Cardiovascular risk health factors and disease among Canadian Immigrants

**Authors:**

**Corresponding author information:**

**Abstract:** In this study, cardiovascular risk factor trends in Canada were updated with respect to migration factors. The national trends in cardiovascular disease (CVD) risk factors, including hypertension, diabetes, smoking, activity levels, alcohol consumption, high blood cholesterol, and obesity were examined using the Canadian Community Health Surveys (CCHS) from 2001 to 2018. The prevalence of each risk factor and combinations of risk factors were examined and compared between immigrant and Canada-born populations. During the study period, heart disease decreased significantly across migrant groups except for non-white long-term immigrants (by 20%). Current smokers also decreased across all groups, especially in non-white populations. Heavy drinking was most prevalent in white Canada-born populations and the lowest being non-white immigrants. Physical inactivity was most prevalent in immigrant populations, especially with long-term non-white immigrants (by 50%). Long-term immigrants in Canada had a higher prevalence of CVD risk factors compared to their native-born counterparts. The prevalence of diabetes, hypertension, and obesity increased for all population groups and provinces in Canada, with a higher prevalence in the Maritime provinces. Having two or more risk factors continued to increase across all population groups. Future strategies should consider migration and geographical gaps when targeted at reducing cardiovascular risk factors for at-risk populations in Canada.

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

**Acknowledgments:** This project is supported by a CANHEART SPOR (www.canheart.ca) summer studentship funded through a Canadian Institutes of Health Research (CIHR) Strategy for Patient Oriented Research (SPOR) Innovative Clinical Trial Multi Year Grant (MYG 151211).

**Word count:** Abstract: 204 ; Text body: 3380

**Table and figures:** 7

## Background

Currently, immigrants make up more than 20% of Canada’s population, and this metric continues to increase. Health status, referring to the quality of life and use of formal and informal health services, differ across all subgroups of immigrants. Certain sub-populations 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 populations in Canada (1).

Heart disease is the second leading cause of death in Canada. With the recent advancements in heart disease interventions and prevention in the past few decades, sustained efforts are required to further decrease the development of health disease risk factors (2). Health-related behaviours can impact both quality of life and overall wellbeing by influencing disease outcomes. Behaviours such as smoking, alcohol use, stress, physical activity, and diet are modifiable predictors of numerous health outcomes including type 2 diabetes, cardiovascular disease, and cancer (3)(4). Many risk factors related to cardiovascular disease (CVD) and stroke can be prevented by changes in daily life and in health policy. The rank of risk factors that had a significant effect on CVD stroke goes as follows: smoking, high blood pressure, hypertension, physical inactivity, obesity, diabetes, and diet (5). National trends in hypertension, diabetes, obesity, and current smoking have been analyzed, but it does not cover the full spectrum of risk factors associated with high CVD morbidity and mortality (6).

Previous studies have evaluated CVD risk factors and their association with socioeconomic status over two time periods: 1994-2005 (7)(8) and 2005-2016 (9). Less is known about migration factors affecting major CVD risk factors. Research often considers immigrants as a homogeneous group and overlooks important ethnic differences (10). 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 culturally appropriate health interventions. In recognizing the prevalence of risk factors across sex, age groups, and broad geographical regions, health professionals and program planners can focus their efforts on specific at-risk groups of the population (8).

In this study, national trends in heart disease and a wider range of risk factors related to cardiovascular disease were examined among the Canadian population aged 12 years or older using the Canadian Community Health Survey (CCHS) from 2000-2018. 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 cardiovascular disease 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

Canadian Community Health Survey (CCHS) is a cross-sectional survey that collects information related to health status, health determinants, and socio-demographic characteristics for non-institutionalized Canadian household population aged 12 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 (11).

In this study, data from the Public Use Microdata Files (PUMF) from Statistics Canada’s 2000-2018 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. 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. The 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. 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 immigrant (0-9 years since immigration), white immigrant (10+ years since immigration), non-white Canada-born, non-white immigrant (0-9 years since immigration), and non-white immigrant (10+ years since immigration).

