose Factory (Table 2) demonstrate a significantly higher prevalence of diabetes among women than men. This finding has been documented in every other Canadian aboriginal diabetes prevalence study. Delisle et al. found a statistically different age-adjusted diabetes prevalence between men and women in the Lac Simon Algonquin of Quebec: 49% of women between 30 and 64 years of age were found to have diabetes in contrast to 24% of men.[23] Reasons for the recorded discrepancies between aboriginal men and women could be that women are often identified as having diabetes during routine pregnancy screening tests. Alternatively, the increased prevalence may relate to a higher rate of obesity, impaired glucose tolerance and type II diabetes at younger ages among native women.[21] The impact of an increased prevalence of gestational diabetes must also be considered a contributing factor in the development of type II diabetes both maternally and in children.[24] Alternatively, women might be more active in seeking medical care than men.

The main limitation of the present study was the use of diabetes registry/chart review data for the diagnosis of cases. This may have resulted in a potentially incomplete picture of the state of diabetes in the Moose Factory Cree. Nonetheless, the data likely represent the minimum prevalence of diabetes in this community. The true rate could be as much as 25–30% higher.[25,26]

Local Omuskegowuk Band Council initiatives have targeted diabetes as an area of community health focus in Moose Factory. The community is well educated about this condition and may have a higher capture rate for diabetes than other communities. If this is the case, the chronic disease registry used in this study may be more representative of the true diabetes prevalence in Moose Factory than in other communities with similar databases.[27]

Another interesting statistic was the large number of individuals with diabetes who were taking anti-hypertensive medications (64%). This finding could be explained either by a significant association between diabetes and hypertension or by the more aggressive use of these medications by physicians for individuals with diabetes.

The average serum creatinine and blood urea nitrogen levels for the entire cohort were within the normal range for individuals without diabetes, suggesting that primary hypertension and not diabetic renal failure may be the likely mechanism for hypertension in these people. The cohort's average serum cholesterol was also within the normal non-diabetic range; however, as might be expected, hemoglobin A_{1C} levels were significantly higher than normal.

The importance of this study is that it documents a high prevalence of diabetes in the Moose Factory Cree when compared with the Quebec Cree population and other Canadian aboriginal populations. No data have been published about the prevalence of diabetes in the James Bay Cree of Ontario. This study serves as a baseline for future surveillance projects. The data also confirm local Band Council concerns about the magnitude of diabetes as a public health problem in Moose Factory and suggest that efforts are warranted toward furthering our understanding of diabetes, its related complications and sex/geographic variability in the James Bay Cree. It is known that the prevalence of diabetes in aboriginal Canadian communities is higher than that of the Canadian population as a whole. This study demonstrates that the prevalence of diabetes in the James Bay Cree is higher than in other Cree populations in the region and may be among the highest in the country. Moreover, the estimates presented here are likely an underestimation of the true prevalence of diabetes in the Moose Factory Cree.

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Status Report

Orius Software: Calculation of Rates and Epidemiologic Indicators, and Preparation of Graphical Output

Long On, Robert M Semenciw and Yang Mao

Abstract

Orius software produces disease surveillance statistics, including output for the Health Canada Web site "Cancer Statistics Online" and on-demand statistics at the Web site for the North American Association of Central Cancer Registries. It allows flexibility in accessing data; storing, modifying and customizing requests; and producing statistical results and graphical output. Results include age-standardized or age-sex-standardized rates, standardized incidence/mortality ratios (observed-to-expected ratios) in which one area is optionally selected as the reference, potential years of life lost, average annual percent change, Mantel-Haenszel and maximum likelihood rate ratios, and the comparative incidence figure.

Key words: *age-standardized rate; cancer registry; software; vital statistics*

Introduction

Orius software was developed in response to the need for descriptive epidemiologic statistics and graphical output for surveillance analysis and user requests. At present it is used internally by Health Canada staff for surveillance projects, including output for the Health Canada Web site "Cancer Statistics Online" <http://www.hc-sc.gc.ca/hpb/lcdc/webmap/>, and to produce cancer incidence statistics on demand at the Web site for the North American Association of Central Cancer Registries (NAACCR), "CiNA+ Online" <http://www.naaccr.org/CINAPlus/index.html>. Common data sources include mortality, cancer incidence and hospital morbidity.

