

# What is the distribution of deaths due to cerebrovascular disease in Ontario?

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## Abstract

**Background:** Although it has been known for some time that mortality from cardiovascular disease (CVD) in general, and ischemic heart disease (IHD) in particular, varies significantly by geographic region, little is known about the distribution of cerebrovascular disease (CBVD) or stroke). To study the geographic distribution of deaths from CBVD in Ontario and to determine the association of the distribution of deaths from IHD and CBVD, mortality in the 49 census divisions in Ontario was studied.

**Methods:** Age-adjusted rates (AARs) of mortality and standardized mortality ratios (SMRs) were calculated for Ontario residents aged 30 to 89 years using Statistics Canada data files for 1991, 1992 and 1993. Those census divisions with statistically significant SMRs  $\geq 1.20$  (i.e., at least 20% above the provincial average) were categorized as having above-average mortality. Those with statistically significant SMRs  $\leq 0.80$  (i.e., at least 20% below the provincial average) were categorized as having below-average mortality. The correlation of AARs between men and women of the various forms of CVD was tested, as was the correlation between deaths from IHD and CBVD.

**Results:** Few census divisions were above average in terms of CBVD mortality. Also, there was little consistency between the sexes in the geographic distribution of CBVD mortality ( $r = 0.294$ ). In contrast, several census divisions had above-average rates of IHD mortality, and there was good correlation between the sexes ( $r = 0.852$ ). Correlation of AARs between men and women was higher for IHD and CVD than for CBVD. Correlation between IHD and CBVD was poor.

**Interpretation:** For the most part, the distribution of mortality from CBVD did not vary significantly across Ontario. This pattern is different for IHD. The correlation between CBVD and IHD mortality is poor, which may have implications in terms of access to treatment and the identification of causative factors.

## Résumé

**Objectif :** Bien que l'on sache depuis un certain temps déjà que la mortalité attribuable aux maladies cardiovasculaires en général, et aux cardiopathies ischémiques en particulier, varie sensiblement selon les régions géographiques, on en sait peu au sujet de la répartition des maladies cérébrovasculaires (ou accidents cérébrovasculaires). Afin d'étudier la répartition géographique des décès causés par des maladies cérébrovasculaires en Ontario et de déterminer le lien entre la répartition des décès causés par des cardiopathies ischémiques et ceux qui sont causés par des maladies cérébrovasculaires, 49 divisions de recensement de l'Ontario ont fait l'objet d'une étude.

**Conception :** Les taux de mortalité ajustés selon l'âge (TMAA) et de ratios standardisés de mortalité (RSM) ont été calculés pour les habitants de l'Ontario âgés de 30 à 89 ans, à l'aide des fichiers de données de Statistique Canada pour 1991, 1992 et 1993. Les divisions de recensement dont les RSM étaient significatifs sur le plan statistique à  $\geq 1,20$  (c.-à-d., au moins 20 % au-dessus de la moyenne provinciale) ont été classées comme ayant un taux de mortalité supérieur à la moyenne. Celles dont les RSM étaient significatifs sur le plan statistique à  $\leq 0,80$  (c.-à-d., au moins 2 % sous la moyenne provinciale) ont été classées comme ayant un taux de mortalité inférieur à la moyenne. On a testé les corrélations entre les TMAA de diverses formes de maladies cardiovasculaires chez les hommes et les femmes, ainsi que les corrélations entre les décès causés par les cardiopathies ischémiques et les maladies cérébrovasculaires.

**Résultats :** Peu de divisions de recensement se sont classées au-dessus de la moyenne pour ce qui est de la mortalité causée par les maladies cérébrovasculaires. Il y avait en outre peu d'uniformité entre les sexes dans la répartition géographique de la mortalité causée par les maladies cérébrovasculaires ( $r = 0,294$ ). En revanche, dans plusieurs divisions de recensement, les taux de mortalité causée par les cardiopathies ischémiques dépassaient la moyenne et il y avait une bonne corrélation entre les sexes ( $r = 0,852$ ). La corrélation entre les TMAA chez les hommes et les femmes était plus élevée dans le cas des cardiopathies ischémiques et des maladies cardiovasculaires que dans celui des maladies cérébrovasculaires. La corrélation entre les cardiopathies ischémiques et les maladies cérébrovasculaires était faible.