### Data cleaning and preparation

When combining the CCHS cycles 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 2000 to 2018, *cchsflow* harmonized the variables such that the same variable type was renamed as a common variable name (12). In addition to the CCHS variables, there were also derived variables from *cchsflow*, such as leisure activity, and binge drinking that was not available in the original CCHS files. 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 heart disease and seven risk factors, derived from the CCHS. The health behaviours are characterized in Table 1. Heart disease and all risk factors are self-report but had to have been diagnosed by a physician (7).

**Table 1**: Risk factor definitions. Risk health behaviours of interest 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. BMI refers to the body mass index, in which a person’s height is divided by the square of their height squared. Obesity was defined as BMI greater than equal to 30 (13). Smoking was based on the respondent’s smoking status (current, former, and never) with current smokers being the status of interest.

In this study, physical inactivity, alcohol consumption, and high blood cholesterol were also included as CVD risk factors. The activity levels of participants were measured using the metabolic equivalents in testing (METs). The MET concept describes exercise intensity and estimates the energy cost from physical activities (14). From CCHS, METs were derived from an aggregate list of leisure-time physical activities related to frequency and duration of activity (15). Participants with less than 1.5 METs/day were considered physically inactive. The categorization of alcohol consumption was based using the seven-year study and combined heavy drinker and binge drinker as one risk category (16). Blood cholesterol was introduced in the 2015-2016 cycle, therefore its trend was only examined from 2015-2018. Patients with high blood cholesterol/lipids were defined as those who have received a diagnosis for this condition from a physician, irrespective of cholesterol-lowering medication.

### 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. All analysis was conducted using R and can be found on GitHub (17). 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. 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

Heart disease has decreased over the 2000-2018 time period. In 2001, the age-sex standardized prevalence for females and males is 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. In 2017, 1.31 million of the study population has heart disease (57.3% male and 42.7% female). The decrease in heart disease rates was also apparent in migrant 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 continue to increase in prevalence, while the prevalence of smoking and physical inactivity decrease significantly among males and females. The prevalence of hypertension in males over age 12 years has significantly increased, whereas females at certain age groups have significantly 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 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. 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 continued to increase 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 with 165.25% (p = 0.44) from 2000 to 2018, and hypertension with 77.14% (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, New Brunswick, Nova Scotia, and Ontario. The greatest difference from 2015-2018 was Prince Edward Island with -18.53% (p = 0.02).

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

## Interpretations

In this national study, several risk factors such as diabetes, hypertension, and obesity warrant increased attention. Compared to 1994-2005 (7), the rate of diabetes and obesity is much higher and the percent difference is almost 1.5 times greater. It is important to provide more effective solutions for obesity management since obesity can increase the risk of hypertension, diabetes, and CVD (9). Of the risk factors, high blood pressure is one of the strongest risk factors for the development of CVD and is largely mediated by obesity (18). Hypertension prevalence in age 12-34 continues to grow to a lesser extent. Focusing prevention efforts on age-related blood pressure increases will substantially reduce aging-related vascular consequences and existing hypertensive-related CVD.

Although smoking rates are decreasing across Canada, 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. Implementing smoking cessation programs is important for the working-age population as quitting smoking can reduce the calculated risk of CVD to the same extent as non-smokers (19). The proportion of high blood cholesterol is significantly higher in older populations, which aligns with the results in the Canadian Health Measures Survey from 2016 to 2019 (20). From 2015 to 2018, high blood cholesterol prevalence decreased but further investigations into its time trend will highlight the importance of elevated blood cholesterol changes in the Canadian population.

Physical inactivity is a well-established risk factor for CVD but has yet to be evaluated across the regions of Canada. With physical inactivity being the highest prevalence of all risk factors, it brings attention to its influences on CVD outcomes. 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). In this study, immigrants had a higher prevalence of inactivity compared to their Canadian counterparts, which is consistent with previous studies (22). This difference can be 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 (23)(24)(25). 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 (26).

While usual consumption of alcohol can be protective against CVD, heavy alcohol consumption increases the risk of CVD and hypertension among older men (27). Increased alcohol drinking is also positively associated with higher levels of high-density lipoprotein cholesterol and higher blood pressure (28), further increasing the CVD risk factor estimates. The overall decrease in alcohol consumption is promising, but further efforts are needed to attenuate alcohol consumption as increased disease risk is not restricted to heavy drinkers.

