Standardized Mortality Ratios and Canadian Health-Care Funding

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Des modèles d'imposition par tête basés sur les besoins ont été suggérés comme alternative aux modes de financement des soins de santé basés sur les taux d'utilisation historiques. Le ratio de mortalité standard (RMS) de concert avec un ajustement pour l'âge et le sexe est la mesure des besoins relatifs la plus couramment utilisée. Cet article utilise des données canadiennes pour traiter de plusieurs questions importantes concernant la construction d'indices et discute leurs implications sur la politique en matière de santé. Ces dernières comprennent l'influence exercée par la structure d'âge (exclusion des personne de 64 ans au lieu de 74), la période optimale sur laquelle on calcule le RMS moyen de façon à filtrer les fluctuations sans significations de même que la correspondance entre RMS, les indicateurs socio-économiques standards (i.e. chômage, éducation et revenu), les besoins en soins de santé et les dépenses.

Needs-based capitation models have been suggested as an alternative to health-care funding methods based on historical utilization patterns. The standardized mortality ratio (SMR) applied in conjunction with an age/gender adjustment is the most widely adopted measure of relative need. This paper addresses a number of important index construction issues using Canadian data and discusses their health policy implications. These include the influence exerted by the age structure (excluding people over 64 versus 74), the optimal period over which to average the SMR in order to smooth meaningless fluctuations, and the correspondence between SMRs, standard socio-economic indicators (i.e., unemployment, education, and income), health-care "need," and expenditures.

Introduction

Regional health status disparities and inequitable health-care access have led many to argue for funding mechanisms that lead to a more equitable distribution of resources. Capitation models have been suggested (and in some jurisdictions adopted) as an alternative to funding methods based on historical utilization. The capitation funding method is fundamentally a population-based system of resource allocation. Resources are distributed to regions, or rosters, in direct proportion to the age- and gender-adjusted population size. Since there is widespread agreement that age and gender alone do not adequately account for relative health needs, it is common practice to include a "needs" measure[1] such as the Standardized Mortality Ratio (SMR).[2] The SMR is a single index number which compares the mortality experience of a given region's population to that of a reference (or base) population.[3]

Although reliance on the SMR to adjust for regional needs has been criticized, it is nevertheless widely used. The SMR is attractive because it is easily calculated, uses readily available data, and is difficult for interested parties to manipulate. However, it has been argued that the SMR is sometimes a poor proxy for morbidity, is biased toward deaths in older age groups, and that the implied one-to-one relationship between relative mortality rates and relative health-care needs may be inaccurate.

The primary objective of this paper is to document the properties of SMRs under different age cut-offs and lengths of time-averaging across provinces, and to discuss the policy implications inherent in using various SMR measures in capitation funding models. We believe that the analysis presented in this paper clearly shows that the SMR is very sensitive to age cut-off and time-averaging definitions. Moreover, differences between various SMR indices cannot be explained, or predicted, by standard socio-economic measures. Although SMR index selection is necessary if SMR-based capitation formulae are to be adopted, the results presented in this paper provide very little justification for choosing any particular set of SMR definitions.

The upshot of these findings for policymakers is that alternative needs measures will lead to sizable differences in regional funding envelopes, and yet there are no clear guidelines for choosing among the many possible indices. Our conclusion is that until more evidence is available to direct SMR index selection or demonstrably better need indicators are identified, these formulae should be regarded as quantitative aids in the budgeting process, to augment but not replace the qualitative judgements of decisionmakers.

This paper addresses what we believe to be the four key SMR index construction issues. First, we document the implications of excluding individuals over the age of 64 versus excluding those over the age of 74 from the SMR calculation. While there are clear conceptual reasons, and empirical support for using premature mortality instead of total mortality (e.g., see Carstairs and Morris 1989*a,b,c*; or Eyles and Birch 1993), we are aware of no Canadian study that compares different age cut-offs across provinces.

The second objective is to explore thoroughly the time-series properties of SMRs. Many people, including Eyles and Birch (1993), have suggested that capitation models should use an SMR that is averaged over several years in order to smooth random fluctuations. However, no study has documented the differences between, or properties of, various averaging lengths. We fully detail the volatility associated with specific averaging periods across provinces and Census Division (CD) sizes. This is fundamentally important since short-run or one-time fluctuations are unlikely to reflect changes in health-care need; while at the other extreme, averaging over a sufficiently long period so as to render the index time invariant will also render the index insensitive to changes in relative need.

Our third objective is to examine the correlation between socio-economic factors and SMRs across provinces. Interest in the relationship between mortality and socio-economic variables has generally arisen because needs-based health-care funding models might use both types of data to allocate funds toward high-need areas or groups. We are interested in the correlation between SMRs and socio-economic factors because we wish to evaluate the ability of the SMR to proxy measures of relative need across jurisdictions.

Since one aim in collecting SMR data is the reallocation of health-care funds to high-need areas, our fourth and final objective is to explore the connection between SMRs, self-reported health status, and current funding levels. We ask two simple questions. First, how does the correlation between the SMR and self-assessed health status change as the age cut-off and averaging period change? And second, are high-need regions currently receiving relatively higher funding?

The remainder of the paper is organized as follows. The next section defines the SMR index and sketches its present use in selected countries. The third section uses maps to illustrate the differences between SMRs constructed using different age cut-offs and averaging periods across CDS between 1986 and 1993. Section four examines the relationship between SMRs and standard socio-economic indicators such as regional unemployment rates, education levels, and income. Section five looks at the relationship between SMRs, health status, and current funding. The final section concludes.

