Comparison of cardiovascular risk profiles among ethnic groups using population health surveys between 1996 and 2007

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Abstract

Background: Although people of South Asian, Chinese and black ethnic backgrounds represent about 60% of the world’s population, most knowledge of cardiovascular risk is derived from studies conducted in white populations. We conducted a large, population-based comparison of cardiovascular risk among people of white, South Asian, Chinese and black ethnicity living in Ontario, Canada.

Methods: We examined the age- and sex-standardized prevalence of eight cardiovascular risk factors, heart disease and stroke among 154,653 white people, 3,364 South Asian people, 3,038 Chinese people and 2,742 black people. For this study, we pooled respondent data from five cross-sectional health surveys conducted between 1996 and 2007: the National Population Health Survey of 1996 and the Canadian Community Health Survey, versions 1.1, 2.1, 3.1 and 4.1.

Results: The four ethnic groups varied considerably in the prevalence of the four major cardiovascular risk factors that we examined: for smoking, South Asian 8.6%, Chinese 8.7%, black 11.4% and white 24.8%; for obesity, Chinese 2.5%, South Asian 8.1%, black 14.1% and white 14.8%; for diabetes mellitus, white 4.2%, Chinese 4.3%, South Asian 8.1% and black 8.5%; and for hypertension, white 13.7%, Chinese 15.1%, South Asian 17.0% and black 19.8%. The prevalence of heart disease ranged from a low of 3.2% in the Chinese population to a high of 5.2% in the South Asian population, and the prevalence of stroke ranged from a low of 0.6% in the Chinese population to a high of 1.7% in the South Asian population. Although the black population had the least favourable cardiovascular risk factor profile overall, this group had a relatively low prevalence of heart disease (3.4%).

Interpretation: Ethnic groups living in Ontario had striking differences in cardiovascular risk profiles. Awareness of these differences may help in identifying priorities for the development of cardiovascular disease prevention programs for specific ethnic groups.
among different groups living within the same social macro-

environment allows true ethnic differences in cardiovascular

risk profiles to be identified.

In this study, we compared the prevalence of eight cardio-

vascular risk factors and the prevalence of heart disease and

stroke in a population-based sample of white, South Asian,

Chinese and black people living in Ontario. We also exam-

ined prevalence estimates by age and sex to identify the sub-

groups at highest risk for specific cardiovascular risk factors

and diseases.

Methods

Data sources and study population

We used data gathered from the Ontario participants in Sta-

tistics Canada’s cross-sectional National Population Health

Survey (1996) and Canadian Community Health Survey,

cycles 1.1 (2001), 2.1 (2003), 3.1 (2005) and 4.1 (2007). The

cross-sectional National Population Health Survey was

replaced by the Canadian Community Health Survey in

2001; the survey methods, however, remained largely con-

sistent. Details about the methodology of these two surveys

are described elsewhere. Briefly, they used a consistent mul-

tistage stratified cluster sampling strategy to collect self-

reported socio-demographic and health-related information

from a representative sample of persons living in private
dwellings. The individual response rates for these govern-

ment-funded surveys ranged from 75.1% to 94.4%. The sur-

veys were conducted by highly skilled interviewers in over

25 languages.

In this study, we analyzed data for people living in Ontario

who were 12 years of age or older and who identified them-

selves, when asked to which “racial or cultural” group they

belonged, as white, South Asian (i.e., of Indian, Pakistani,

Bangladeshi or Sri Lankan origin), Chinese (i.e., mainly from

China and Hong Kong) or black (i.e., of African or Caribbean
descent). We combined data from the five survey cycles and

included survey questions that were consistent across cycles

over the survey period from 1996 to 2007.

Study variables

Socio-demographic characteristics were age, sex, marital sta-

tus, highest level of education attained in the household and by

the individual, household and individual income in Canadian

dollars, and urban versus rural dwelling. Using annual house-

hold income and household size, we estimated income ade-

quacy (i.e., lowest, lower-middle, upper-middle and highest

income) as a four-level measure of socio-economic status, as
defined by Statistics Canada.

