Trends in Cardiovascular Risk Factors in Canada: Variation by Migration, Temporal, and Socioeconomic Factors, 2000-2018

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**Abstract**

**Background:** This study provides an update of the prevalence of cardiovascular disease (CVD) risk factors in the Canadian population, with an examination of patterns across migration status, socioeconomic factors, and time.

**Methods:** The Canadian Community Health Surveys (CCHS) from 2000 to 2018 (1,065,391 respondents) were used to estimate the national trends in health conditions (hypertension, diabetes, high blood cholesterol, and obesity) and health behaviours (smoking, activity levels, and alcohol consumption). The trends were then compared across immigration status.

**Results:** During the study period, the prevalence of self-reported diabetes, hypertension, and obesity increased for all population groups in Canada. Conversely, with the exception of non-white long-term immigrants, the prevalence of self-reported heart disease decreased (20% mean relative decrease). Having two or more risk factors increased across all population groups. With respect to health behaviour, current smoking decreased across all groups, especially in non-white populations. Heavy drinking was most prevalent for white Canada-born populations and the lowest for non-white immigrants. Physical inactivity was most prevalent for immigrant populations, especially with established non-white immigrants.

**Conclusions:** Overall, there was a mixed pattern of risk factor change in Canada. Established immigrants in Canada (10 or more years since immigrating to Canada) had a higher prevalence of CVD risk factors compared to their native-born counterparts.

**Keywords:** cardiovascular disease, chronic disease, risk factors, Canada, migration, health

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**What is already known on this subject?**

* Management of major risk factors such as hypertension, diabetes, smoking, and obesity can reduce cardiovascular incidence and mortality.
* The current analysis of distributions of cardiovascular risk factors examined a subset of risk factors and has not accounted for equity factors such as ethnicity and immigration status.

**What does this study add?**

* This study provides an update to cardiovascular risk factor trends in Canada within context of immigrant health over a 18 year period (2000-2018).This study also examines additional risk factors such as physical activity levels, alcohol consumption, and high blood cholesterol.
* Established and non-white immigrants report a higher prevalence of cardiovascular risk factors compared to non-immigrant Canadians.
* Monitoring the trends and disparities of cardiovascular risk factors with the respect to immigrant status can support effective strategies in reducing cardiovascular disease.

## Background

Currently, immigrants make up more than 20% of Canada’s population, and the proportion continues to increase. Health status, referring to the health-related quality of life (HRQoL) and use of formal and informal health services, differs across different immigrant groups. Certain groups experience a higher risk of chronic diseases such as cancer, diabetes, and heart disease, which has clinical implications for preventative care and provision of health services to migrant groups in Canada(1).

Cardiovascular disease (CVD) is the second leading cause of death in Canada. With the advancements in heart disease interventions and prevention seen over the past few decades, sustained efforts are required to further decrease the prevalence of health disease risk factors(2). Unhealthy behaviours are associated with increased disease risk, and lower HRQoL and overall well being. Behaviours such as smoking, alcohol use, stress, physical activity, and diet are modifiable predictors of numerous health outcomes including type 2 diabetes, CVD, and cancer[(3)](4). These health behaviours are modifiable through a wide range of individual and population interventions(5).

Previous studies have described CVD risk factors and their association with socioeconomic status over two time periods: 1994-2005[(6)](7) and 2005-2016(8). From a population perspective, smoking, followed by high blood pressure, physical inactivity, obesity, diabetes, and poor diet are the most influential risk factors for CVD(5). Less is known about the association between migration factors and major CVD risk factors. Research often considers immigrants as a homogeneous group and overlooks important ethnic differences(9). With the growing diversity in Canada, a greater understanding of health status and risk factors prevalent in different groups within the population is important to guide contextually appropriate health interventions. In recognizing the prevalence of risk factors across sex, age, immigrant groups, and broad geographical regions, health professionals and program planners can focus their efforts on specific at-risk groups of the population(7).

In this study, national trends in heart disease and a wide range of risk factors related to CVD were examined among the Canadian population aged 12 years or older using the Canadian Community Health Survey (CCHS) from 2001 to 2018. It is of interest to know how risk factors such as hypertension, diabetes, smoking, activity levels, alcohol consumption, high blood cholesterol, and obesity can influence CVD prevalence in different regions in Canada, as well as to see how the prevalence of each factor has changed over time across migrant groups.

