Increasing Rates of Ischemic Heart Disease in the Native Population of Ontario, Canada

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Background: The prevalence of ischemic heart disease (IHD) has been declining in North America since the 1960s. Over this time, Native populations, which have traditionally had low rates of IHD, have undergone striking lifestyle changes that may have had health consequences. In this context, IHD trends in the Native communities of Ontario, Canada, were evaluated.

Objective: To assess trends in admission rates for IHD in the Native population of Ontario compared with the general population of Ontario.

Methods: A comprehensive administrative database of all hospital admissions in Ontario 1981 to 1997, was used. Age- and sex-adjusted rates of hospital admissions with IHD-related diagnostic or procedure codes were determined in all residents of Ontario communities that had regular census participation and at least 95% of their population claiming Native origins (N=16874 in 1991). Comparison was made with all residents of the surrounding northern Ontario region (N=822450) and of the whole province (N=10084885).

Results: In 1981, the rate of IHD admissions was similar in all groups, at 99 to 124 per 10000 persons. By 1997, it decreased to 82 per 10000 in the province (slope, –1.09; 95% confidence interval, –1.26 to –0.91), with a similar trend in northern Ontario. However, in the Native communities, it increased to 155 per 10000 (slope, 5.6; 95% confidence interval, 3.8-7.5). A similar trend was seen for acute myocardial infarction admissions, a more precisely coded subset of IHD. Spurious causes of increasing rates were ruled out.

Conclusions: Hospitalizations for IHD have doubled in the Native population despite declining rates in the general population. These findings document an alarming trend in Native health and support the need for further research and targeted intervention.

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ISCHEMIC HEART disease (IHD) is the leading cause of mortality in most Western countries. In Canada, rates of IHD have been steadily declining after peaking in the 1960s.1 Similarly, a recent study of 4 American communities showed declining mortality from IHD.2 Much of the reduction in incidence and mortality has been attributed to behavior and lifestyle changes and other forms of primary and secondary prevention.3 However, this overall improvement in IHD mortality may not extend to all subgroups of the population.

Native North Americans have traditionally been thought to have a low prevalence of IHD. Mortality from IHD among Native Americans was lower than that among the general US population in 1984,4 and studies of several Native Canadian groups have demonstrated IHD rates that are lower than those of a comparable broad population.5,6 However, Native populations have undergone significant social, economic, and cultural changes in the past several decades, some of which would be anticipated to have negatively affected the health status of Native North Americans. Several studies have examined whether or not IHD prevalence has risen as a result. Among the Navajo Indians of the southwestern United States, admissions for acute myocardial infarction increased 3-fold between 1976-1979 and 1984-1986.7 However, separate evaluations of the American Indian populations of New Mexico and of the entire United States showed no increase in IHD mortality between the 1960s and 1980s, and even a decrease paralleling that seen in the general population.8,9 In Canada, examination of death certificates found no change in circulatory system mortality rates for Native Canadians comparing 1978-1981 with 1982-1985.10

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SUBJECTS AND METHODS

STUDY POPULATION

The study and comparison populations were defined using the census of Canada, which is performed every 5 years. Each population was defined as the entire population of a group of communities.

In the 1991 census, there were 142 Ontario communities identified as Native reserves or settlements. Native Canadian communities that did not participate in at least 2 censuses, which included small communities (9 communities) for which detailed population information was suppressed. Communities in which fewer than 95% of the population reported Native Canadian ancestry were also excluded (13 communities). While this cutoff point was arbitrary, only 3 additional communities, with a total population of 10,588 in 1991, would have been included had the cutoff point been set at 90% instead. Finally, since we required data from several census years to interpolate populations in the intercensal years, any communities that did not participate in at least 2 of the 3 other censuses in the study period (1981, 1986, and 1996) were excluded (25 communities). Thus, the remaining cohort of 41 Native communities, with a total population of 16,874 in 1991, were selected to define the Native population for the study.

More than 80% of Ontario’s Native communities are located in northern Ontario. Indeed, 39 of the cohort of 41 communities are in the north. Therefore, 2 comparison groups were used: the population of the 10 districts and 1 regional municipality in northern Ontario (total population, 82,245,0 in 1991), and the population of all Ontario (total population, 10,084,885 in 1991, with 2.5% claiming Native Canadian ancestry).