We analyzed a total of eight cardiovascular risk factors: four

major risk factors (current smoking, obesity, diabetes and hy-

derension) and four other risk factors (psychosocial stress,
inadequate consumption of fruits and vegetables, inadequa-
te physical activity and nonregular alcohol consumption). We also examined two cardiovascular condi-
tions: heart disease (which included angina, myocardial

infarction and congestive heart failure) and stroke. Dia-

betes, hypertension, heart disease and stroke were self-

reported physician-diagnosed conditions. Obesity was
defined as body mass index (calculated from self-reported

weight and height) of at least 30. Psychosocial stress was
defined as the individual’s self assessment of stress on most
days: “extremely” or “quite a bit” v. “not at all,” “not very”
or “a bit.” Inadequate intake of fruits and vegetables was
defined as eating fruits or vegetables less than three times a

day and inadequate physical activity was defined as partici-

pating in no more than 15 minutes of leisure time physical

activity per day (e.g., walking for exercise, jogging, swim-

ming, bicycling). Nonregular alcohol consumption was
defined as fewer than three drinks per week. We calculated

the percentage of the population with two or more of the

four major cardiovascular risk factors and used this com-

posite measure to rank the risk factor profiles of the ethnic

groups from most to least favourable.

Statistical analyses

We calculated the age- and sex-standardized prevalence of

socio-demographic characteristics, cardiovascular risk factors

and cardiovascular diseases for each of the four ethnic groups

using the direct standardization method with five-year age

bands and the 2001 Ontario census as the standard popula-
tion. Each ethnic-specific prevalence estimate was compared

with that for the overall study population and that for the

white group. Relative differences and ratios were calculated

using exact statistics, rather than the rounded values that are

reported in the tables. To examine whether ethnic differences

in cardiovascular risk varied by age and sex, we stratified par-

ticipants by sex and categorized them according to the follow-

ing age groups: 12–19, 20–44, 45–64 and ≥65 years.

For all analyses, we weighted the data using Statistics

Canada’s sample weights to account for the complex survey

sampling design and to allow for study results to be represen-
tative of the overall population of Ontario between 1996 and

2007. We used bootstrap methods to test statistical signifi-
cance. The p value was derived using the appropriate z test.

All tests were two-sided, and p < 0.05 was considered statis-
tically significant. Additional details on the bootstrap methods
are reported in Appendix 1 (available online at www.cmaj.ca/
/cgi/content/full/cmaj.091676/DC1).

Ethics committee approval

The analysis, for the purposes of this study, of the Ontario
data from the national surveys was approved by the Research

Ethics Board at Sunnybrook Health Sciences Centre. Statis-
tics Canada obtained informed consent from all survey par-

ticipants at the time of the original surveys.

Results

Study population

We analyzed data for a total of 163 797 survey participants:

154 653 of white background, 3364 of South Asian back-

ground, 3038 of Chinese background and 2742 of black back-

ground) over the five population-based survey cycles. The
distribution of the four ethnic groups in the weighted survey
population was representative of the 2001 Ontario census.
Socio-demographic characteristics
The mean age of the study population was 42.3 years, and 49.1% of the participants were male (Table 1). We standardized the survey data by age and sex across ethnic groups so that differences in responses would reflect ethnic differences, rather than differences in the age and sex distribution of the respondents. In general, South Asian and Chinese respondents were most likely to report having a college or university degree, and white respondents had the most favourable income adequacy.

Cardiovascular risk factors, heart disease and stroke
We found large differences among the ethnic groups in the prevalence of major cardiovascular risk factors: for smoking, South Asian 8.6%, Chinese 8.7%, black 11.4% and white 24.8%; for obesity, Chinese 2.5%, South Asian 8.1%, black 14.1% and white 14.8%; for diabetes, white 4.2%, Chinese 4.3%, South Asian 8.1% and black 8.5%; and for hypertension, white 13.7%, Chinese 15.1%, South Asian 17.0% and black 19.8%) (Table 2). Age- and sex-standardized mean body mass index was lowest among the Chinese respondents.