**Interprétation :** Dans l'ensemble, la répartition de la mortalité causée par les maladies cérébrovasculaires ne varie pas beaucoup en Ontario. Cette tendance est différente dans le cas des cardiopathies ischémiques. La corrélation entre la mortalité causée par les maladies cérébrovasculaires et les cardiopathies ischémiques est faible, ce qui peut avoir des répercussions sur l'accès au traitement et l'identification des causes.

## Special Supplement

### Suppléments Spécial

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**D**iseases of the circulatory system (cardiovascular disease [CVD]) are the major cause of death in Canada. In 1995, for instance, CVD accounted for 79 116 deaths in Canada (37.5% of all deaths). Cerebrovascular disease [CBVD or stroke] was responsible for 19.6% of all CVD mortality (7.4% of all-cause mortality), with 15 537 deaths.<sup>1</sup>

It has been known for some time that indicators of health status and rates of a wide range of diseases and conditions vary across Canada.<sup>2</sup> For example, mortality from ischemic heart disease (IHD) in particular, and CVD in general, demonstrate an east-west gradient; rates are highest in eastern Canada and lowest in western Canada.<sup>3</sup> Given the similarities in modifiable or lifestyle risk factors for IHD and CBVD (smoking, high blood pressure, inactivity, obesity and elevated blood cholesterol), it might be expected that mortality from the 2 diseases would exhibit similar distribution patterns. However, from the existing data, this does not appear to be true.<sup>3-7</sup>

Although there is province-to-province variation in CBVD mortality, it appears that the variation is less than that for IHD mortality.<sup>8</sup> For example, rates of death for CBVD range from a low of 13.7 per 100 000 (Northwest Territories) to a high of 71.3 per 100 000 (Manitoba), for a range of 57.6 per 100 000.<sup>9</sup> In contrast, the range for rates of death from IHD is 160.2 per 100 000, with a low of 19.0 per 100 000 (Northwest Territories) to a high of 179.2 per 100 000 (Prince Edward Island). Even when the territories (which have death rates of CBVD and IHD markedly lower than most provinces) are excluded, the range for rates of death from CBVD remains considerably smaller than the range for IHD (24.4 per 100 000 v. 82.8 per 100 000).

Provincial statistics do not provide a breakdown of death rates by smaller geographic units. To examine the issue of regional variations in CBVD mortality in greater detail, the Heart and Stroke Foundation of Ontario carried out an analysis of CBVD, IHD and CVD mortality within Ontario by census division (county or region). The distribution of CBVD mortality within the province and its relation to IHD had not previously been analysed.

In order to concentrate on the people most likely to benefit from health promotion and acute-care services, the analysis was restricted to mortality of Ontario residents aged 30 to 89 years. Thus, the study excluded the most elderly seniors who, by virtue of their age alone, have extremely high rates of death from IHD and CBVD.

This study is a preliminary analysis to determine what, if any, patterns can be detected for CBVD mortality within Ontario. No attempt was made in this study to correlate CBVD mortality and cardiovascular risk factors such as smoking, high blood pressure, inactivity and obesity.

## Methods

Statistics Canada data for 1991, 1992 and 1993 were analysed, including the number of deaths by sex, census division (county

or region) and age (10-year groupings) for Ontario residents aged 30 to 89 years and the number of deaths from circulatory disease (International Classification of Diseases [ICD] codes 390-459), IHD (ICD codes 410-414) and CBVD or stroke (ICD codes 430-438). To calculate age-adjusted rates (AARs), data were used for all 10-year age groupings (30-39, 40-49, 50-59, 60-69, 70-79 and 80-89). To reduce the anomalies for any one year (especially in light of the small population of some census divisions), all analyses were conducted on 3-year aggregate data (i.e., combined 1991, 1992 and 1993 data).