## Data and methods

### Study data

The Canadian Community Health Survey (CCHS) is a cross-sectional survey that collects information related to health status, health determinants, and socio-demographic characteristics for the Canadian household population aged 12 years and up. The survey covers the ten provinces and the three territories, excluding persons living on First Nations reserves and settlements, full-time members of the Canadian Forces, and institutionalized persons. Data collection was conducted over the phone or in-person, and the data was collected directly from the respondents using computer-assisted personal and telephone interview software. The interview can be conducted in English or French. Each Statistics Canada Regional Office recruited interviewers with a variety of language competencies to remove language barriers. Detailed information about the CCHS is available online(10).

In this study, data from the Public Use Microdata Files (PUMF) from Statistics Canada’s 2001-2018 CCHS were used to analyze the risk factors of interest. The year for the earliest PUMF was defined as 2001, and subsequent PUMFs were defined for every two-year interval using the 24-month files. For example, the 2017/2018 cycle has the cycle year of 2017. The population age was from 12 years and older. Respondents that did not indicate Canadian or immigrant status in the survey were excluded from the analysis (n = 62,371). The final sample consisted of 1,065,391 respondents across all cycles and was weighted to represent 241 million Canadians (Table 2). The overall response rate across all cycles is greater than 75%. The respondents were stratified by sex and age groups (12-34, 35-49, 50-64, 65-74, and ≥ 75 years), following the age groups of the previous analyses(6). The participants were based on time spent in Canada, country of birth, immigrant status, and ethnicity. Six immigration groups were generated: white Canada-born, white recent immigrant, white established immigrant, non-white Canada-born, non-white recent immigrant, and non-white established immigrant. Recent immigrants refer to immigrants who have resided in Canada for up to 9 years, whereas established immigrants refer to those in Canada for 10 years or more.

### Data cleaning and preparation

When combining information from various cycles, the variable names can differ between cycles. To minimize the time required to match the variables with each cycle, the *cchsflow* R package was used to clean and prepare data across CCHS survey data between 2000 to 2018. To combine the cycles from 2001 to 2018, *cchsflow* harmonized the variables such that the same variable type was renamed as a common variable name(11). *cchsflow* also accounts for variable changes from the survey redesign in 2015. In addition to the CCHS variables, there were also derived variables from *cchsflow*, such as binge drinking that was not available in the original CCHS PUMF. The derived variables combined numerous CCHS variables related to the health behaviour of interest to quantify a health behaviour over time.

### Variables of interest

The current analysis focused on cardiovascular disease and seven risk factors, derived from the CCHS. The health behaviours are characterized in Table 1. Heart disease and related risk factors are based on self-report (6).

**Table 1**: Risk factor definitions with categories are marked with (\*).

Patients with hypertension were those who have received a diagnosis for this condition from a physician, irrespective of antihypertensive treatment. Respondents with diabetes were defined as patients who have received a diagnosis of diabetes from a physician, regardless of whether they are receiving treatment with insulin or oral hypoglycemic medications. Respondents who had diabetes during pregnancy were defined as not having diabetes. Body mass index (BMI) was derived from the respondent’s self-reported height divided by the square of their self-reported height. Obesity was defined as BMI greater than equal to 30(12). Smoking was based on the respondent’s past year smoking status (current, former, and never).

Physical inactivity, alcohol consumption, and high blood cholesterol were also included as CVD risk factors. The activity level of respondents was derived from an aggregate list of self-reported leisure-time physical activities related to frequency and duration of activity(13). measured using the metabolic equivalents in testing (METs). MET describes exercise intensity and estimates the energy cost from physical activities(14). Respondent’s average daily energy expenditure during leisure-time physical activity was calculated using the frequency and duration of the physical activity and the MET value of the activity. Participants with less than 1.5 MET-hours/day were categorized as physically inactive. The categorization of alcohol consumption was based on a previous study and combined heavy drinker and binge drinker as one risk category(15). High blood cholesterol, defined as having received a physician diagnosis for high blood cholesterol/lipids irrespective of cholesterol-lowering medication, was introduced in the 2015-2016 CCHS cycle. Trend analysis for this risk factor only included two CCHS cycles (2015-2016 and 2017-2018).

### Regional variations

The prevalence of each risk factor was determined across all provinces and territories in Canada.