Table 1: Age- and sex-standardized prevalence of socio-demographic characteristics, by ethnic group, Ontario, Canada, 1996–2007 (n = 163 797)*

| Characteristic                      | Overall n = 163 797 | White n = 154 653 | South Asian n = 3364 | Chinese n = 3038 | Black n = 2742 |
|------------------------------------|---------------------|-------------------|----------------------|------------------|----------------|
| Age, yr, mean                      | 42.3                | 42.3              | 42.2                 | 42.3             | 42.3           |
| Sex, male                          | 49.1                | 49.1              | 49.1                 | 49.1             | 49.1           |
| Marital status                     |                     |                   |                      |                  |                |
| Divorced                           | 3.9                 | 4.0               | 1.9                  | 1.7              | 6.1            |
| Separated                          | 2.4                 | 2.4               | 1.4                  | 0.6              | 4.9            |
| Widowed                            | 5.3                 | 5.2               | 6.8                  | 5.1              | 5.2            |
| Single, never married              | 30.2                | 30.0              | 25.8                 | 32.0             | 39.1           |
| Common-law                         | 5.3                 | 5.9               | 0.7                  | 0.9              | 4.5            |
| Married                            | 53.0                | 52.5              | 63.3                 | 59.6             | 40.2           |
| Highest level of education in household |                   |                   |                      |                  |                |
| Less than high school graduation   | 7.5                 | 7.7               | 5.1                  | 4.9              | 7.6            |
| High school graduation             | 12.7                | 12.9              | 10.0                 | 11.5             | 11.3           |
| Some postsecondary                 | 6.0                 | 6.0               | 6.1                  | 4.4              | 8.2            |
| College or university degree       | 73.8                | 73.4              | 78.8                 | 79.2             | 73.0           |
| Annual household income, $         | 76 564              | 78 930            | 63 886               | 66 954           | 54 428         |
| Household size, mean, no. of people| 3.2                 | 3.1               | 4.2                  | 3.6              | 3.3            |
| Income adequacy group‡             |                     |                   |                      |                  |                |
| 1 (lowest)                         | 7.9                 | 7.1               | 11.9                 | 11.0             | 16.5           |
| 2 (lower-mid)                      | 18.8                | 17.7              | 28.5                 | 22.1             | 27.7           |
| 3 (mid-higher)                     | 34.2                | 34.3              | 33.1                 | 32.9             | 33.9           |
| 4 (highest)                        | 39.1                | 40.9              | 26.5                 | 33.9             | 21.9           |
| Living in urban area               | 70.9                | 68.8              | 86.3                 | 86.6             | 82.2           |

*Data were derived from the Ontario components of Statistics Canada’s National Population Health Survey and Canadian Community Health Surveys. Estimates were age- and sex-standardized to the 2001 Ontario Census population using five-year age categories and were weighted by the survey sample weight.

†Bootstrap methods were used to derive p values for comparisons of estimates for specific ethnic groups with estimates for the entire study population.

‡Using annual household income and household size, income adequacy was estimated as a four-level measure of socio-economic status as defined by Statistics Canada.
| Risk factor               | Prevalence, % | p† | Prevalence, % | p† | Prevalence, % | p† | Prevalence, % | p† |
|--------------------------|---------------|----|---------------|----|---------------|----|---------------|----|
| Overall n = 163,797      |               |    |               |    |               |    |               |    |
| Male                     | 74,978        |    | 70,555        |    | 1,741         |    | 1,468         |    |
| Female                   | 88,819        |    | 84,098        |    | 1,623         |    | 1,570         |    |
| South Asian n = 3,364    |               |    |               |    |               |    |               |    |
| Male                     | 25.2          | 1.00 | 13.8          | < 0.001 | 14.4          | < 0.001 | 15.4          | < 0.001 |
| Female                   | 20.3          | 1.00 | 3.6           | < 0.001 | 3.3           | < 0.001 | 7.6           | < 0.001 |
| Chinese n = 3,038        |               |    |               |    |               |    |               |    |
| Male                     | 20.3          | 1.00 | 3.6           | < 0.001 | 3.3           | < 0.001 | 7.6           | < 0.001 |
| Female                   | 20.3          | 1.00 | 3.6           | < 0.001 | 3.3           | < 0.001 | 7.6           | < 0.001 |
| Black n = 2,742          |               |    |               |    |               |    |               |    |
| Male                     | 12.1          | 1.00 | 2.6           | < 0.001 | 2.6           | < 0.001 | 16.8          | 0.008 |
| Female                   | 12.1          | 1.00 | 2.6           | < 0.001 | 2.6           | < 0.001 | 16.8          | 0.008 |