Statistics Canada data files were aggregated using SPSS-PC+ Version 5.0 (SPSS Inc., Chicago, Ill.; 1992) and then imported into the US Centers for Disease Control and Prevention Health Information Retrieval System (HIRS) software (EpiInfo and Epi-Map shareware, US Centers for Disease Control and Prevention, Atlanta, Ga.; 1996). Three-year age-specific rates were calculated for the 20-29, 30-39, 40-49, 50-59, 60-69, 70-79 and 80-89 age groups; from these, 3-year AARs for 30 to 89 years were determined.

Standardized mortality ratios (SMRs) were calculated using the indirect method and standardized to the 1991 population of Canada. Given the relatively small number of CBVD deaths in some census divisions, the indirect method was the preferred means of calculating these ratios.<sup>10</sup> Upper and lower 95% confidence intervals (CI) and degrees of statistical significance were also calculated for the SMRs.

It was arbitrarily decided that census divisions with statistically significant (lower limit of 95% CI  $\geq 1.00$  and  $p < 0.001$ ) SMRs that were at least 20% higher than the provincial average (i.e., SMR  $\geq 1.20$ ) were considered to have above-average mortality. Similarly, census divisions with statistically significant (upper limit of 95% CI  $< 1.00$  and  $p < 0.001$ ) SMRs that were at least 20% lower than the provincial average (i.e., SMR  $\leq 0.80$ ) were considered to have below-average mortality.

To determine the degree of correlation of AARs between the sexes and between IHD and CBVD mortality, Spearman rank correlation coefficients were calculated.

## Results

### *Cerebrovascular disease*

#### Men

Over the 3-year study period, CBVD accounted for 6822 deaths among Ontario men aged 30 to 89 years (6.6% of all-cause male mortality; 15.6% of male CVD deaths). AARs ranged from a low of 23 per 100 000 (Haliburton: SMR 0.45, 95% CI 0.14-0.76,  $p = 0.020$ ) to a high of 81 per 100 000 (Rainy River: SMR 1.59, 95% CI 1.02-2.15,  $p = 0.010$ ). An SMR 20% or more above the provincial average at the 0.001 significance level was reported only for Thunder Bay (Table 1), although Rainy River was significant at the 0.01 level. Only Halton was at least 20% below the provincial average ( $p = 0.006$ ).

## Women

During the 3-year study period there were 10 046 deaths among women aged 30 to 89 years from CBVD (11.8% of female all-cause mortality; 23.1% of female CVD deaths). Although the average AAR for CBVD was lower for women than for men (46 v. 51 per 100 000), a greater proportion of female deaths was due to CBVD (12% v. 7%). AARs ranged from a low of 31 per 100 000 (Haliburton: SMR 0.66, 95% CI 0.32–0.76,  $p = 0.116$ ) to a high of 75 per 100 000 (Dufferin: SMR = 1.62, 95% CI 1.20–1.67,  $p < 0.001$ ).

Dufferin was the only census division for which the SMR for female death from CBVD was at least 20% higher than the provincial average at the 0.001 level (Table 2). Prince Edward and Wellington counties had rates 20% or more higher than the provincial average, but at significance levels of 0.04 and 0.08 respectively (and thus were not listed in Table 2). No counties had statistically significant rates that were 20% or more below the provincial average.

## Both sexes

For both sexes, the number of deaths from CBVD for Ontario

residents aged 30 to 89 years during the study period was 16 868 (8.9% of all-cause mortality; 19.4% of CVD deaths). The average AAR for CBVD was 49 per 100 000, ranging from a low of 28 per 100 000 (Haliburton: SMR 0.58, 95% CI 0.34–0.82,  $p = 0.010$ ) to a high of 72 per 100 000 (Dufferin: SMR 1.47, 95% CI 1.17–1.77,  $p < 0.001$ ). Correlation between CBVD AARs by sex was poor (Spearman rank correlation coefficient = 0.294).