Background: SMRs in Capitation Funding Models

An SMR compares the age/gender specific mortality rates for a given region to those of the base population. More precisely, an SMR compares the number of actual deaths that occur in region $r(r = 1,...,R)$ to the number of deaths that would be expected if region r experienced the same age/gender specific death rates as the base (reference) population.

$$SMR_r = \frac{RRMR_r}{(1/R)\sum_{r=1}^{R} RRMR_r} \qquad RRMR_r = \frac{\sum_{g=1}^{2}\sum_{i=1}^{n} d_{rgiPgi}}{\sum_{g=1}^{2}\sum_{i=1}^{n} d_{giPgi}},$$

where $RRMR$ = relative regional mortality rate, d = death rate, p = population, and i = age groups $(i=1,...,n)$. The death rate is defined as the number of deaths in a specific region/gender/age group divided by the population of the specified group. The term P_{gi} refers to all individuals of gender g in age group i in the specified reference population (a province or the country as a whole). The SMR is the $RRMR_r$ divided by the mean $RRMR_r$ which standardizes the index to have an average of 1. Regions with below-average mortality rates have SMRs below1, and high mortality regions have SMRs above1.

Capitation funding models can be constructed to adjust for specific factors, exclude programs, weight the redistribution associated with certain factors, and so on. In its most simple form, a capitation funding model might simply distribute a fixed provincial or national budget (B), across regions according to the age/gender composition and need:

$$\theta_r = \frac{SMR_r B_r^{a/g}}{\sum_{r=1}^{R} SMR_r B_r^{a/g}} \qquad B = \sum_{r=1}^{R} \theta_r B$$

where θ_r = the share of the budget allocated to region r. Region r's share depends on its population, age/gender composition, and relative need (SMR). It is important to keep in mind that this formulation is only one of many possible functional relationships between the SMR and the associated monetary transfer to a region.

The specific functional form in which the SMR enters a capitation funding model is important, and as of yet little work has been done to guide this decision.[4] While the exact functional relation may differ from place to place (in the United Kingdom the square root enters the formula), all share the feature that a higher SMR for region *r* leads to more resources for that region. Of course, the exact monetary transfer depends on the functional form. Rather than focus on the implied financial aspects, we step back slightly and examine the more basic problem of constructing the SMR index. SMR constructions that lead to substantially different indices (different age cut-offs, for example) almost certainly lead to very different resource allocations under most functional forms.

It is worth noting that region *r* can refer either to a geographic region or to a roster of individuals. However, most policy discussions focus on geographic-based regional definitions and we follow this convention. One drawback to geographic regions is that funding tensions can arise when people cross boundaries to obtain health services. While roster schemes avoid cross-boundary accountability problems, they have other inherent shortcomings such as the incentive to select desirable, low-cost individuals (cream-skimming).

There has been a significant movement toward capitation funding in many countries. The United Kingdom, Australia, New Zealand, and Canada have adopted, or are in the process of adopting, needs-based funding to various degrees. The UK's Regional Allocation Working Party (RAWP) funding formula distributes resources to 14 Regional Health Authorities (RHAs) which in turn allocate funds to District Health Authorities (DHAs). The RAWP model incorporates an age/gender adjustment as well as several socio-economic and morbidity adjustments. SMRs are included to reflect aspects of relative need not completely accounted for by age and gender.[5] RAWP also includes an adjustment for interregional patient flows. In the absence of a flow adjustment, regions with outflows benefit to the detriment of regions with inflows. Refer to Raftery (1993); Carr-Hill and Sheldon (1992); Sheldon and Carr-Hill (1992); or Snaith (1978) for more detail.

In Australia, the health-care resource allocation disparities between Sydney and the North and Central Coast areas prior to the 1990s were largely the result of an historical-utilization-based funding which failed to account for recent demographic trends. In the early 1990s, New South Wales switched to a population-based Resource Allocation Formula (RAF) in an attempt to distribute health-care services more equitably (Services Development and Planning 1993; and Gilbert *et al.* 1992). However, like the RAWP model, the RAF was criticized for incorporating SMRs as a proxy for morbidity. The SMR was generally regarded as a poor proxy for health needs in New South Wales. The RAF was revised in 1993 to include a composite SMR/socio-economic/rural-urban indicator.

The New Zealand Population-Based Funding Formula (PBFF) was designed to allocate funds across four Regional Health Authorities (RHAs). As with all operational capitation formulae, the New Zealand model includes a needs adjustment. Unlike most models, New Zealand chose the Health Equity Quotient (HEQ) rather than the SMR. The HEQ is a rather complex statistical index (based upon principal component analysis) composed of socio-economic variables which were found to be related to need in New Zealand. However, few resources are actually redistributed as a result of needs adjustments once age and gender are accounted for (Health Reforms Directorate 1992).

Although only Alberta, British Columbia, Saskatchewan, and Manitoba have done so, there is some pressure in Canada to move away from historical utilization-based funding and toward capitation-based funding. Saskatchewan instituted a capitation funding model that includes an SMR adjustment in 1994-95 (Saskatchewan Health 1996; Driver 1994; Strategic Planning Branch 1994). The major services included in the Saskatchewan model include: long-term care, non-primary and acute care, home-based programs, and rural health initiatives. These programs constitute approximately 60 percent of regional health-care funding. Although the capitation models proposed for Manitoba and British Columbia differ somewhat from the Saskatchewan model, and from each other, the SMR treatments are similar. The SMR enters all models in a linear manner. More specifically, regional age/gender adjusted population expenditures are multiplied by an SMR that is standardized to have a mean of one.[6] Alberta, on the other hand, has opted not to include an SMR adjustment on the grounds that SMRs do not correlate well with utilization rates in Alberta, are volatile, and despite their use in other jurisdictions they have not been scientifically validated in any setting (Health Services Funding Advisory Committee 1996).