### Statistical analysis

The prevalence and trends of each risk factor were analyzed from 2000 to 2018, adjusting for survey sampling weights, and evaluated using linear regression analysis. Using the pooled approach, sampling weights from the combined PUMFs are bootstrapped to assess the variance of estimates. All analysis was conducted using R and can be found on GitHub. The prevalence of the risk factors was directly standardized for age and sex, using the 2011 Canadian Census population. The time trends in risk factors were stratified by migrant group categories. The relative change from 2000 to 2018 for each risk factor were determined by calculating the percent change in the last year of the study period and the baseline prevalence in 2001. Regression beta coefficients with p-values less than 0.05 were considered statistically significant.

## Results

### Study data

The distribution of the study sample by sex from all cycles is described in Table 2. In 2001, the largest age group was 12-34 years old (35%) with 49% males. In 2017, the largest age group was also 12-34 years old (37%) with 51% males. The largest group was white Canada born (72%), followed by non-white immigrants (10+ years in Canada) with 8.4%, white immigrants (10+ years in Canada) with 7.8%, non-white Canada-born with 6%, non-white immigrants (0-9 years in Canada) with 4.8%, and white immigrants (0-9 years in Canada with 1.3%. Approximately 70% of the study sample has at least one of the following risk factors.

**Table 2**: Baseline characteristics of unweighted and weighted total CCHS population from 2000 to 2018, stratified by sex.

### Heart disease

In 2017, 1.31 million of the study population has heart disease (57.3% male and 42.7% female). That stated, the prevalence of heart disease has decreased over the 2000-2018 time period. In 2001, the age-sex standardized prevalence for females and males was 4.95% and 5.67%, respectively. In 2017, the national prevalence for heart disease in females was 4.16%, and males with 5.62%, indicating a relative decrease by 0.87% for females and 15.95% for males. The decrease in heart disease rates was also apparent in immigrant groups except for non-white immigrants (10+ years in Canada) with a 20% increase (Figure 1). Compared to 2001, the prevalence of heart disease in 2017 decreased by 35% in non-white Canada-born, 1% in white Canada-born, 22% in non-white immigrants (0-9 years in Canada), 42% in white immigrants (0-9 years in Canada), and 12% in white immigrants (10+ years in Canada).

**Figure 1**: Age- and sex-adjusted trends in heart disease from 2000 to 2018, stratified by migrant groups.

### Trends in Risk Factors

National risk factor trends by sex and age group are presented in Table 3. Obesity, diabetes, and hypertension increased in prevalence, while the prevalence of smoking and physical inactivity decreased among males and females. The prevalence of hypertension in males over age 12 years increased, whereas females at certain age groups decreased prevalence (Table 4). In 2017, physical inactivity had the highest prevalence, followed by hypertension, obesity, current smoker, high blood cholesterol, diabetes, and heavy drinking. Physical inactivity increased among populations aged 65+. Smoking prevalence significantly decreased in all age groups except for ages 35-64.

**Table 3**: Age- and sex-adjusted prevalence of risk factors for survey respondents aged 12 years and older, from 2000 to 2018.

**Table 4**: Prevalence of risk factors, by age categories, from 2000 to 2018.

### Trends in risk factors by migrant group

Both white and non-white immigrants (10+ years in Canada) had a higher prevalence of CVD risk factors than Canada-born populations, however, their time trends are similar to white Canada-born populations (Figure 2). This is true for hypertension, diabetes, high blood cholesterol, and physical inactivity. The prevalence of heavy drinking was lowest among non-white immigrants and highest among white Canada-born respondents. Current smokers were decreasing across all groups with the most drastic decrease in 2015 where non-white populations had the lowest prevalence. The prevalence of physical inactivity was higher in immigrants than Canada-born populations, especially with non-white immigrants with prevalence greater than 50%. Hypertension, obesity, and diabetes continued to grow in all population groups. Obesity was greatest with white Canada-born and white immigrants (10+ years in Canada), and in 2017, the lowest prevalence is observed with immigrants (0-9 years in Canada). Across all risk factors, white Canada-born populations had a higher prevalence compared to non-white Canada-born populations. Having two or more risk factors increased in all population groups.

**Figure 2**: Age- and sex-adjusted prevalence of hypertension, diabetes, obesity, physical inactivity, current smokers, heavy drinkers, and high blood cholesterol from 2000 to 2018, stratified by migrant groups.