Dufferin, Rainy River and Essex counties had SMRs 20% or more above the provincial average, although only Dufferin was significant at the 0.001 level (Table 3); Rainy River and Essex counties were significant at the 0.03 and 0.05 levels respectively. Haliburton had a rate 20% or more below the provincial average, statistically significant at the 0.10 level.

## Ischemic heart disease

### Men

IHD accounted for 28 262 deaths among men aged 30 to 89 years (27.2% of all-cause male mortality; 64.8% of male CVD deaths). The average AAR for mortality from IHD for

**Table 1: Ontario census divisions with cardiovascular disease mortality 20% or more above provincial average (men aged 30–89 years)**

Cardiovascular disease (ICD codes) by census division	AAR	SMR (and 95% CI)*	% of all mortality
<b>Cerebrovascular disease (430–438)</b>			
Thunder Bay	68	1.32 (1.11–1.53)	8
All Ontario	51	1.00	7
<b>Ischemic heart disease (410–414)</b>			
Kent	333	1.61 (1.48–1.75)	37
Bruce	290	1.40 (1.26–1.55)	35
Thunder Bay	283	1.37 (1.26–1.48)	32
Sudbury Region Municipality	275	1.33 (1.22–1.44)	31
Haldimand–Norfolk	270	1.31 (1.18–1.43)	34
Hastings	253	1.23 (1.12–1.33)	30
Niagara	253	1.22 (1.16–1.28)	32
Essex	250	1.21(1.14–1.28)	31
All Ontario	207	1.00	27
<b>All circulatory disease (390–459)</b>			
Kent	430	1.34 (1.24–1.44)	47
Bruce	419	1.30 (1.19–1.42)	50
Thunder Bay	418	1.30 (1.22–1.39)	48
Sudbury Region Municipality	408	1.27 (1.18–1.36)	45
Prescott–Russell	397	1.24 (1.10–1.37)	46
Haldimand–Norfolk	397	1.24 (1.14–1.33)	50
Cochrane	390	1.22 (1.10–1.33)	39
Renfrew	387	1.20 (1.11–1.30)	47
All Ontario	321	1.00	42

Note: ICD = International Classification of Diseases; AAR = age-adjusted mortality rate; SMR = standardized mortality ratio; CI = confidence interval  
\*All SMRs statistically significant at 0.001

men was 207 per 100 000, ranging from a low of 162 per 100 000 (Peel: SMR 0.79, 95% CI 0.74–0.83,  $p < 0.001$ ) to a high of 333 per 100 000 (Kent: SMR 1.61, 95% CI 1.48–1.75,  $p < 0.001$ ).

There were 8 census divisions for which SMRs were 20% or more above the provincial average at the 0.001 significance level (Table 1). In all 8 districts, the proportion of deaths from IHD was above the provincial average (31% to 37% of deaths, compared with the provincial average of 27%). Sudbury District and Prescott–Russell had SMRs 20% or more above the provincial average but are not listed in Table 1 because their significance levels were 1.28 (CI 1.01–1.54,  $p = 0.018$ ) and 1.23 (CI 1.07–1.40,  $p = 0.002$ ) respectively. There were 3 census divisions in which the SMR was 20% or more below the provincial average: Metropolitan Toronto, Peel and York.

## Women

For women aged 30 to 89 years, there were 23 633 deaths from IHD during the study period (27.9% of all-cause female mortality; 54.5% of female CVD mortality). The average AAR for IHD mortality for women was 111 per 100 000, ranging from a low of 80 per

100 000 (Manitoulin: SMR 0.71, 95% CI 0.44–0.98,  $p = 0.073$ ) to a high of 190 (Kent: SMR 1.70, 95% CI 1.56–1.85,  $p < 0.001$ ).

There were 12 census divisions for which the SMR was statistically significant ( $p < 0.001$ ) and 20% above the provincial average (Table 2). Census divisions that approached (but did not achieve) the 0.001 significance level included Sudbury District (SMR 1.38, 95% CI 1.03–1.73,  $p = 0.012$ ), Temiskaming (SMR 1.24, 95% CI 1.03–1.46,  $p = 0.013$ ) and Victoria (SMR 1.22, 95% CI 1.07–1.37,  $p = 0.002$ ). Only Metropolitan Toronto had a rate at least 20% below the provincial average (SMR 0.77,  $p < 0.001$ ).