The flexibility in accessing data, storing, modifying and customizing requests, and producing statistical results and graphical output varies depending on the computing environment. Currently, the desktop version operates in a stand-alone mode on Windows 95/NT or in a client/server mode with the client component on Windows 95/NT and the server component on HP-UX (UNIX-based operating system). The Web-enabled version runs on the Windows NT platform and is compatible with any web server that supports the Common Gateway Interface, for example, Apache and Internet Information Server. This version can also be delivered in a cross-platform environment consisting of Windows NT and UNIX (HP-UX or Sun Solaris) servers.

Statistical Methods

The following statistics are currently produced with Orius software.

Age- or age-sex-standardized rates and standardized incidence/mortality ratios (also called observed-to-expected ratios) in which one area is optionally selected as the reference[1,2]

Potential years of life lost[3]

Average annual percent change (AAPC)

Mantel-Haenszel and maximum likelihood rate ratios, and the comparative incidence figure[4]

The AAPC can be approximated by the slope of the log of the rates based on the following approximation, where y represents the annual rate and x the year.

$\log y = a + bx$

$y = \exp(a + bx) = \exp(a)\exp(bx)$

y approximately equal to $\exp(a)(1 + bx)$, if ax less than, say, 5%

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Because the log rate is used, zero rates are excluded from the AAPC calculation, and hence a table is provided giving the number of available points. Although Poisson regression allows zero rates, it requires the creation and use of age-specific rates (or perhaps 10-year groups) when broad age ranges are involved, such as all ages. The extra effort required to implement this step is not part of the current menu system, but SAS code is available to produce the required file from standard output created by Orius.

Graphical Output

The Web-based version produces tabular statistics as well as bar charts, pie charts, line charts and chloropleth maps. ArcView GIS is used to generate these graphical outputs. The category colour for the maps is based on the rate quintiles. At present, graphical output is provided to the user in JPEG file format.

System Architecture

The software comprises three main components. The **Manager Application** creates the data definition that describes the available data sets. For each set of available data, a data definition package is created.

The **Client Application** (desktop version) accesses the choices available in the data definition package and presents the choices to the user through an index-tab-based menu. The user can create, modify, copy, delete and save the request selections in the local database stored on the user's machine, if desired. The Client Application also allows the user to submit the request to the third component **SAS** directly (in stand-alone mode) or through a TCP/IP socket connection (in client/server mode) to obtain the SAS statistical result file and ASCII labelled output print file. A middle-tier SAS server is required to manage multiple client connections and requests. It performs the actual SAS execution calls and returns output results to the client.

The Web version extends the existing architecture with the use of **ArcView GIS** to provide the graphical output as required. The desktop Client Application is replaced by a **WebClient Application,** which interacts with a user through a series of dynamically generated HTML pages to collect request information. Again, a middle-tier ArcView server is required to request graphical output services on behalf of the client. A SAS format library and/or user supplied formats provide information for the titles on output formatted for printing.

All components, with the exception of SAS and ArcView GIS, are written in VisualAge for Smalltalk. This product is an industrial strength, cross-platform, object-oriented software development environment. Within the environment is a comprehensive class hierarchy with many ready-to-use and reusable objects. It also contains an integrated development environment with features for browsing and writing user-defined classes and methods, incremental compilation, program execution and testing, and object inspection as well as a breakpoint debugger. Other integrated features include source code management, configuration management and support for rapid application development in a team setting. The statistical routines are written in the SAS programming language through the use of macro scripts. The graphical routines are written in Avenue, ArcView GIS's scripting language.

The following is a list of the menus.

1. Age ranges
2. Age midpoints
3. Standard populations
4. Geographic areas
5. Causes
6. Sex
7. Year range
8. Age standard population set
9. Data definition (using one or more lists in 1-8 above)
10. Data definition package (using one or more data definitions specified in 9 above)

On-line help files for the Manager Application and Client Application, accessed using standard browser programs, provide further information on the lists, file requirements, outputs and current program limitations.

Data required for the rate calculation are accessed through summarized tables created by a program or database views along with an optional index. These tables, described further in the on-line help menu, contain summarized outcome data by age, area, year, cause, sex and, optionally, race. For SAS tables, a direct point access option is used for retrieval efficiency.[5] The required case and population data are selected separately and summarized according to information supplied for the request. The two resulting files are merged, rates are calculated, and finally the output listings and graphical output are created.