*Data were derived from the Ontario components of Statistics Canada’s National Population Health Survey and Canadian Community Health Surveys. Estimates were age- and sex-standardized to the 2001 Ontario Census population using five-year age categories and were weighted by the survey sample weight.
†Bootstrap methods were used to derive p values comparing ethnic-specific estimates with overall estimates.
‡Obesity, body mass index ≥ 30; inadequate fruit and vegetable intake, < three times per day; inadequate physical activity, ≤ 15 min/day; nonregular alcohol consumption, < three drinks per week.
§Percent with two or more major risk factors.
**1 = most favourable, 4 = least favourable.
(22.3), followed by the South Asian (24.2), white (25.3) and black (25.5) populations. In general, smoking, obesity and psychosocial stress were significantly more common among those of white ethnicity, whereas diabetes and hypertension were significantly more common among those of black or South Asian ethnicities. Black women were more likely to be physically inactive and obese than the overall population, and South Asian and Chinese women were also less likely to participate in daily physical activity than the overall population. Relative to the white respondents, people with black ethnicity had a 2-fold higher prevalence of diabetes (\( p < 0.001 \)) and a 44% higher prevalence of hypertension (\( p < 0.001 \)). Similarly, South Asian people were more likely than white people to have diabetes (prevalence ratio 1.91, \( p < 0.001 \)) or hypertension (prevalence ratio 1.24, \( p < 0.001 \)) (Table 2).

Overall, Chinese respondents had the most favourable cardiovascular risk factor profile, with 4.3% of the population reporting two or more major cardiovascular risk factors, followed by the South Asian (7.9%), white (10.1%) and black (11.1%) respondents (Table 2). The prevalence of heart disease ranged from a low of South Asian respondents. The Chinese population had the highest overall prevalence of heart disease or stroke (3.2% among Chinese respondents to a high of 5.2% among South Asian respondents. The prevalence of stroke ranged from a low of 0.6% among Chinese respondents to a high of 1.7% among South Asian respondents. The Chinese population had the lowest overall prevalence of heart disease or stroke (3.8%) as compared with the black (4.4%), white (5.7%) and South Asian (6.6%) populations (Table 3). Despite having the least favourable overall cardiovascular risk profile, the black population had a relatively low prevalence of heart disease (3.4%) (Table 3, Figure 1, at the end of this article).

### Risk factor and disease profiles by age and sex

White males were the most likely to smoke and to be obese, irrespective of age (see Figure 2, at the end of this article). The prevalence of smoking was also much higher among white females than their counterparts in other ethnic groups (e.g., 25.5% for white women v. 4.2% for Chinese women aged 20 to 44 years). We observed a higher prevalence of diabetes at younger ages among South Asian men and women and among black women than among their white and Chinese counterparts. The data also suggest that stroke may occur at an earlier age, on average, among black males and South Asian females (Figure 3, at the end of this article).