DATA SOURCE

The Canadian Institute for Health Information (CIHI) database is an administrative database containing abstracts of all hospital discharges. The records contain demographic data for the patient, including a location code that identifies the community of the patient’s home address, up to 8 discharge diagnoses recorded using the International Classification of Diseases, Ninth Revision (ICD-9) codes and up to 8 procedures performed during the admission recorded using the Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures (CCP) codes. Data from the fiscal years 1981 through 1997 (April 1, 1981, to March 31, 1998) were used in this study.

RATE DETERMINATION

Population-based rates of IHD events were calculated for Native Canadian communities in aggregate, for northern Ontario and for Ontario as a whole. Numerators for IHD event rates were determined by selecting ICD-9 codes corresponding to IHD diagnoses (410, 411, 413, and 414) and the CCP code for coronary angioplasty and bypass (48.0 and 48.1). An IHD event was defined as a hospital admission that had a selected ICD-9 code as 1 of the first 2 diagnoses or a selected CCP code as one of the first 2 procedures listed. The location code for the admission determined under which populations the admission was counted.

The rate denominator was the population obtained from census data at the community, regional, and provincial levels for the 3 study groups, respectively. Crude rates were age and sex adjusted to the provincial population of 1991. Seventeen of the Native Canadian communities under investigation did not participate during 1 of the 1981, 1986, or 1996 census years, so population characteristics for the missing years were interpolated using linear regression from the available data.

Because coding practices may have differed over time and between regions, the analysis was repeated using only those separations that had acute myocardial infarction (ICD-9 code 410) as 1 of the first 2 diagnostic codes. Because of its standardized diagnostic criteria, acute myocardial infarction is a relatively reliably coded medical condition.11,12

In 1988, the Ontario Ministry of Health adopted a system of unique identifying numbers for each resident of Ontario. These health card numbers were fully implemented by 1991. Therefore, after 1991, it was possible to examine the frequency of readmissions for the same individual patient. A readmission was defined a priori as an IHD event that began within 2 days of the completion of another IHD event bearing the same health card number. This definition would capture transfers between hospitals, where separate CIHI records would be made for each hospital’s admission. Events with invalid health card numbers were also counted as readmissions to conservatively estimate the number of new events. The proportion of all admissions that were readmissions was determined for each group in each year possible.

Finally, differences in admission rates between groups may represent actual differences in disease prevalence between populations, or they may represent differences in intensity of resource use between populations with similar prevalence of disease. To discriminate between these possibilities, inception cohorts were created for each year from 1991 to 1995. The average number of IHD events per patient in the inception year and subsequent 2 years was ascertained for each cohort and each group. Thus, for each year, the average number of hospitalizations per patient was determined.

To ensure that any trends in IHD admissions seen in the Native Canadian population were not a reflection of changing access to health care resources, a similar analysis was conducted for all 3 populations, counting admissions with an ICD-9 code for acute appendicitis (540, 541, or 542) and the CCP code for appendectomy (59.0). Like IHD, appendicitis usually results in an urgent hospital admission and is also reliably coded41,12; however, it was anticipated that the rate of admissions for appendicitis would not be different between the groups or changing over time.

STATISTICAL ANALYSIS

Data were analyzed using a commercially available statistical software package (Release 6; STATA Corp, College Station, Tex, 1998). Confidence intervals were calculated on annual rates for the Native Canadian population; for the other 2 groups, the number of events was so large as to make the confidence intervals exceedingly narrow.

Linear regression models were fit to the annual rates, and confidence intervals were calculated around the slopes.
Using a comprehensive administrative database, we sought to examine the trend in hospital admissions for IHD diagnoses among Ontario Natives over the past 2 decades and to compare it with corresponding trends in the same geographic region and in the province as a whole.

**RESULTS**

Over the 17-year study period, a total of 1888 IHD events (54% male) were identified in the Native Canadian population, 163094 events (60% male) among northern Ontario residents, and 1476962 events (60% male) among all Ontario residents. The rates of IHD events for each year are shown in Figure 1, age and sex adjusted to the 1991 Ontario population. In the Native Canadian population, IHD event rates have been progressively rising, from a nadir of 76 admissions per 10000 persons (95% confidence interval [CI], 57-95) in 1984 to 186 per 10000 persons (95% CI, 157-214) in 1995. In the same time period, rates in the northern Ontario population have decreased from a peak of 129 per 10000 in 1986 to 110 per 10000 in 1995. Finally, event rates in the Ontario population as a whole have been steadily decreasing, from a high of 101 per 10000 in 1982 to 82 per 10000 in 1997.