Discussion

Orius software provides output for typical requests within a few seconds (slightly longer for the Web-based version because of additional processing). In the client/server environment of the Population and Public Health Branch at Health Canada there are normally only a few simultaneous users. Further experience with the NAACCR Web site will indicate how the program manages larger numbers of concurrent users in a Web environment. Using VisualAge for Smalltalk has resulted in a portable program with reliable and transparent communication for the user when it is used in a client/server mode. Analysts can access the SAS code when needed for additional requirements. It may be possible to add the graphics outputs available in the Web-based version to the current client/server version, but no development is planned. This addition would be particularly useful if results could also be supplied in the template of a common graphics program that would allow users to make further changes as required.

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ArcView GIS	Environmental Systems Research Institute, Inc.
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Oracle	Oracle Corporation
SAS	SAS Institute Inc.
Sun Solaris	Sun Microsystems, Inc.
UNIX	UNIX Systems Labs Inc.
VisualAge for Smalltalk	IBM Corporation
Windows, Windows 95, Windows NT, and Internet Information Server	Microsoft Corporation

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Book Reviews

Qualitative Research Methods: A Health Focus

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South Melbourne (Australia): Oxford University Press, 1999;
x + 295 pp; ISBN 0-19-550610-3; $37.95 (paper)

This text provides a concise undergraduate-level introduction to a number of qualitative research methods and their theoretical basis, and does so within the context of health research. Its timing is highly appropriate, given the asymptotic rise in the popularity of qualitative research methods. Indeed, this trend is perhaps nowhere more evident than in health-related research, in which researchers, like the Australian-based authors of this text, are making many useful empirical contributions using qualitative methods and contributing to discussions of qualitative methodology.

Rice and Ezzy begin their book with a chapter entitled "Theory in Qualitative Research: Traditions and Innovations," which provides an informed and useful overview of the various theoretical perspectives guiding different research methods, including logical positivism, ethnography, phenomenology, symbolic interactionism, feminism, post-modernism and hermeneutics. This background information is extremely useful as it helps the reader understand the reasons for using the different qualitative methods presented in the text and what they have to offer for both the researcher and the research participants.

The second chapter, "Rigour, Ethics and Sampling," offers a theoretical overview that nicely paves the way for understanding the diverse criteria used to evaluate the quality (i.e. validity and reliability) of qualitative research, criteria that differ among the various theoretical perspectives discussed in Chapter 1. These criteria range from measures of inter-rater reliability, audit trails, provision of direct quotes and triangulation through to the relatively relativist and reflexive stance of post-modernism. Combining the discussion of research rigour with ethics is a notably commendable feature of the book in that, if nothing else, research must be at least rigorously ethical. In the last section of this chapter the reader is given a quick overview of various sampling issues, including sample size, generalizability, a paragraph outlining each of 12 sampling strategies (e.g. deviant case, maximum variation, typical case and criterion sampling) and two pages on theoretical sampling.

The authors then devote one chapter (about 20 pages) to each of seven qualitative research methods, including traditional methods (in-depth interviews, focus groups, unobtrusive methods and ethnography), some more complex approaches (narrative analysis and life history, participatory action research) and one relatively novel approach, namely memory-work. For each method, the authors locate the method within the various theoretical perspectives described in the first chapter, define the key terms and describe the basic steps and processes involved. In addition, the authors provide brief but clear examples of each method in action in research addressing a range of health concerns (e.g. AIDs, mental health, public health, child health and women's health). They also present a concise, but useful, list of the advantages and limitations of each method, a handful of references for additional reading and a tutorial exercise asking readers to apply what they have learned.

The seven chapters on qualitative methods are followed by one on qualitative data analysis. Among the analytic techniques considered are content analysis, grounded theory and semiotic and poststructuralist approaches, as well as various coding techniques and computer-assisted analysis. In this section the authors rightly clarify the distinction between deductive content analysis and inductive qualitative analysis. Unfortunately, they also blur the distinction between thematic analysis and grounded theory, claiming that "the main difference between grounded theory and thematic analysis is that grounded theory includes theoretical sampling, whereas thematic analysis does not" (page 193). Given its focus on theory development, grounded theory is substantially different from thematic analysis. As Strauss and Corbin[1] explain, "If theory building is indeed the goal of a research project, then findings *should* be presented as a set of interrelated concepts, not just a list of themes."