SMRs in Canada

All of the analysis in this paper is conducted at the Census Division (CD) level, using 1991 definitions, due to data availability. CDs were selected as the unit of measure because a reasonably long time series of both mortality[7] and population are available for all provinces. The mortality data are for 1986-93, and population counts are for 1986 and 1991 (Table A1 reports all data sources). All data are standardized to the 1991 CD definitions; 290 CDs which are further broken into five-year age groups by gender (there are 28 age/gender groups within each CD). All indices prior to 1990 use the 1986 population and all post-1990 indices use the 1991 population. It would clearly be preferable to use annual population figures, standardized to the 1991 CD definitions, but these were unavailable. However, one would expect relative population growth to be more stable than relative mortality changes.

Base Case: Provincial Base Excluding People over 74

Our analysis begins with the most commonly used SMR definition: the SMR restricted to individuals under 75 years of age calculated using provinces as the base population. Previous studies have employed the 75 year age cut-off because it has been found that the SMR for a population, excluding the elderly, is correlated with those types of morbidity that are associated with considerable medical costs (Eames, Ben-Shlomo and Marmot 1993; Mays, Chinn and Ho 1992; and Carstairs and Morris 1989*c* are examples). The provincial base is a natural starting point because health care is under provincial jurisdiction.

Unless otherwise indicated, all figures and discussions in this section pertain to 1993. We have selected 1993 because the data for this year appear to be more reliable than for previous years.[8] Figure1 highlights several regularities. First, CDs with high Aboriginal populations (the northern CDs in each province from Quebec to British Columbia and the Territories) have high SMRs. This is not surprising given the strong positive correlation between SMRs and the percentage of the population reporting Aboriginal heritage. Second, three of the Northwest Territory CDs report low SMRs. This is an artifact of the provincial reference population; they are low because they are measured against two very high CDs, not because they have low mortality rates.[9] Third, the western SMRs appear to be more similar across CDs than those in Ontario and Quebec.

To further investigate the variance in SMRs within provinces, Table 1 presents the sample sizes, the minimum SMR, the maximum SMR, and the standard deviation for all observations and the standard deviation excluding the minimum and maximum.[10] With the exception of Alberta, the western provinces display the most variation. Note that the variance in the Saskatchewan and British Columbia SMRs are heavily affected by the presence of outliers. Excluding the minimum and maximum SMRs lowers the standard deviation from 0.25 to 0.05 in Saskatchewan and from 0.22 to 0.11 in British Columbia. On the other hand, the Manitoba SMRs continue to exhibit the highest variance.

FIGURE 1
1993 Province-Based <75 SMRs: Restricted to People Aged 74 or Younger

TABLE 1
1993 SMRs Excluding People over 75 Years of Age

	No. of CDs	*Std Dev (rank)*	*Min SMR*	*Max SMR*	*Std Dev* (rank)*
Newfoundland	10	0.18 (6)	0.76	1.33	0.13 (7)
Nova Scotia	18	0.12 (1)	0.77	1.21	0.09 (2)
New Brunswick	15	0.16 (4)	0.66	1.27	0.12 (5)
Quebec	99	0.17 (5)	0.63	1.65	0.15 (8)
Ontario	49	0.13 (2)	0.77	1.33	0.12 (6)
Manitoba	23	0.37 (9)	0.56	1.97	0.30 (9)
Saskatchewan	18	0.25 (8)	0.82	1.98	0.05 (1)
Alberta	19	0.13 (3)	0.82	1.27	0.11 (3)
British Columbia	30	0.22 (7)	0.73	1.97	0.11 (4)

Note: *Excluding the minimum and maximum SMRs.

While it is true, broadly speaking, that northern areas tend to have high SMRs, and more populous areas tend to fare somewhat better, the pattern of SMRs across more and less urban CDs are distinct across provinces. For example, the SMRs across southern Saskatchewan are relatively homogeneous, but there is substantial variation across southern Ontario.

Excluding People over 64

Carstairs and Morris (1989*a,b,c*) find that SMRs for the non-elderly are a good indicator of health-care requirements in the United Kingdom. They find that hospital bed use and SMRs are highly correlated under both a 65 and 75 year age cut-off, although somewhat less so under the latter definition. We explore the possibility that the SMR age cut-off changes affect each province in a distinct manner.

In Table 2, we present the mean and standard deviation in the percent change in SMRs when we move from a 75-year age cut-off to a 65-year age cut-off by province. The simple summary statistics presented in this table suggest that an age cut-off change will impact each province in a unique way. The mean change is approximately zero in all provinces, but this masks the large CD-specific changes. We do not see trends across regions; contiguous CDS experience drastically different changes when SMRs are restricted to individuals under the age of 65. The large differences between SMR_{65} and SMR_{75} reported in Table 2 imply quite different resource allocations under the competing indices. Regions will, therefore, not be indifferent about age group inclusion, and policymakers will have to think carefully about choosing the appropriate SMR measure.

The SMR Across Time

Short-run, or one-time fluctuations in regional SMRs are unlikely to reflect changes in health-care needs. Small populations are particularly vulnerable to this problem. A wide range of abnormal occurrences can have a major impact on annual SMRs. For example, a major accident or natural disaster in a small region might cause spurious swings in the SMR. Such high frequency fluctuations suggest that we should smooth the index by calculating a rolling average over some suitable time period. For instance, Birch, Eyles and Newbold (1995), and Eames, Ben-Shlomo and Marmot (1993) use SMRs averaged over five years. While it is clear that we do not want to use an annual SMR, it is equally obvious that averaging over a very long period will render the SMR virtually time invariant. That is, the index would not