Geographically, the prevalence of risk factors vary across provinces and territories, but the patterns of change are similar to national trends. The greatest prevalence in CVD risk factors is with the Maritime provinces. Previous studies have established that Atlantic Canada has the highest prevalence of CVD risk factors and negative health outcomes compared to Canada overall (29). Across ethnic and migration factors, risk factor prevalence vary significantly. Long-term migrants report higher prevalence of risk factors compared to their Canadian counterparts, supporting the healthy immigrant effect. The healthy immigrant effect describes how the recent immigrants report better health than the non-migrant population, but their health status declines to the same level as their Canada-born counterparts (30)(31). Consistent with previous studies in Westernized cultures, long-term 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 (32)(33). The prevalence of obesity, hypertension, and smoking increased with time since immigration to the United States (33)(34). With Ontario-landed immigrant data, longer-term residents had a significantly higher risk of diabetes compared to recent immigrants (35). Therefore, the uneven distribution of national CVD risk factors trends among migrant groups draws attention to enhanced efforts for primary interventions with ethnic and migration factors in mind.

### Limitations

Despite the representative sample, the study poses some limitations. CCHS relies heavily on self-report data, resulting in the underestimation of risk factors and recall bias. Physical activity only measures leisure physical activity and does not account for active transportation (such as walking and biking to work), work activity, or sedentary time. The physical activity at hand may not be sufficient in accurately portraying the complete effect of physical activity on each subgroup. In surveys, respondents tend to over-report their health 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 (36).

In terms of the information related to immigrants, the information related to country of origin is limited 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.’ 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 because of a cohort effect, where long-term immigrants may have had worse cardiovascular risk profiles before immigrating to Canada (31). Previous studies using longitudinal data provide evidence to validate our findings (37). As a next step, it is feasible to link immigration data related to country of origin, settlement time, and ethnicity for a more detailed assessment of risk CVD 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 for public health surveillance.

### Conclusion

The current study highlights the distributions and trends of CVD risk factors among 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 long-term cardiovascular health. This is especially evident in long-term 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 in the design of targeted interventions and health promotion strategies. Such approaches can reduce the burden of CVD and their inequalities among migrant groups.

## References

1. Gushulak BD, Pottie K, Roberts JH, Torres S, DesMeules M. Migration and health in Canada: Health in the global village. Canadian Medical Association Journal. 2011 Sep;183(12):E952–8.

2. Public Health Agency of Canada. Heart Disease in Canada. https://www.canada.ca/en/public-health/services/publications/diseases-conditions/heart-disease-canada.html; 2017.

3. Mudryj AN, Riediger ND, Bombak AE. The relationships between health-related behaviours in the Canadian adult population. BMC Public Health. 2019 Oct;19(1):1359.

4. Rosella LC, Kornas K, Huang A, Grant L, Bornbaum C, Henry D. Population risk and burden of health behavioralrelated all-cause, premature, and amenable deaths in Ontario, Canada: Canadian Community Health Surveylinked mortality files. Annals of Epidemiology. 2019 Apr;32:49–57.e3.

5. Lloyd-Jones DM, Hong Y, Labarthe D, Mozaffarian D, Appel LJ, Van Horn L, et al. Defining and Setting National Goals for Cardiovascular Health Promotion and Disease Reduction. Circulation. 2010 Feb;121(4):586–613.

6. Langellier BA, Garza JR, Glik D, Prelip ML, Brookmeyer R, Roberts CK, et al. Immigration Disparities in Cardiovascular Disease Risk Factor Awareness. Journal of immigrant and minority health / Center for Minority Public Health. 2012 Dec;14(6):918–25.

7. Lee DS, Chiu M, Manuel DG, Tu K, Wang X, Austin PC, et al. Trends in risk factors for cardiovascular disease in Canada: Temporal, socio-demographic and geographic factors. Canadian Medical Association Journal. 2009 Aug;181(3-4):E55–66.