Writing a qualitative research proposal and a qualitative research report are the topics of the last two chapters, and both are informative. Each of the key components of a research proposal is clearly explicated, including the significance of the proposed research, background and rationale, research design, dissemination of findings, time frame and budget justification, and in each case an example is discussed. Similarly, the key considerations to bear in mind when writing up a qualitative study are articulated, such as the audience to whom the paper is directed and the format of the

manuscript (i.e. reports versus journal articles or books). Unlike many other texts, this one outlines the submission process. Also in this section is a practical list of criteria for evaluating qualitative papers, a list that might be a helpful reminder for all of us.

Overall, Rice and Ezzy have done a wonderful job explaining a diverse range of qualitative methods and the theoretical rationale that underlies them. Moreover, the accessibility of this text makes it likely that they will achieve their goal of stimulating students' interest in doing qualitative health research.

The expansive breadth, however, has necessarily been at the expense of depth. As a result, the book is unlikely to be useful to people who are already reasonably versed in qualitative research methods. However, it may be a worthwhile read for quantitative health researchers who want to understand the methods behind what may seem like the madness of qualitative research. This is especially likely because, unlike some researchers whose preference for qualitative methods is part of a reactive backlash against the decontextualized, theory-driven nature of deductive research methods, Rice and Ezzy (page 251) "do not suggest that qualitative research methods should be employed in all health research and programs." As they say, "there are many situations in which qualitative research methods are highly inappropriate, such as those which require epidemiological data, when randomized-controlled trials will provide broad-based information, or when generalization across large populations is needed. There are also situations where qualitative research methods need to be combined with quantitative methods in order to respond adequately to the research questions. Rather, … qualitative research methods … are valuable in trying to understand and interpret the meanings people attach to the experiences of health and illness. When it is important to know about this, then qualitative research methods need to be used" (pages 251–252).

Overall rating:	Excellent
Strengths:	Thorough and accessible survey of qualitative research methods as applied to health research Tutorials and glossary of terms extremely useful to instructors and students
Weaknesses:	Lack of depth
Audience:	Undergraduate students and people unfamiliar with qualitative research methods

Reference

1. Strauss A, Corbin C. *Basics of qualitative research: techniques and procedures for developing grounded theory*. Thousand Oaks (California): Sage Publications, 1998:145.

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Social Epidemiology

Edited by Lisa F Berkman and Ichiro Kawachi
New York: Oxford University Press, 2000;
xxii + 391 pp; ISBN 0-19-508331-8; $104.00 (cloth)

The past decade has been a fertile, if challenging, period for the discipline of epidemiology. The classical epidemiologic paradigm focuses on the measurement of exposures and risk factors in individuals and estimates the contribution of these exposures to the risk of developing specific pathologies. Despite the development of sophisticated techniques for measuring exposures and the advances in analytic methods, the limitations of the classical paradigm in providing comprehensive explanations for the incidence of disease in individuals and the health of populations has been given significant critical attention in the past decade.

In responding to these limitations, conceptual and methodological scholarship in the epidemiologic sciences has advanced on two seemingly separate frontiers: molecular epidemiology and social epidemiology. The former gives attention to the interaction of individual exposures and individual biology at the cellular or molecular level and increasingly integrates measures of genetic variation across individuals in etiologic hypotheses. The latter gives focus to the social environments in which individuals are located, which both shape the nature of the exposures experienced by the individual and influence the biological resilience of the individual's host defence mechanisms.

The collection of papers published in *Social Epidemiology* (edited by Lisa Berkman and Ichiro Kawachi of the Harvard School of Public Health) is

among the most successful of a large number of recent volumes that have attempted to synthesize the conceptual frameworks and empirical evidence at this frontier. The volume has four prominent strengths.

The sixteen chapters collected in this volume provide a powerful illustration of the interdisciplinary nature of social epidemiology. While a common commitment to the empirical methods of epidemiology is present across the collection, the authors are drawn from a diversity of disciplinary backgrounds, ranging from sociology, psychology and political science to physiology and medicine. Like the volume published earlier in the decade by members of the Population Health Program of the Canadian Institute for Advanced Research, *Why Are Some People Healthy and Others Not?*,[1] this collection demonstrates the imperative for epidemiology to form interdisciplinary unions with other human and life science disciplines in order to advance understanding of population health.