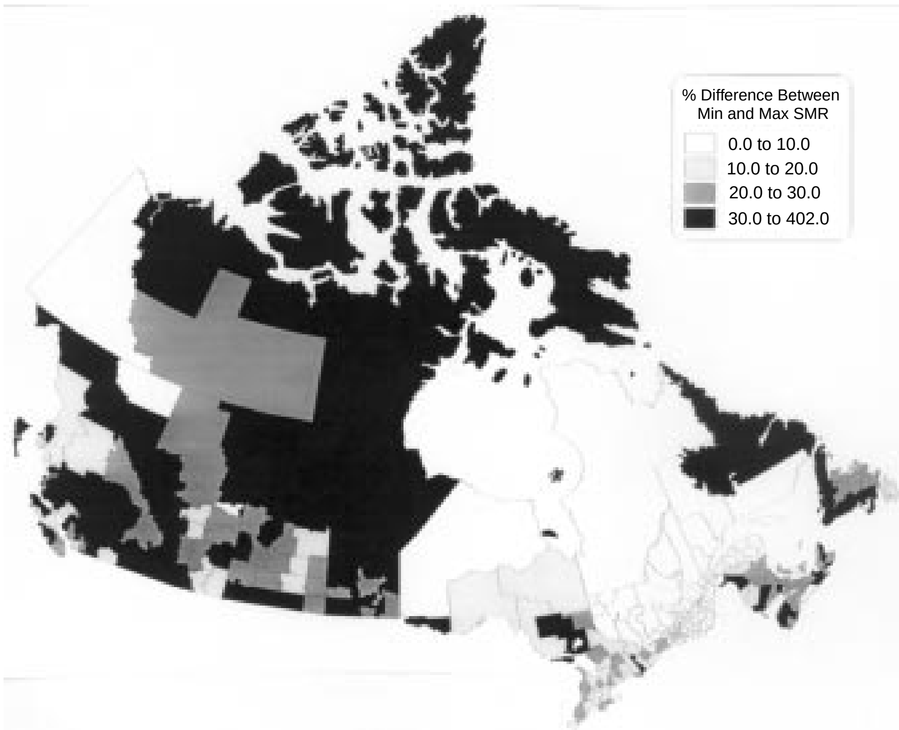
TABLE 2

Percent Change in 1993 SMR when the Age Cut-Off is Changed from <75 to <65

	Mean	*Std. Dev.*	*Min*	*Max*
Newfoundland	0.16	6.31	-9.04	11.94
Prince Edward Island	0.01	0.43	-0.46	0.40
Novia Scotia	0.09	7.27	-10.00	14.21
New Brunswick	0.37	10.98	-29.72	16.99
Quebec	-0.18	11.07	-29.26	41.96
Ontario	-0.42	7.91	-12.95	22.68
Manitoba	-0.89	15.67	-26.28	34.86
Saskatchewan	-0.40	8.57	-12.54	15.41
Alberta	-0.26	11.06	-20.20	28.12
British Columbia	0.04	7.98	-20.72	12.69
Northwest Territories	-0.79	9.62	-13.48	13.58

FIGURE 2

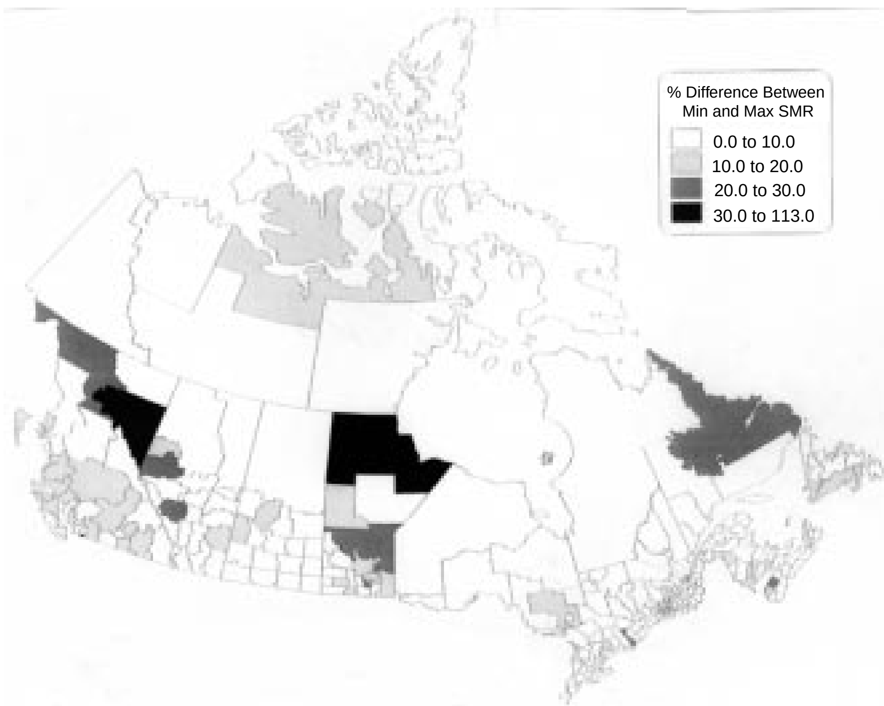
Percent Difference Between Min and Max Single Year <75 SMRs 1986-93 Excluding Quebec



change from year to year and would be relatively insensitive to secular trends.