### Regional trends

Diabetes doubled in prevalence in all provinces and territories (Table 5). Diabetes was most prevalent in New Brunswick with a 103% increase (p < 0.01). Although Yukon, Northwestern Territories (NWT), and Nunavut had the lowest prevalence in diabetes and hypertension, they also had the greatest increase in prevalence for diabetes by 165% (p = 0.44) from 2000 to 2018, and hypertension with 77% (p = 0.02). Hypertension was most prevalent in New Brunswick, Newfoundland and Labrador, and Nova Scotia, with the greatest increase in New Brunswick (62%, p < 0.01). Obesity is most prevalent in Newfoundland and Labrador, New Brunswick, and Yukon/NWT/Nunavut. The greatest increase in obesity prevalence occurred in Quebec (53%, p = 0.1). Physical inactivity has decreased in all provinces and territories from 2000 to 2018. Current smokers were the most prevalent in Yukon/NWT/Nunavut in 2001 with the greatest difference of -59%. From 2001 to 2015, heavy drinking was least prevalent in Prince Edward Island but has the greatest difference of 59% (p = 0.03). The percent difference in the prevalence of heavy alcohol consumption is calculated from 2001 to 2015. The missing prevalence across certain cycles is attributed to the skip patterns for certain provinces and territories. High blood cholesterol was prevalent in Newfoundland and Labrador (20%), New Brunswick (15%), Nova Scotia (15%), and Ontario (13%) for the 2017-2018 cycle. The greatest difference from 2015-2018 was Prince Edward Island with approximately -19% (p = 0.02).

**Table 5**: Prevalence of risk factors, by provinces and territories in Canada, from 2000 to 2018.

## Interpretation

This national study of over 1 million Canadians described seven cardiovascular risk factors across an 18-year period. Canadian-born and immigrant respondents by immigrant status, duration in Canada, country of birth and ethnicity were examined. Between 2000 to 2018, there was a mixed pattern where some risk factors decreased, while other risk factors increased. Self-reported prevalence of heart disease was highest among established immigrants in Canada.

Rates of diabetes, obesity, and hypertension steadily increased over the study period. Compared to 1994-2005(6), the rate of diabetes and obesity was higher, with approximately 1.5 times increase over the study period. The increasing prevalence of hypertension, diabetes, and obesity followed increasing trend of previous decades[(7)](6)(8). Of the risk factors, high blood pressure is one of the strongest risk factors for the development of CVD(16).

The prevalence of heavy smoking, high blood cholesterol, physical inactivity, and heavy alcohol consumption decreased during the study period. Although smoking rates are decreasing across Canada[(6)](8) and globally(17), populations aged 35-64 have an increased prevalence of smoking. Among individual CVD risk factors, smoking is an independent risk factor in the working-age population. Cessation of smoking at this age group can reduce the calculated risk of CVD to the same extent as non-smokers(18). While there is some evidence to suggest that healthy consumption of alcohol may be protective against CVD, heavy alcohol consumption has been associated with increased risk of CVD and hypertension among older men(19). Increased alcohol consumption is also positively associated with higher levels of high-density lipoprotein cholesterol and higher blood pressure(20). Physical inactivity is a well-established risk factor for CVD. Physical inactivity was the most prevalent of all CVD risk factors. Previous studies have established that physical activity is associated with a 40-50% reduction of risk in CVD, independent of blood pressure and other known cardiovascular risk factors(21). Encouragingly, there was a small decline in physical inactivity, which corroborates the fitness trends found in the Canadian Health Measures Survey (CHMS) from 2007 to 2017 (22). The CHMS is a smaller national survey of Canadians that collects physical measures, including blood tests and blood pressure measurement. Physical activity in the CHMS is measured using accelerometers, as well as self-reported measures. Self-reported measures of high blood pressure and cholesterol are subject to measurement error because not all Canadians have these measures taken or know their measures when they are taken. That stated, there was general alignment between self-reported measures in the CCHS and the CHMS. A strength of the CCHS compared to the CHMS is the large sample size of the CCHS which allows examination of subgroups.