## Both sexes

For both sexes, IHD accounted for 51 923 deaths during the study period (27.5% of all-cause mortality; 59.7% of all CVD deaths). The average AAR was 153 per 100 000, ranging from a low of 119 per 100 000 (Metropolitan Toronto: SMR 0.78, 95% CI 0.76–0.79,  $p < 0.001$ ) to a high of 251 per 100 000 (Kent: SMR 1.64, 95% CI 1.54–1.73,  $p < 0.001$ ). Correlation of IHD AARs by sex was good to excellent (Spearman rank correlation coefficient = 0.852).

**Table 2: Ontario Census divisions with cardiovascular disease mortality 20% or more above provincial average (women aged 30–89 years)**

Cardiovascular disease (ICD codes) by census division	AAR	SMR (and 95% CI)*	% of all mortality
<b>Cerebrovascular disease (430–438)</b>			
Dufferin	75	1.62 (1.20–1.67)	17
All Ontario	46	1	12
<b>Ischemic heart disease (410–414)</b>			
Kent	190	1.70 (1.56–1.85)	45
Sudbury Region Municipality	159	1.43 (1.29–1.56)	32
Prescott–Russell	156	1.40 (1.21–1.59)	32
Haldimand–Norfolk	154	1.38 (1.24–1.53)	37
Hastings	154	1.38 (1.26–1.51)	36
Thunder Bay	145	1.30 (1.18–1.42)	35
Elgin	144	1.29 (1.14–1.44)	35
Bruce	143	1.29 (1.12–1.45)	31
Nipissing	142	1.28 (1.12–1.44)	29
Lanark	142	1.27 (1.10–1.45)	34
Niagara	139	1.24 (1.18–1.31)	35
Essex	138	1.24 (1.17–1.31)	33
All Ontario	111	1	28
<b>All circulatory disease (390–459)</b>			
Kent	262	1.29 (1.20–1.38)	61
Sudbury Region Municipality	256	1.26 (1.17–1.36)	52
Prescott–Russell	256	1.26 (1.13–1.40)	54
Haldimand–Norfolk	250	1.23 (1.13–1.33)	58
Hastings	244	1.20 (1.11–1.29)	57
Essex	243	1.20 (1.14–1.25)	59
All Ontario	203	1.00	51

\*All SMRs statistically significant at 0.001.

Fourteen census divisions had statistically significant SMRs at least 20% above the provincial average (Table 3). Among these census divisions, the proportion of the total mortality from IHD ranged from a low of 27% to a high of 40% (provincial average 28%). Only Metropolitan Toronto had a rate at least 20% below the provincial average (SMR 0.78,  $p < 0.001$ ).

### All circulatory disease

#### Men

During the study period, CVD was responsible for 43 616 deaths among men aged 30 to 89 years (42.0% of all-cause male mortality). The average rate was 321 per 100 000, ranging from a low of 267 per 100 000 (Halton: SMR 0.83, 95% CI 0.78–0.89,  $p < 0.001$ ) to a high of 430 per 100 000 (Kent: SMR 1.34, 95% CI 1.24–1.44,  $p < 0.001$ ). IHD accounted for 64.8% of male CVD mortality, and CBVD for 15.6%.

Eight census divisions had rates significantly higher than

average (Table 1). Sudbury District achieved statistical significance only at the 0.50 level (AAR 382, SMR 1.20, 95% CI 0.99–1.40,  $p = 0.035$ ). No district had an SMR 20% or more below the provincial average.

#### Women

For women aged 30 to 89 years, CVD accounted for 43 397 deaths (51.2% of all-cause female mortality). The average AAR for all of Ontario was 203 per 100 000, ranging from a low of 169 per 100 000 (Haliburton: SMR 0.83, 95% CI 0.64–1.02,  $p = 0.107$ ) to a high of 265 per 100 000 (Sudbury District: SMR 1.30, 95% CI 1.05–1.56,  $p = 0.008$ ). IHD accounted for 54.5% of female CVD mortality and CBVD for 23.1% of female CVD mortality.