In an attempt to document the speed at which SMRs approach time invariance, we calculate the percentage spread between the minimum and maximum of each possible moving average between 1986 and 1993 for each CD. This gives us a sense of the variation across time in individual CDs. Figures 2 and 3 present the spread between the minimum and maximum SMRs for single-year SMRs (eight observations) and SMRs averaged over four years (five observations).[11] Several regularities are immediately apparent. First, there is substantial year-to-year fluctuation in annual SMRs across all provinces, although it is somewhat less dramatic in Ontario. Second, the SMRs become smooth relatively quickly. By the time SMRs are averaged over four years (Figure 3), the vast majority of CDs exhibit less than a 10-percent difference between the highest and lowest SMR. British Columbia and Manitoba are exceptions; more than 20 percent of CDs in these provinces (some with substantial populations) exhibit at least a 10 percent min./max. spread when averaged over four years. However, by six years, even the CDs in these provinces have less than a 10 percent min./max. spread (except for two British Columbia CDs and one Manitoba CD). Third, SMRs are generally smoother in more populous areas. Despite the apparent link between population and the averaging length required for virtual time invariance, it is not possible to define the averaging length required for stationarity as a simple function of population. For example, non-

FIGURE 3
Percent Difference Between Min and Max 4 Year <75 SMRs 1986-93 Excluding Quebec



metropolitan CDs in Saskatchewan are generally smaller than those in British Columbia, but time-averaged SMRs are smoother in Saskatchewan than in British Columbia. More generally, the averaging length required to ensure sufficient smoothness is province specific.

SMRs and Standard Socio-Economic Variables

Many studies have shown that there exists a positive relationship between socio-economic status and health status (Hay 1988; D'Arcy and Siddique 1985; Kessler 1982). Still other studies have shown that community level unemployment, income, and education levels are correlated with mortality rates (Eames, Ben-Shlomo and Marmot 1993; Carstairs and Morris 1989*a,b,c;* D'Arcy and Siddique 1985). It has also been reported that the low life expectancy of Aboriginal Canadians is related to these socio-economic factors (D'Arcy 1989). Interest in the relationship between mortality and socio-economic factors has generally arisen because there is a desire to use both types of information to direct health-care funds toward higher need areas. We are interested in this link because we wish to evaluate the ability of the SMR to proxy measures of relative need across jurisdictions.

All data used in this section are for 1991. The socio-economic data are 1991 Canadian Census data aggregated to the 1991 CD definitions. Hence, all reported SMRs are for 1991, or are averages that end in 1991 and use a provincial base.

In Table 3, we regress the three-year average SMR under both the 65- and 75-year age cut-off on a variety of socio-economic variables for each province. While we have calculated heteroscedastic robust variance-covariance matrices for inference, the estimated specifications are unlikely to "pass" a serious model evaluation exercise. Instead, these regressions are intended to identify important correlations in the data and are not to be viewed as a model determining SMRs.[12]

The first panel (of Table 3) presents the regression results under a 75-year age cut-off, and the second panel presents the results under a 65-year age cut-off. The dependent variable is the three-year average SMR for 1991, and the socio-economic variables include high-school graduation rates, unemployment rates (for men[13]), the proportion of families classified as low income (annual income ≤ \$20,000), the proportion of the labour force employed in the manufacturing sector, and the percentage of people who are of aboriginal origin.[14] While the magnitudes of the coefficients for the socio-economic variables differ substantially across provinces, they are generally of the same sign when the variables are statistically significant (at conventional levels). A higher unemployment rate, a larger aboriginal population, and a smaller manufacturing sector are all associated with higher mortality and hence higher SMR values. The only anomalous result is the negative relationship between the proportion of families earning less than \$20,000 and the SMR in British Columbia. It is generally found that income and health status (as well as life expectancy) are positively related.

While socio-economic variables generally explain a somewhat greater percentage of the intraprovincial SMR variation when the dependent variable is the SMR_{65}, the relationship between specific socio-economic variables and the SMR changes substantially. Under the 65-year age cut-off, the unemployment rate in Ontario, the low-income measure in New Brunswick and BC, and the aboriginal population size in Newfoundland and Manitoba become statistically insignificant, while the proportion of low-income families becomes insignificant in Alberta. Most importantly, the proportion of intraprovincial SMR variation which is explained by the selected socio-economic variables ranges from 0.46 to 0.96 for SMR_{65} and from 0.48 to 0.96 for SMR_{75}. These differences suggest that a needs-based funding model that performs well in one province (or jurisdiction) might perform poorly in another. It is, therefore, imperative that needs-based funding formulae be validated within each jurisdiction separately.

One might ask whether the apparent patterns hold under a different degree of time averaging. To investigate this, we repeat the Table 3 regressions using SMRs averaged over one through six years.[15] Using different averaging lengths has little impact, and more importantly, the changes are not consistent across socio-economic variables or provinces. Just as we were unable to identify a province invariant averaging length that smoothed meaningless fluctuations while capturing secular changes, there is no clear reason to choose a specific averaging length or age cut-off on the basis of correlation with socio-economic factors.

Ontario SMRs, Health Status and Current Funding

Since one aim in collecting SMR data is the reallocation of health-care resources to high need regions, it is also useful to consider the connection between SMRs (or various SMRs) and reported health status measures and current levels of funding. Current health status measures such as self-assessed health status are most often cited as the appropriate relative need measure (e.g., see Birch, Eyles and Newbold 1995). These variables could not themselves be used in an ongoing index due to data