### Interpretation

In this large population-based study in Ontario, we found striking differences across ethnic groups in the prevalence of cardiovascular risk factors and diseases. The white population had a disproportionately higher prevalence of smoking and obesity, whereas the South Asian and black populations had disproportionately higher prevalences of diabetes and hypertension. People of Chinese origin had significantly lower levels of most cardiovascular risk factors, heart disease and stroke, whereas those of South Asian origin had intermediate levels of risk factors and the highest prevalence of heart disease and stroke. A paradox was observed in the black population, whereby high levels of cardiovascular risk factors were accompanied by a relatively low prevalence of heart disease. A key finding from this study was that the white, South Asian, Chinese and black populations in Ontario had distinct

| Table 3: Age- and sex-standardized prevalence of heart disease or stroke or both, by ethnic group, Ontario, Canada, 1996–2007 \((n = 163 797)^*\) |
|-----------------|---|---|---|---|---|
| **Outcome**     | **Overall** | **White** | **South Asian** | **Chinese** | **Black** |
|                 | \( n = 163 797 \) | \( n = 154 653 \) | \( n = 3364 \) | \( n = 3038 \) | \( n = 2742 \) |
| **Sex, no.**    |               |               |               |               |               |
| Male            | 74 978        | 70 555        | 1741          | 1468          | 1214         |
| Female          | 88 819        | 84 098        | 1623          | 1570          | 1528         |
| **Heart disease** |               |               |               |               |               |
| All             | 5.0           | 5.1           | 0.36          | 5.2           | 0.82         |
| Male            | 5.4           | 5.4           | 1.00          | 5.2           | 0.81         |
| Female          | 4.7           | 4.7           | 1.00          | 5.2           | 0.66         |
| **Stroke**      |               |               |               |               |               |
| All             | 1.1           | 1.1           | 0.94          | 1.7           | 0.28         |
| Male            | 1.1           | 1.1           | 1.00          | 1.1           | 0.97         |
| Female          | 1.2           | 1.2           | 1.00          | 2.2           | 0.25         |
| **Heart disease or stroke** |               |               |               |               |               |
| All             | 5.7           | 5.7           | 0.54          | 6.6           | 0.22         |
| Male            | 6.0           | 6.0           | 1.00          | 6.0           | 0.98         |
| Female          | 5.4           | 5.4           | 1.00          | 7.1           | 0.15         |

*Data were derived from the Ontario components of Statistics Canada’s National Population Health Survey and Canadian Community Health Surveys. Estimates were age- and sex-standardized to the 2001 Ontario Census population using five-year age categories and were weighted by the survey sample weight.†Bootstrap methods were used to derive \( p \) values for comparisons of ethnic-specific estimates with overall estimates.
cardiovascular risk profiles, which suggests the need for the development of ethnic-specific cardiovascular risk prevention programs and health services in Canada.

The overall prevalence of heart disease and stroke was highest among South Asian respondents and lowest among Chinese respondents. This is consistent with results from the Study of Health Assessment and Risk in Ethnic groups living in three Ontario cities, which found a disproportionately higher prevalence of cardiovascular disease among South Asian participants (10.7%) than among Chinese participants (2.4%). Our study findings are also consistent with a previous study of 1.2 million deaths in Canada, which showed that the rates of cardiovascular-related mortality were highest in the South Asian population, followed by the European and Chinese populations. The high risk of heart disease that we observed for the South Asian respondents might be explained in part by their relatively high susceptibility to insulin resistance and the metabolic syndrome, which is characterized by central obesity, glucose intolerance, a poor lipid profile and diabetes. In our study, South Asian respondents were 1.91 times more likely to have diabetes than white respondents, a result similar to that reported in a previous investigation of biochemically measured diabetes.

A noteworthy observation in our study was the much lower levels of smoking observed among Chinese (8.7%) and South Asian (8.6%) respondents living in Ontario relative to rates documented in China (28.9%) and India (15.6%). These findings might be attributable in part to a “healthy immigrant” effect and/or Canada’s tougher antismoking policies. In Ontario, physical inactivity was most prevalent among Chinese and South Asian respondents. Although people of these ethnic backgrounds have a lower average body mass index than white people, there is growing evidence that they also tend to have a higher percentage of body fat and a greater risk of cardiovascular events at a lower body mass index. As such, regular exercise and maintenance of a healthy weight are important goals for South Asian and Chinese people.