There were 6 census divisions for which the CVD SMR for women was significantly higher than the provincial average at the  $p = 0.001$  level (Table 2). Sudbury District had an SMR of 1.30 with a  $p$  value of 0.008. None of the census divisions had SMRs 20% or more below the provincial average.

**Table 3: Ontario census divisions with cardiovascular disease mortality 20% or more above provincial average (men and women aged 30–89 years)**

Cardiovascular disease (ICD codes) by census division	AAR	SMR (and 95% CI)*	% of all mortality
<b>Cerebrovascular disease (430–438)</b>			
Dufferin	72	1.47 (1.17–1.77)	12
All Ontario	49	1.00	9
<b>Ischemic heart disease (410–414)</b>			
Kent	251	1.64 (1.54–1.73)	40
Sudbury Region Municipality	212	1.39 (1.30–1.47)	32
Bruce	210	1.37 (1.26–1.48)	33
Thunder Bay	208	1.36 (1.27–1.44)	33
Haldimand–Norfolk	206	1.34 (1.25–1.44)	35
Sudbury District	205	1.34 (1.12–1.55)	28
Prescott–Russell	203	1.32 (1.20–1.45)	31
Hastings	200	1.31 (1.22–1.39)	33
Nipissing	189	1.23 (1.13–1.34)	28
Niagara	189	1.23 (1.19–1.28)	33
Essex	187	1.22 (1.17–1.27)	32
Elgin	185	1.21 (1.11–1.31)	32
Temiskaming	185	1.21 (1.07–1.35)	27
Victoria	183	1.20 (1.10–1.30)	37
All Ontario	153	1.00	28
<b>All circulatory disease (390–459)</b>			
Kent	333	1.31 (1.24–1.37)	54
Sudbury Region Municipality	324	1.27 (1.21–1.34)	48
Sudbury District	321	1.26 (1.10–1.42)	44
Bruce	321	1.26 (1.18–1.34)	51
Prescott–Russell	320	1.25 (1.16–1.35)	49
Thunder Bay	318	1.25 (1.19–1.31)	51
Haldimand–Norfolk	314	1.23 (1.16–1.30)	54
All Ontario	255	1.00	46

\*All SMRs statistically significant at 0.001.

## Both sexes

During the study period, CVD accounted for 87 013 deaths of men and women aged 30 to 89 years (46.1% of all-cause mortality). The average AAR for both sexes was 255 per 100 000, ranging from a low of 214 per 100 000 (Halton: SMR 0.84, 95% CI 0.84–0.88,  $p < 0.001$ ) to a high of 333 per 100 000 (Kent: SMR 1.31, 95% CI 1.24–1.37,  $p < 0.001$ ). IHD accounted for 59.7% of CVD mortality for both sexes and CBVD for 19.4%. Correlation of CVD AARs by sex was good ( $r = 0.805$ ), although somewhat less than what it was for IHD ( $r = 0.852$ ).

There were 7 census divisions for which the SMRs for CVD for both sexes were 20% or more above the provincial average at the 0.001 level (Table 3). None of the census divisions had SMRs 20% or more below the provincial average.

### Correlation between IHD and CBVD

We tested the degree to which the rankings of census divisions for IHD and CBVD mortality agreed. Spearman rank correlation coefficients were 0.302 for men, 0.103 for women and 0.315 for both sexes.