The individual chapters give significant attention to the historical work in the field. The tracing of this history is an important contribution and is given direct attention in a chapter by the volume's editors and in the preface by S Leonard Syme, who has had a substantial influence on the development of the field (and who spent his childhood and adolescence in the north end of Winnipeg).

Many of the contributing authors are among the leading international scholars in the field of social epidemiology. The chapter by John Lynch and George Kaplan on socio-economic position is an exceptionally strong contemporary synthesis of the conceptual and empirical issues in understanding the relationship between socio-economic status and health. The chapter by Sally Macintyre and Anne Ellaway and the chapter by Michael Marmot are very strong statements of the conceptual implications of incorporating measures of physical and social environments in studies of the determinants of disease. And the chapter by Eric Brunner provides an excellent summary of the evidence for direct effects of social environments on the regulation of homeostatic endocrine and immune functions.

The fourth strength of the volume rests with the conceptual organization of the collection. Individual chapters describe the conceptualization and measurement of the major social factors that influence health (socio-economic position, income distribution, discrimination related to race/ethnicity or sex, social networks and social support, social capital and social cohesion, work environment, and life transitions) rather than category of disease. The consequence of this organization is a strong statement emphasizing the pervasive and persistent influence of social environments on the distribution of health and well-being in human populations and an emphatic emphasis on the importance of public policy actions that influence the quality and form of the social environments we inhabit across the stages of life.

Reference

1. Evans RG, Barer ML, Marmor TR. *Why are some people healthy and others not? Determinants of health of populations.* New York, Aldine de Gruyter, 1994.

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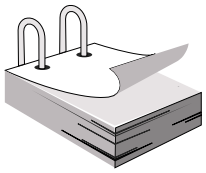

Calendar of Events

November 29–December 1, 2000 **Washington, DC** **USA**	"Living Healthier, Living Longer: The Will and the Way" 15th National Conference on Chronic Disease Prevention and Control Sponsors: Centers for Disease Control and Prevention (CDC), Association of State and Territorial Chronic Disease Program Directors (ASTCDPD) and Prevention Research Centers Program	Estella Lazenby The KEVRIC Company, Inc. Silver Spring Metro Plaza One 610 – 8401 Colesville Road Silver Spring, MD USA 20910 Tel: (301) 588-6000 <www.cdc.gov/nccdphp> <www.astcdpd.org>
January 26–27, 2001 **Toronto, Ontario**	"Better Breathing 2001" The Ontario Thoracic Society's Annual Scientific Conference on Respiratory Health	The Ontario Thoracic Society 201 – 573 King Street East Toronto, Ontario M5A 4L3 Tel: (416) 864-9911 Fax: (416) 864-9916 E-mail: julianaq@on.lung.ca <www.on.lung.ca>
April 1–3, 2001 **Banff, Alberta**	"Optimal Therapeutics Through Evaluation, Policy and Practice" Annual Meeting of the Canadian Association for Population Therapeutics (CAPT) *Abstract deadline: December 15, 2000*	Kris Schindel E-mail: kschindel@interbaun.com <www.capt-actp.com>
May 13–18, 2001 **Toronto, Ontario**	9th International Women and Health Meeting York University Campus	Monica Riutort, Coordinator Canadian Planning Committee Tel: (416) 323-6249 Fax: (416) 323-7318 E-mail: monicari@web.net
June 13–16, 2001 **Toronto, Ontario**	Congress of Epidemiology 2001 Combined meeting of American College of Epidemiology, American Public Health Association's Epidemiology Section, Canadian Society for Epidemiology and Biostatistics and Society for Epidemiologic Research	<www.epi2001.org>
July 1–6, 2001 **Vancouver, British Columbia**	"Global Aging: Working Together in a Changing World" 17th Congress of the International Association of Gerontology *Abstract deadline: December 31, 2000*	Congress Secretariat Gerontology Research Centre Simon Fraser University 2800 – 515 West Hastings Street Vancouver, BC V6B 5K3 Tel: (604) 291-5062 Fax: (604) 291-5066 E-mail: iag_congress@sfu.ca <www.harbour.sfu.ca/iag>

Tenure-Track Position — Health Informatics

Department of Health Studies and Gerontology
University of Waterloo

The Department of Health Studies and Gerontology, Faculty of Applied Health Sciences, University of Waterloo has available a tenure-track position in health informatics. This position is currently funded through a five-year Partnership award from the Canadian Institutes of Health Research (CIHR), but the University has committed to ongoing support of that position at the end of CIHR's funding period. The Faculty of Applied Health Sciences aims to establish a research centre and graduate program in health informatics in collaboration with the Department of Computer Science, the Department of Statistics and Actuarial Science and other Canadian universities.