Linear regression models were fit to the adjusted annual rates for the 3 groups. For the province as a whole, a decline in rate was observed (slope, –1.09 admissions per 10000 persons per year; R²=0.99), and in all Ontario (R²=0.92), 1981-1997. Values are age and sex adjusted to the 1991 Ontario population (95% confidence intervals for the rates in Native communities are shown; for the other groups, confidence intervals are vanishingly small).

The admission rates of acute myocardial infarction, a more precisely coded subset of IHD, were used to verify the overall trends seen for IHD. The age- and sex-adjusted data are presented in Figure 2. Admission rates of acute myocardial infarction in the Native Canadian population, which were initially lower than those of the comparison populations, have notably increased, from 11 admissions per 10000 persons (95% CI, 4-18) in 1982 to 47 per 10000 (95% CI, 32-63) in 1995 (slope, 1.8 admissions per 10000 persons per year; R²=0.75; and 95% CI, 1.3-2.4). In northern Ontario, rates have remained stable, with a range from 26 to 29 per 10000 (slope, –0.07 admissions per 10000 persons per year; R²=0.10; and 95% CI, –0.18 to 0.04). In Ontario as a whole, rates have gradually declined, from 27 per 10000 in 1982 to a low of 24 per 10000 in 1992 (slope, –0.16 admissions per 10000 persons per year; R²=0.62; and 95% CI, –0.23 to –0.09).

Table 1 shows the proportion of the total number of admissions that were readmissions in all 3 study groups. All groups had very low proportions of readmissions, with the lowest in the Native Canadian communities. Only 2% of the total events in each group had invalid health card numbers.

The average number of admissions per patient per 3-year period in each group is shown in Table 2. Although the Native Canadian communities had more admissions with IHD per individual patient than either

![Figure 1. Rates of ischemic heart disease (IHD) admissions in Native communities of Ontario, Canada (R²=0.73), in northern Ontario (R²=0.59), and in all Ontario (R²=0.92), 1981-1997. Values are age and sex adjusted to the 1991 Ontario population (95% confidence intervals for the rates in Native communities are shown; for the other groups, confidence intervals are vanishingly small).](image1)

![Figure 2. Rates of acute myocardial infarction (MI) admissions in Native communities of Ontario, Canada (R²=0.75), in northern Ontario (R²=0.10), and in all Ontario (R²=0.62), 1981-1997. Values are age and sex adjusted to the 1991 Ontario population (95% confidence intervals for the rates in Native communities are shown; for the other groups, confidence intervals are vanishingly small).](image2)

<table>
<thead>
<tr>
<th>Year</th>
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<th>Northern Ontario</th>
<th>All Ontario</th>
</tr>
</thead>
<tbody>
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<td>11</td>
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</tr>
<tr>
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</tr>
<tr>
<td>1997</td>
<td>7</td>
<td>11</td>
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</table>

* IHD indicates ischemic heart disease. A readmission was defined as either an IHD event where another IHD event bearing the same health card number had been completed within the previous 2 days, or an IHD event with an invalid health card number. See the “Rate Determination” subsection of the “Subjects and Methods” section for an explanation of the health card numbers.

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We have identified a dramatic increase in the rate of hospital admissions for IHD among Ontario Native people over a 17-year period. At the same time, rates in the surrounding region and the province as a whole have been stable or declining in a manner consistent with evidence from other jurisdictions.

These increasing admission rates are most plausibly explained by an increased prevalence of IHD in Native Canadian communities. Coding practices for hospital discharge abstracts may have changed over the study period, leading to apparent rate changes; alternatively, rates may have been affected by changing practice patterns, such as increasing outpatient management of disease or variable access to health care resources. However, the analysis of rates for the northern Ontario region addresses these practice and access factors, since, in most cases, persons in the Native Canadian communities would have attended the same secondary and tertiary care hospitals as those in the general population. Also, the similar result in the analysis of acute myocardial infarction admissions, a more precise and reliably coded diagnosis that always results in patient admission, supports the interpretation that these findings reflect important differences in disease prevalence rather than artifacts of administrative data. Finally, trends in admissions for acute appendicitis, an unrelated but reliably coded diagnosis that also usually results in an urgent hospital admission, were not statistically different between the Native Canadian population and the 2 comparison populations.