TABLE 3
1991 SMR Regressions on Selected Socio-Economic Variables

	Nfld	*NS*	*NB*	*Ont*	*Man*	*Sask*	*Alta*	*BC*
				Dependent Variable: 3 Year Average <75 SMR				
H.S. Grad	-0.205	-0.146	-0.034	-0.064	-0.030	0.018	0.230	-1.226
	(0.361)	(0.495)	(0.178)	(0.324)	(0.187)	(0.075)	(1.204)	(1.686)
UER	-1.570	2.959*	-0.880	3.249 **	4.357**	4.168	-0.165	5.035
	(0.816)	(2.564)	(1.407)	(2.773)	(3.615)	(1.863)	(0.063)	(1.731)
Low Inc.	1.507	-0.996	1.543**	0.145	-0.377	-0.873	0.748	-4.986*
	(1.395)	(1.035)	(3.602)	(0.182)	(1.066)	(1.367)	(0.657)	(2.344)
Man. Emp.	-0.243	-0.150	0.082	-0.603*	-0.015	-1.650	1.117	-2.281
	(0.310)	(0.241)	(0.394)	(2.395)	(0.026)	(1.682)	(1.050)	(1.883)
Abor. Pop.	3.064*	-0.989	-1.830	1.088*	1.153**	1.151*	1.215*	0.130
	(3.669)	(0.325)	(1.039)	(2.252)	(3.976)	(3.009)	(2.751)	(0.228)
Constant	1.123	1.119	0.795*	0.934**	0.755**	0.969**	0.535	2.878*
	(1.275)	(1.995)	(3.031)	(3.278)	(3.984)	(3.882)	(1.794)	(2.761)
N	10	18	15	49	23	18	19	29
F(5,N-6)	17.38**	4.93*	19.80**	7.75**	105.07**	302.27**	78.67**	48.47**
R-Squared	0.61	0.60	0.60	0.59	0.96	0.95	0.53	0.46
				Dependent Variable: 3 Year Average <65 SMR				
H.S. Grad	-0.365	-0.442	-0.084	-0.241	-0.516	-0.073	0.359	-0.753
	(0.457)	(1.497)	(0.331)	(1.620)	(1.947)	(0.265)	(2.006)	(1.193)
UER	-1.506	2.747*	-0.063	0.588	7.089**	5.221	-1.354	4.559
	(0.574)	(2.703)	(0.092)	(0.563)	(3.798)	(1.648)	(0.473)	(1.693)
Low Inc.	2.007	-1.250	1.252	1.259*	-0.556	-0.339	2.595*	-2.732
	(1.400)	(1.660)	(2.055)	(2.262)	(1.068)	(0.347)	(2.457)	(1.434)
Man. Emp.	-0.682	-0.067	0.287	-0.590**	-0.398	-0.668	1.809	-2.429
	(0.656)	(0.119)	(0.722)	(2.783)	(0.503)	(0.492)	(1.741)	(2.090)
Abor. Pop.	3.198	1.014	-0.757	1.836**	0.933	1.319*	2.179**	0.956
	(2.736)	(0.373)	(0.383)	(8.334)	(1.995)	(2.294)	(4.099)	(1.780)
Constant	1.194	1.420*	0.780	1.087**	1.089**	0.842*	0.080	2.055*
	(0.972)	(2.585)	(2.156)	(5.107)	(3.702)	(2.423)	(0.338)	(2.229)
N	10	18	15	49	23	18	19	29
F(5,N-6)	9.12*	8.64**	7.14**	45.69**	56.15**	833.65**	102.79**	50.58**
R-Squared	0.48	0.61	0.59	0.77	0.93	0.96	0.70	0.59

Notes: Absolute value of heteroscedastic consistent t-statistics in parentheses.
*Statistically significant at the 5 percent level.
**Statistically significant at the 1 percent level.

availability and potential manipulation from interested parties. Nevertheless, a good measure of need is expected to be highly correlated with these types of health status measures. On the other hand, it is interesting to see how current (historical) expenditures relate to SMRs. Are regions with high SMRs receiving relatively more dollars under the current funding system?

The analysis in this section is restricted to Ontario. This exercise requires health status measures and expenditure data by region, as well as mortality and population data. We were able to obtain the required health status data from the Ontario Health Survey (OHS) and expenditure data from the *Ontario Health Expenditures* (Ontario Ministry of Health 1989-90). All data are aggregated to the health district level (which differ somewhat from CDs). The OHS was conducted in 1990, expenditure data are for 1990-93 (deflated to 1990 dollars), the mortality data are for 1987-90, and the population data are for 1986.

Ontario SMRs and Health Status Outcomes

Following the literature, we take self-assessed health status (SAHS) as our measure of relative need. As with the SMR, a health district level standardized health ratio (SHR)[16] compares the age/gender specific health status rates for a given health district to those of the province. The construction of this index is identical to that of the SMR (with slightly

TABLE 4
1990 Ontario SMR Regressions on Self-Assessed Health Status

	SMR Averaged Over			
	4 Years	*3 Years*	*2 Years*	*1 Year*
	Dependent Variable: <75 SHR			
<75 SMR	0.468**	0.489**	0.454**	0.391*
	(3.251)	(3.107)	(2.900)	(2.593)
Constant	0.532**	0.511**	0.546**	0.609**
	(3.934)	(3.448)	(3.718)	(4.298)
N	37	37	37	37
R-Squared	0.20	0.20	0.17	0.13
	Dependent Variable: <65 SHR			
<65 SMR	0.482**	0.467**	0.407**	0.359*
	(3.696)	(3.216)	(2.842)	(2.680)
Constant	0.518**	0.533**	0.593**	0.641**
	(4.228)	(3.896)	(4.407)	(5.085)
N	37	37	37	37
R-Squared	0.23	0.20	0.15	0.14

Notes: Absolute value of heteroscedastic-consistent t-statistics in parentheses.
*Statistically significant at the 5 percent level.
**Statistically significant at the 1 percent level.

different age group definitions). Health districts with below average health status have an SHR above 1, and high health status health districts have an SHR below 1.

The OHS asks people to rate their health compared to people their age on a scale from 1 (excellent) to 5 (poor). The frequency of empty cells necessitates aggregation. We aggregate to two categories: 1-2 (excellent-very good) and 3-5 (good-poor). The results are not sensitive to this definition; we also ran all regressions defining the groups as 1-3 and 4-5, and the differences are always negligible. Unlike the SMR calculations, we use ten-year age categories instead of five-year age categories, again because some cells have very few observations. As before, our results are not sensitive to this definition, all regression results are largely unchanged when 5- or 15-year age categories are used. Finally, there is no SAHS variable for people under 15-years of age, so children are excluded from the SHR.