Applicants must have an advanced degree at the doctoral level and a demonstrated commitment to both funded research and teaching at the undergraduate and graduate level. Examples of the areas of expertise of particular interest for this position are health information management, performance measurement, health indicators, health services research, application of the Internet to epidemiology and public health, health data mining, evaluation of informatics and Internet tools in health promotion and health services, and tele-health. The appointment will be made at the Assistant Professor level. We expect the appointment to occur by July 1, 2001. Send curriculum vitae (including a statement of teaching and research interests accompanied by two research articles) and three letters of reference **by December 15, 2000** to Dr Patricia Wainwright, Chair of Search Committee, Department of Health Studies and Gerontology, University of Waterloo, Waterloo, Ontario N2L 3G1.

In accordance with Canadian immigration requirements, this advertisement is directed to Canadian citizens and permanent residents. The University of Waterloo encourages applications from qualified individuals, including women, members of visible minorities, native peoples and persons with disabilities. This appointment is subject to the availability of funds.

Population Health Researcher — Cancer

Division of Epidemiology, Prevention and Screening
Alberta Cancer Board

The Alberta Cancer Board is the provincial agency responsible for the coordination of cancer prevention, early detection, treatment and supportive care, and it places a high value on research to underlie all of its activities. The Division of Epidemiology, Prevention and Screening includes the Scientific Research Group, the Alberta Cancer Registry (a population-based registry of all cancers in the province), the Provincial Breast Screening Program and several community prevention initiatives. Alberta provides a dynamic health research environment, and the Alberta Cancer Board has recently inaugurated fund-raising for a long-term cancer research endowment.

The Alberta Cancer Board invites applications for a full-time position in population health research in cancer for the Division of Epidemiology, Prevention and Screening. The Division conducts population-based research in cancer epidemiology, surveillance and modelling, in behavioural aspects of cancer prevention and screening, and in utilization of preventive and screening strategies. We are seeking scientists whose interests fall in one or more of the above areas, or complementary areas in cancer control research. This position offers an excellent opportunity to develop an independent research program within a multidisciplinary environment.

Applicants should have a PhD or MD with additional research training. These graduate degrees should be in appropriate fields of research. The selected candidate will receive core funding support, but will be encouraged to seek salary and grant support from external agencies such as the Alberta Health Foundation for Medical Research, the National Health Research and Development Program and/or the Medical Research Council of Canada. If successful in attaining external funding, additional benefits will be provided by the Alberta Cancer Board.

Collaboration will be encouraged with colleagues working in cancer etiology, prevention, early detection and surveillance, as well as with other scientists and clinicians at the Alberta Cancer Board and the Universities of Alberta and Calgary. Appropriate adjunct appointments within University departments will also be sought.

In accordance with Canadian immigration requirements, this advertisement is directed to Canadian citizens and landed immigrants; however, others are encouraged to apply to the address below.

Dr H Bryant, Director
Division of Epidemiology, Prevention and Screening
Alberta Cancer Board
3330 Hospital Drive NW, Room 382
Calgary, Alberta T2N 4N1

CDIC: Information for Authors

Chronic Diseases in Canada (CDIC) is a peer-reviewed scientific journal published four times a year. Contributions are welcomed from outside of Health Canada as well as from within this federal department. The journal's focus is the prevention and control of non-communicable diseases and injuries in Canada. This may include research from such fields as epidemiology, public/community health, biostatistics, behavioural sciences and health services. CDIC endeavours to foster communication about chronic diseases and injuries among public health practitioners, epidemiologists and researchers, health policy planners and health educators. Submissions are selected based on scientific quality, public health relevance, clarity, conciseness and technical accuracy. Although CDIC is a Health Canada publication, authors retain responsibility for the contents of their papers, and opinions expressed are not necessarily those of the CDIC Editorial Committee or of Health Canada.