The overall decrease in heavy alcohol consumption, heavy smoking, physical activity, and high blood cholesterol comes with variations in age groups. For example, the proportion of high blood cholesterol is significantly higher in older populations. Hypertension increased more slowly in younger respondents. In general, the age specific trends that were observed in the CCHS correspond the results the same physical measures that were reported in the CHMS from 2016 to 2019(23). Although heart disease has decreased across the study period, the increasing burden of diabetes, obesity and hypertension may result in future increases in CVD. This study did not examine the effect of changing risk factors on future cardiovascular disease but these effects can be assessed in simulation models, such as the Population Health Model (POHEM)[(24)](25).

The results of this study reflected the difference in the relationships between major CVD risk factors and immigration-related characteristics. In this study, immigrants had a higher prevalence of inactivity compared to their Canadian counterparts, which corroborates with previous studies(26). This difference has been attributed to socioeconomic status, employment, and social norms towards physical activity. In addition, the cost associated with certain activities can be an additional deterrent to adopting an active lifestyle[(27)](28)(29). Specifically, non-white/visible minority immigrants have a higher prevalence of physical inactivity. A large majority of incoming migrants that identify as a visible minority are coming from countries in Asia/South Asia. As a result, this may translate to a higher prevalence of physical inactivity at a population level(30). Established migrants report higher prevalence of risk factors compared to Canada-born respondents, supporting the healthy immigrant effect.

The healthy immigrant effect describes how the recent immigrants report better health than the non-immigrant populations, but their health status declines to the same level as their Canada-born counterparts[(31)](32). Consistent with previous studies in Westernized cultures, established immigrants who have settled in the United States for 15 years or longer were more likely to report smoking, obesity, and high blood cholesterol than immigrants who resided in the United States for less than 10 years[(33)](34). The prevalence of obesity, hypertension, and smoking increased with time since immigration to the United States[(34)](35). With Ontario-landed immigrant data, longer-term residents had a significantly higher risk of diabetes compared to recent immigrants(36). Therefore, the uneven distribution of national CVD risk factors trends may have significant health implications on recent and established immigrants.

### Limitations

Despite the representative sample, the study poses some limitations. CCHS relies heavily on self-report data, resulting in the potential underestimation of risk factors and recall bias. Physical activity items only measure leisure physical activity and does not account for active transportation (such as walking and biking to work), work activity, or sedentary time. The leisure physical activity may not be sufficient in accurately portraying the complete effect of physical activity on each subgroup. In surveys, respondents tend to over-report their healthy behaviours and underreport their unhealthy behaviours. This is referred to as “social desirability bias”. For example, self-reported alcohol consumption in surveys accounts for half the volume of alcohol sold(37).

In terms of the information related to immigrants, the information related to country of origin is limited in the PUMF with only one survey question asking if their country of origin is Canada or outside of Canada. Ethnicity is dichotomously categorized into ‘white’ and ‘non-white’ in the PUMF. More detailed ethnicity is recorded in the CCHS and can be assessed with permission at Statistics Canada’s Regional Data Centres.

Health behaviours can vary by country of origin and ethnicity because of cultural norms and customs. Because of the differences in place of origin and ethnicity, health differences observed among immigrant groups may be due to a cohort effect, where established immigrants may have had worse cardiovascular risk profiles before immigrating to Canada(32). Previous studies using longitudinal data provide evidence to validate our findings(38). As a next step, it is feasible to link immigration data related to country of origin, settlement time, and ethnicity for a more robust assessment of CVD risk factors in immigrants. Further investigations into the immigrant subgroups such as protected persons, economic immigrants, and humanitarian immigrants will detail further context into the health behaviours from different circumstances. Cohort analysis by place of origin and more detailed ethnic groups can be used to identify at-risk immigrant cohorts.

### Conclusion

The current study highlights the distributions and trends of CVD risk factors among Canadians and Canada’s migrant population from 2000 to 2018. With promising trends such as decreased smoking and physical inactivity, the increasing prevalence of obesity, diabetes, and hypertension is still of concern. The varying trends are further divided by provincial and territorial differences. The substantial variations in CVD risk factors among immigrant groups may have serious implications for established cardiovascular health. This is especially evident in established immigrants in Canada. A focus on CVD risk factor management along with equitable access to health care services could prevent many cardiovascular events. The shift in migration pattern necessitates the need to consider migration and geographical factors for support and services. Such approaches can reduce the burden of CVD and their inequalities among migrant groups.

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