## Discussion

This study had 2 major weaknesses. First, it used data collected by Statistics Canada as its sole source. The reliability and validity of results depend in large part on the accuracy of the death certification information from which these data are derived. However, Statistics Canada notes that the completeness of reporting of core statistical data during the 5-year period from 1982 to 1986 was 99%, suggesting that the data for the study period likely have a high degree of completeness.<sup>9</sup> Moreover, during the study period (1991 to 1993), causes of death were consistently coded according to ICD-9. Finally, Statistics Canada routinely undertakes quality-control studies of its data and makes improvements in its collection processes accordingly.<sup>9</sup>

Analyses of the accuracy of death certificate diagnoses in other jurisdictions have tended to report high validity (90% to 100%) for broad categories such as CBVD (ICD 430–438), IHD (ICD 410–414) and cancer (ICD 140–239), but show less accuracy (40% to 87%) for subcategories.<sup>11–13</sup> Thus, our study, which examined mortality within the parameters of broad ICD categories, has an unknown but probably reasonable degree of accuracy.

Some census divisions had few CBVD deaths, which could call into question the robustness of the results. However, several measures were taken to protect against unreliable results. First, data were taken for a broad age range (ages 30 to 89 years) over a 3-year period. This increased the number of deaths from which AARs and SMRs were calculated and eliminated bias from any 1 year. Second, conservative cutoff points were used (e.g., the preference for  $p$  values of 0.001 and the

decision to look for SMRs that were at least 20% more or less than the provincial average).

CVD is the major cause of death among Ontario residents aged 30 to 89 years, accounting for 46% of all-cause mortality during the 3-year study period. For the ages and years studied, the number of CVD deaths for men and women was almost equal (44 000 v. 43 000), despite the fact that the total number of all-cause deaths was 22% higher among men. However, because of the smaller number of deaths in women overall, the proportion of deaths from CVD was significantly higher in women than in men, contradicting the common perception of CVD as a “man’s disease.”

When IHD and CBVD were analysed, the differences between the sexes became clear. IHD is responsible for more CVD deaths in men than women (28 000 v. 24 000 deaths; 65% v. 55%). However, CBVD causes not only more deaths in women than men (10 000 v. 7000) but also a greater proportion of CVD deaths in women than men (23% v. 16%).

In the case of IHD, strong geographic differences and patterns emerged. Almost a dozen “hot spots” (i.e., census divisions with IHD SMRs  $\geq 1.20$ ) and a small number of “cold spots” (SMRs  $\leq 0.80$ ) were identified. There was considerable overlap among men and women of census divisions that were hot spots, as one would expect from the relatively high degree of correlation ( $r = 0.852$ ) of AARs by sex. This suggests that the distribution of IHD mortality is not random but tied to any number of genetic, socioeconomic, cultural, lifestyle or medical variables with distinct geographical patterns. For reasons yet unknown, most hot spots tended to be rural or nonurban areas, whereas the cold spots centred around Metropolitan Toronto.

The situation was very different for CBVD mortality. Using the same cutoff points, there were no CBVD hot spots or cold spots for men, women or both sexes. Given this lack of consistency, it was not surprising to see that the correlation between the sexes for CBVD mortality was only fair to poor ( $r = 0.294$ ).

This paradox — high rates of stroke and low rates of coronary heart disease — has been previously observed, particularly in Asian populations.<sup>14,15</sup> Attempts to explain it have focused on a variety of lifestyle and hemostatic risk factors.<sup>16–19</sup>

In his review of urban-rural variations in health, Verheij<sup>20</sup> noted that geography (i.e., choice of an urban or rural setting) may interact with any number of demographic and personal variables. Moreover, the impact of environmental forces may not be uniform but may vary from person to person. Thus, research into the distribution of CVD death rates, including different forms of CVD, will necessarily be complex, not only because of the number of geographic, socioeconomic, medical and lifestyle factors that must be examined, but also because of their interactive and personalized nature.

Although the current analysis lacks the data necessary to explore the reasons for the different distributions of CBVD and IHD mortality in Ontario, it does demonstrate an important public health issue: CBVD is equally important in all parts of the province. No part of Ontario can be considered “safe” from

CBVD, and all parts could benefit from better organization of stroke care. International research has shown that organized stroke care can reduce mortality and morbidity, improve patient outcomes and reduce health care costs.<sup>21-23</sup> However, maximum societal benefit can be achieved only if access is as equitable as the distribution of CBVD mortality.

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