FEATURE ARTICLES

Regular Feature Articles: Maximum 4,000 words for main text body (excluding abstract, tables, figures, references) in the form of original research, surveillance reports, meta-analyses, methodological papers, literature reviews or commentaries

Short Reports: Maximum 1,200 words (as above)

Status Reports: Describe ongoing national programs, studies or information systems at Health Canada (maximum 3,000 words)

Workshop/Conference Reports: Summarize workshops, etc. organized or sponsored by Health Canada (maximum 3,000 words)

Cross-country Forum: For authors outside of Health Canada to exchange information from research or surveillance findings, programs under development or program evaluations (maximum 3,000 words)

ADDITIONAL ARTICLE TYPES

Letters to the Editor: Comments on articles recently published in CDIC will be considered for publication (maximum 500 words)

Book/Software Reviews: Usually solicited by the editors (500–1,300 words), but requests to review are welcomed

SUBMITTING MANUSCRIPTS

Submit manuscripts to the Editor-in-Chief, *Chronic Diseases in Canada*, Population and Public Health Branch, Health Canada, Tunney's Pasture, CDIC Address Locator: 0602C3, Ottawa, Ontario K1A 0L2.

Since CDIC adheres in general (section on illustrations not applicable) to the **"Uniform Requirements for Manuscripts Submitted to Biomedical Journals"** as approved by the International Committee of Medical Journal Editors, authors should refer to this document for complete details before submitting a manuscript to CDIC (see **<www.cma.ca/publications/mwc/uniform.htm>** or *Can Med Assoc J* 1997;156(2):270–7).

Checklist for Submitting Manuscripts

- ☐ **Cover letter:** Signed by all authors, stating that all have seen and approved the final manuscript and have met the authorship criteria of the Uniform Requirements and including a full statement regarding any prior or duplicate publication or submission for publication
- ☐ **First title page:** Concise title; full names of all authors and institutional affiliations; name, postal and e-mail addresses, telephone and fax numbers for corresponding author; separate word counts for abstract and text
- ☐ **Second title page:** Title only; start page numbering here as page 1
- ☐ **Abstract:** Unstructured (one paragraph, no headings), maximum 175 words (100 for short reports); include 3–8 **key words** (preferably from the Medical Subject Headings (MeSH) of *Index Medicus*)
- ☐ **Text:** Double-spaced, 1 inch (25 mm) margins, 12 point font size
- ☐ **Acknowledgements:** Include disclosure of financial and material support in acknowledgements; if anyone is credited in acknowledgements with substantive scientific contributions, authors should state in cover letter that they have obtained written permission
- ☐ **References:** In "Vancouver style" (consult Uniform Requirements and a recent CDIC issue for examples); numbered in superscript (or within parentheses) in the order cited in text, tables and figures; listing up to 6 authors (first 3 and "et al." if more); ***without any automatic reference numbering feature used in word processing***; any unpublished observations/ data or personal communications used (discouraged) to be cited in the text in parentheses (authors responsible for obtaining written permission); authors are responsible for verifying accuracy of references
- ☐ **Tables and Figures:** Each on a separate page and in electronic file(s) separate from the text ***(not imported into the text body)***; as self-explanatory and succinct as possible; not duplicating the text, but illuminating and supplementing it; not too numerous; numbered in the order that they are mentioned in the text; explanatory material for tables in footnotes, identified by lower-case superscript letters in alphabetical order; figures limited to graphs or flow charts/templates (no photographs), with software used specified and titles/footnotes on a separate page
- ☐ **Number of copies:** Four complete copies, including tables and figures; 2 copies of any related supplementary material

Chronic Diseases in Canada

a publication of the

Population and Public Health Branch
Health Canada

Chronic Diseases in Canada (CDIC) is a quarterly scientific journal focusing on current evidence relevant to the control and prevention of chronic (i.e. non-communicable) diseases and injuries in Canada. Feature articles may include research from such fields as epidemiology, public/community health, biostatistics, behavioural sciences and health services. Scientific articles are peer reviewed. The journal publishes a unique blend of public and private sector authors, with information for authors in every issue. Subscription is available free upon request. Authors retain responsibility for the contents of their papers, and opinions expressed are not necessarily those of the CDIC Editorial Committee or of Health Canada.

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