Despite a higher prevalence of most traditional cardiovascular risk factors, the black population had a lower prevalence of heart disease than the overall population. This paradox might be explained, at least in part, by the lower levels of smoking and psychosocial stress reported by this group. Populations of African descent also have lower levels of plasma fibrinogen than the general population, which would decrease their risk of thrombosis and clinical events. The relatively low prevalence of heart disease among black respondents might also be a function of differential survival rates for this group relative to the other ethnic groups. For example, studies in the United States have reported that black people undergo fewer invasive cardiac procedures and tend to have poorer survival rates after myocardial infarction than white people, which could lead to a survival bias and apparent paradox of lower prevalence of heart disease if black patients die relatively soon after developing heart disease.

**Limitations**

The cross-sectional design of this study limited our ability to draw conclusions about the causal relationships between risk factors and disease. Another limitation of the study was that our analyses were based on data, including ethnicity, that were self-reported rather than measured. There is no “gold standard” for defining ethnicity, and self-reported ethnicity is the best measure currently available. We were also unable to analyze variables that were not routinely collected in the surveys (e.g., information about lipids, waist-to-hip ratio and family history of cardiovascular diseases). Nevertheless, these limitations were counterbalanced by the much larger sample size that was possible in this study as compared with most previous studies involving direct physical measurements. Furthermore, the findings presented here are congruent with those based on direct measurements and are generally consistent with those of earlier comparisons of two or three ethnic groups. We recognize that diversity also exists within each of the four ethnic groups and that the ethnic differences presented in this study are the results of complex interactions between and among genetics, lifestyle, socio-economic status, provision of health care and reporting. Further examination of these interactions is necessary.

**Conclusion**

Despite universal access to health care, ethnic groups living in Ontario differed markedly in their cardiovascular risk profiles. Awareness of these differences will become increasingly important as ethnic minority groups come to represent a larger proportion of the Canadian population. Although Canada is one of the most ethnically diverse countries in the world, relatively little research has been done on ethnic differences in cardiovascular health, and most cardiovascular prevention programs and policies are targeted to the general population and have been based on studies typically involving the white population. Our findings suggest that there may be a need to develop ethnically tailored strategies for preventing cardiovascular risk factors in Canada. Developing strategies for preventing diabetes and hypertension that are targeted specifically to high-risk South Asian and black populations, designing obesity-prevention programs for black women and for white people, and promoting physical activity among South Asian and Chinese people and black women are some examples of approaches that might help to reduce ethnic disparities in cardiovascular risk factors and the burden of cardiovascular disease.

This article has been peer reviewed.

**Competing interests:** None declared.

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See following pages for Figures 1–3.
Figure 1: Relation between the percentage of the population with two or more major cardiovascular risk factors and the prevalence of heart disease, stroke, and heart disease or stroke, by ethnic group, Ontario, Canada, 1996–2007. Major cardiovascular risk factors were current smoking, obesity, diabetes mellitus and hypertension. All estimates were age- and sex-standardized to the 2001 Ontario Census using five-year age categories and were weighted by the survey sample weight. Data were derived from the Ontario components of Statistics Canada’s National Population Health Survey and Canadian Community Health Surveys.
Figure 2: Age- and sex-specific prevalence of major cardiovascular risk factors, by ethnic group, Ontario, Canada, 1996–2007. Estimates were age-standardized to the 2001 Ontario Census population using five-year age categories and were weighted by the survey sample weight. Data were derived from the Ontario components of Statistics Canada’s National Population Health Survey and Canadian Community Health Surveys.
Figure 3: Age- and sex-specific prevalence of heart disease and stroke, by ethnic group, Ontario, Canada, 1996–2007. Estimates were age-standardized to the 2001 Ontario Census population using five-year age categories and were weighted by the survey sample weight. Data were derived from the Ontario components of Statistics Canada’s National Population Health Survey and Canadian Community Health Surveys.