Since the OHS was conducted in 1990, and our earliest mortality data are for 1987, the longest SMR averaging period is four years. Table 4 presents our regression results on the SHR as the dependent variable under all four averaging lengths and both age cut-offs. The coefficients, under all averaging lengths, are significant at the 5 percent level and the regression fit rises with the averaging length. However, there is very little difference in the coefficients or the regression fit between base definitions. A 1-percent increase in the SMR is associated with a 0.5 percent and 0.4 percent increase in the SHR under a four-year average and a single year respectively for both the 75- and 65-year age cut-offs. These results are consistent with those of Birch, Eyles and Newbold (1995) for Quebec.

These results show that varying the time-averaging for the SMR does not change the correlation of the SMR with health status and therefore does not indicate a preferred length for time-averaging. On the other hand, regional health budgets would change substantially under different time-averaging lengths, while at the same time providing policymakers no justification for any particular averaging choice.

Ontario SMRs and Health-Care Expenditures

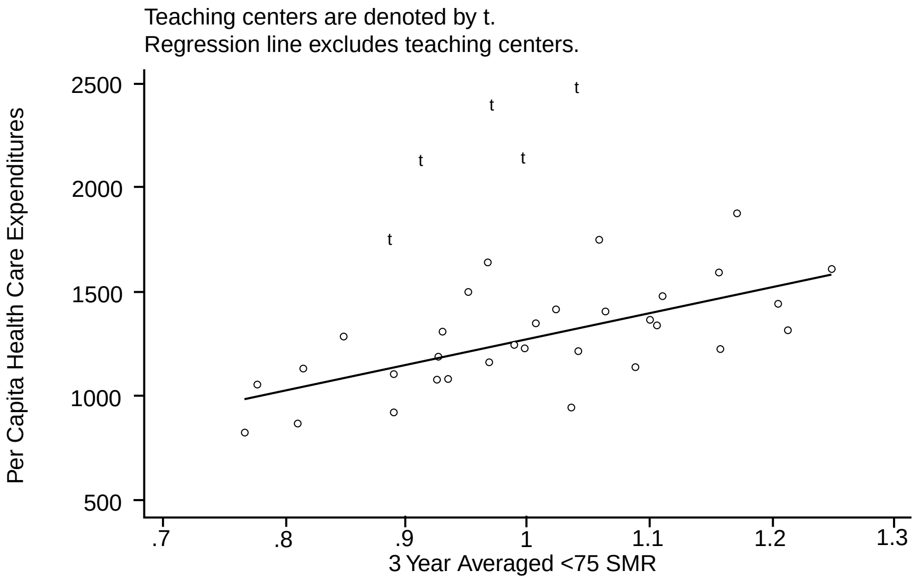
Since SMRs are ultimately to be used for reallocating funds to high need (high SMR) areas, it seems wise to look at the relationship between current health district level per capita expenditures and the SMR. Figure 4 and Table 5 summarize our results. This figure illustrates the correlation between real (in 1990 dollars) per capita expenditures and the three-year averaged SMR from 1990-93 for Ontario. Health districts with teaching hospitals are denoted by *t* and are not included in the regression lines in Figure 4. It is clear that we must control for teaching centres when estimating the relationship between expenditures, as the dependent variable, and the SMR. This is not surprising since the SMR cannot account for the expenditures required to maintain teaching hospitals. The relationship between expenditures and SMRs is both statistically significant and numerically large. A 1-percent increase in the SMR is associated with increase in per capita expenditures for non-teaching centres of approximately 1 percent and approximately 0.6 percent for teaching centres. As expected, decreasing the cut-off age to 65 reduces the SMR coefficients and increases the constant.

The positive association of SMRs and current health-care budgets suggests that higher mortality regions are receiving more funding. However, these are simple correlations and there are many other factors that determine regional health-care budgets (e.g., population, age/gender mix, physician density, and so on). We explore this relationship using a more structural approach in Bedard, Dorland, Gregory and Roberts (1998).

Conclusion

This paper has presented an extensive analysis of several standardized mortality ratio (SMR) indices for Canada. We have explored the impact of different

FIGURE 4
1993 Ontario SMRs and Per Capita Health Expenditures



age cut-offs (75 versus 65) and various averaging periods. Further, we have analyzed the relationship between these various SMR measures and socio-economic factors, health status, and current expenditures.

The results can easily be summarized. The regional SMR will be different under different age cut-offs and time-averaging. Moreover, regardless of SMR definition, there are *weak* correlations with health status measures and economic variables that broadly speaking seem sensible. However, there is little evidence that the relationships are consistent across provinces or SMR definitions. If SMRs are to be included in capitation funding models, any index selection criteria will imply the adoption of province-specific SMR measures.

What implications do these findings have for a policy aimed at incorporating SMRs into a funding formula? We would argue that there is little statistical support to guide SMR selection, and that choosing one index over another is arbitrary and may lead to a resource reallocation that is not necessarily linked to redistribution on the basis of relative need. Although Saskatchewan, Manitoba, and British Columbia use — or are in the process of adopting capitation models that include an SMR — we have found no documentation that would indicate that their indices would fare any better against the challenges raised here.