Transfers between hospitals may have falsely elevated the IHD event rates, since separate records would have been generated for the CIHI database from each institution. However, since 1991, it has been possible to track individuals in the CIHI database, and it was found that patients relatively infrequently were being admitted with an IHD event within 2 days of discharge from another IHD event (Table 1). In fact, this practice occurred less often in the Native Canadian population than in the comparison populations, which indicates that interhospital transfers are not falsely elevating the IHD event rates in Native Canadian communities and which only accentuates the difference in admission rates seen between the groups.

Different IHD admission rates between groups can be caused either by different prevalences of IHD or by different intensities of hospital resource use between groups with similar prevalence rates. While Native Canadians were admitted more often per person than individuals in the comparison populations (Table 2), the difference was not large enough to explain the much higher admission rate; therefore, there must also be a higher prevalence of IHD in this population. Moreover, while multiple admissions for the same patients may make accurate estimation of incidence and prevalence from admission data difficult, the data may still be used to accurately reflect the burden of IHD on society and the health care system.

The high frequency of IHD hospital admissions in the Native Canadian population may be explained in part by IHD risk factors. The Strong Heart Study was initiated in 1988 to elucidate the IHD risk factors for American Indians in selected centers in the southwestern and midwestern United States. It suggested that the independent risk factors in its cohort were similar to those identified in the general population: age, diabetes, smoking, hypertension, serum cholesterol disturbances, and obesity. In particular, diabetes was observed to be the strongest risk factor.

Although diabetes has historically been rare among Native North Americans, it has become increasingly common. The prevalence of diabetes among Native North Americans is higher than that of the general population, and one of the highest reported prevalence rates is in Sandy Lake, Ontario, one of the Native Canadian communities included in this study.

The prevalence of other IHD risk factors is also noteworthy. A 1990 survey of urban residents found that 59% of surveyed Native Canadians were regular smokers, compared with 23% of the general population. Smoking prevalence in northwestern Ontario reserves is known to be high. Diastolic blood pressure levels among a group of Cree and Ojibwa communities are higher than those of the general population; however, systolic blood pressure levels were equal or lower. Interestingly, a national nutritional survey demonstrated a lower proportion of hypercholesterolemia among Native Canadians than among the general population, but found that Native Canadians, particularly females, were more obese than

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**Table 2. Average Number of IHD Events per Patient per 3-Year Period in the Native Communities of Ontario, Canada, in Northern Ontario, and in All Ontario**

<table>
<thead>
<tr>
<th>Period</th>
<th>Native Communities</th>
<th>Northern Ontario</th>
<th>All Ontario</th>
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<td>1991-1993</td>
<td>3.51</td>
<td>2.89</td>
<td>2.81</td>
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<tr>
<td>1995-1997</td>
<td>3.57</td>
<td>2.84</td>
<td>2.79</td>
</tr>
</tbody>
</table>

* IHD indicates ischemic heart disease.
the average Canadian. Another study found that in some age and sex groups in a Cree and Ojibwa population, almost 90% of those studied were overweight or obese. Similar results have been documented in many different Native North American groups.

The high prevalence of these risk factors may in part explain the observed high frequency of IHD admissions in 1997; however, changes in the prevalence of risk factors that could account for the increasing frequency of IHD seen in Native Canadians over the study period are less well documented. Nevertheless, some indirect evidence suggests that the high prevalence of diabetes observed among Native Canadians is a new phenomenon: in a northern Ontario Native population, nearly half of the cases of diabetes had been diagnosed within 5 years or less.

Ischemic heart disease is a major health risk among the Native communities of Ontario. While the disease burden has decreased for society as a whole, our study demonstrates that Native Canadians have not realized the same benefit. The observation that the growth in IHD burden for the Native Canadian population has not abated over 17 years gives additional cause for concern. Further evaluation of risk factor prevalence and the interaction of risk factors as predictors of IHD events in Native Canadians is urgently needed. These studies must be coupled with a culturally appropriate community-based intervention and prevention strategy.

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REFERENCES