Nevertheless, we are not pessimistic about the trend toward capitation funding for health programs. The approach has significant benefits. It shifts the emphasis, properly, we believe, onto the potential recipients of health services, rather than on the suppliers of services. Also, the desire for quantitative formulae has stimulated healthy inquiry and debate about the nature of "need" for health services, and about valid, reliable, measurable indicators of need. This debate is far from over. The search for good

TABLE 5
Ontario Per Capita Health-Care Expenditures Regressions on SMRs

	1990	*1991*	*1992*	*1993*
	Dependent Variable: Real Per Capita Expenditures (1990 $)			
<75 SMR	1229.908**	1435.187**	1354.071**	1298.985**
	(5.803)	(5.281)	(5.286)	(5.580)
Teaching Center	851.734**	846.514**	905.917**	936.359**
	(7.965)	(8.751)	(9.967)	(9.966)
Constant	-99.149	-274.843	56.904	-25.145
	(0.474)	(1.052)	(0.228)	(0.110)
N	37	37	37	37
F(2,34)	52.29**	58.78**	69.53**	68.11**
R-Squared	0.75	0.76	0.77	0.76
	Dependent Variable: Real Per Capita Expenditures (1990 $)			
<65 SMR	1004.339**	1123.656**	1057.071**	1008.153**
	(4.377)	(4.362)	(4.078)	(4.317)
Teaching Center	847.565**	844.490**	906.136**	939.042**
	(8.687)	(8.906)	(9.885)	(9.757)
Constant	126.982	36.963	240.067	265.325
	(0.545)	(0.151)	(0.963)	(1.184)
N	37	37	37	37
F(2,34)	52.57**	57.07**	62.94**	59.58**
R-Squared	0.73	0.73	0.75	0.75

Notes: Per capita expenditures are deflated using the Ontario CPI.
Absolute value of heteroscedastic-consistent t-statistics in parentheses.
*Statistically significant at the 5 percent level.
**Statistically significant at the 1 percent level.

Canadian socio-economic need indicators, to augment or replace mortality variables, is only beginning.

In the meantime, we support continued experimentation with capitation funding, with a particular mindset, and within a particular framework. The mindset should be that these formulae are quantitative tools which aid in determining health-care budgets; they augment, but do not replace, the subjective judgements of decisionmakers. They isolate key factors for debate, thereby elevating the level of discussion around the budget, but they do not generate a final answer. Accordingly, we recommend a framework that recognizes the state of imperfection of the formulae, and the continued importance of decisionmakers' subjective input. For example, some portion of the budget may be allocated through the capitation formula, while the remainder is allocated through conventional processes. How large a portion is in itself a subjective decision, and will depend on judgements about the degree of perceived inequity in historical allocations, the acceptable pace of change, among other factors. As the formulae improve, and prove themselves in practice, they may take a more prominent role in determination of the final budget allocations.

NOTES

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[1]In an ideal world, these "needs" adjustments would be made using prospective measures. Since no such measures exist, capitation funding models must rely on retrospective indicators.

[2]The capitation models used, or proposed, in the United Kingdom, Finland, Canada, and Australia all include an SMR.

[3]Since a capitation model operates under a balanced (fixed) budget, the allocation formula is constructed to address relative, rather than absolute need. Everything else being equal, regions with greater relative health-care requirements (higher SMRs) are therefore allocated relatively more resources.

[4]The only work we are of aware of is Bedard, Dorland, Gregory and Roberts (1998).

[5]It is assumed that the SMR serves as a proxy for morbidity, which in turn, serves as a proxy for need.

[6]For a detailed description of the Saskatchewan, Manitoba, and British Columbia needs-based funding models, refer to Saskatchewan Health (1996), Barer and Stoddart (1991), and BC Ministry of Health (1996) respectively.

[7]The mortality data are from Statistics Canada. Place of residence is supposed to be used to assign deaths to CDs. However, this is clearly not perfectly executed since some Quebec CDs report no deaths from 1986 through 1992 (this is also the case for one British Columbia CD). To deal with this, we are forced to omit Quebec, and one CD from BC, from some parts of the analysis; this is noted where applicable. It is also likely that some elderly deaths are misreported because they are in long-term care outside of their region of residence. This may not be so problematic since we exclude people over the age of 74 anyway.

[8]Prior to 1993, several Quebec CDs (and one British Columbia CD) report no deaths. This is clearly incorrect given the population of non-reporting CDs, and this misreporting affects the SMRs in the CDs reporting no deaths as well as those reporting higher death rates as a result. However, the 1993 patterns are consistent with those from 1986-92 in all unaffected areas.

[9]The Yukon has only one CD and hence an SMR of one by definition.

[10]Prince Edward Island, the Yukon, and the Northwest Territories are excluded because they have very few CDs.

[11]Quebec is excluded because some CDs fail to report deaths prior to 1993. The single British Columbia CD that reports no deaths prior to 1993 is excluded, but the rest of British Columbia is included. While this error does distort the remaining British Columbia numbers somewhat, the small size of the excluded CD (the population was about 5,000 in 1991) ensures that resulting misreporting in other CDs is also minimal.

[12]The results presented in Table 3, as well as the correlation between socio-economic variables, suggest that precise estimates of individual coefficients will be difficult because of collinearity.

[13]Overall and female unemployment rates are in general not very highly correlated with SMRs. It should also be noted that the male unemployment rates presented throughout the paper are for the male population aged 25 and over. The results are not particularly sensitive to this definition; similar results are found using the male unemployment rate for men aged 15 and over.

[14]Quebec is excluded due to non-reporting CDs prior to 1993. The Yukon, the Northwest Territories and Prince

Edward Island are excluded because they contain a small number of CDs.

[15]These results are available upon request.

[16]We adopt the index name coined by Birch, Eyles and Newbold (1995).

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APPENDIX

TABLE A1
Data Sources

Variable	*Data*	*Sources*	*Years*
SMRs (all CDs)	Mortality	Statistics Canada – Special Tabulation	1986-1993
	Population	Census Profile Files (Pcensus)	1986-1991
Socioeconomic Variables		Census Profile Files (Pcensus)	1991
SMRs (Ontario)	Mortality	Ministry of Health – Special Tabulation	1987-1993
	Population	Ministry of Health – Special Tabulation	1986-1991
SHR (Ontario)	Health Status	Ontario Health Survey	1990
Ontario Health Expenditures		Ontario Health Expenditures	1990-1993