8. Tanuseputro P, Manuel DG, Leung M, Nguyen K, Johansen H, Canadian Cardiovascular Outcomes Research Team. Risk factors for cardiovascular disease in Canada. The Canadian Journal of Cardiology. 2003 Oct;19(11):1249–59.

9. Dai H, Younis A, Kong JD, Bragazzi NL, Wu J. Trends and Regional Variation in Prevalence of Cardiovascular Risk Factors and Association With Socioeconomic Status in Canada, 2005-2016. JAMA Network Open. 2021 Aug;4(8):e2121443.

10. Adjei JK, Adu PA, Ackah BBB. Revisiting the healthy immigrant effect with diabetes risk in Canada: Why race/ethnicity matters. Ethnicity & Health. 2020 May;25(4):495–507.

11. Statistics Canada. Canadian Community Health Survey - Annual Component (CCHS). https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226; 2021.

12. Yusuf W, Vyuha R, Bennett C, Sequeira Y, Maskerine C, Manuel DG. Cchsflow: An open science approach to transform and combine population health surveys. Canadian Journal of Public Health. 2021 Aug;112(4):714–21.

13. Akil L, Ahmad HA. Relationships between Obesity and Cardiovascular Diseases in Four Southern States and Colorado. Journal of Health Care for the Poor and Underserved. 2011;22(4 Suppl):61–72.

14. Jetté M, Sidney K, Blümchen G. Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. Clinical Cardiology. 1990 Aug;13(8):555–65.

15. Manuel DG, Perez R, Sanmartin C, Taljaard M, Hennessy D, Wilson K, et al. Measuring Burden of Unhealthy Behaviours Using a Multivariable Predictive Approach: Life Expectancy Lost in Canada Attributable to Smoking, Alcohol, Physical Inactivity, and Diet. PLOS Medicine. 2016 Aug;13(8):e1002082.

16. Manuel DG, Institute for Clinical Evaluative Sciences in Ontario, Public Health Ontario. Seven more years: The impact of smoking, alcohol, diet, physical activity and stress on health and life expectancy in Ontario : An ICES/PHO report. Toronto, Ont.: Institute for Clinical Evaluative Sciences : Public Health Ontario; 2012.

17. Chen K. Big-Life-Lab/CANHEART. Big Life Lab; 2022.

18. Fuchs FD, Whelton PK. High Blood Pressure and Cardiovascular Disease. Hypertension. 2020 Feb;75(2):285–92.

19. Keto J, Ventola H, Jokelainen J, Linden K, Keinänen-Kiukaanniemi S, Timonen M, et al. Cardiovascular disease risk factors in relation to smoking behaviour and history: A population-based cohort study. Open Heart. 2016 Jul;3(2):e000358.

20. Statistics Canada. Cholesterol levels of adults, 2016-2019. https://www150.statcan.gc.ca/n1/pub/82-625-x/2021001/article/00003-eng.htm; 2021.

21. Wannamethee SG, Shaper AG. Physical Activity in the Prevention of Cardiovascular Disease. Sports Medicine. 2001 Feb;31(2):101–14.

22. Bryan SN, Tremblay MS, Pérez CE, Ardern CI, Katzmarzyk PT. Physical Activity and Ethnicity. Canadian Journal of Public Health. 2006 Jul;97(4):271–6.

23. Pratt M, Macera CA, Sallis JF, O’Donnell M, Frank LD. Economic interventions to promote physical activity: Application of the SLOTH model. American Journal of Preventive Medicine. 2004 Oct;27(3):136–45.

24. Dogra S, Meisner BA, Ardern CI. Variation in mode of physical activity by ethnicity and time since immigration: A cross-sectional analysis. International Journal of Behavioral Nutrition and Physical Activity. 2010 Oct;7(1):75.

25. Dawson AJ, Sundquist J, Johansson S-E. The Influence of Ethnicity and Length of Time since Immigration on Physical Activity. Ethnicity & Health. 2005 Nov;10(4):293–309.

26. Mahmood B, Bhatti JA, Leon A, Gotay C. Leisure Time Physical Activity Levels in Immigrants by Ethnicity and Time Since Immigration to Canada: Findings from the 2011 Canadian Community Health Survey. Journal of Immigrant and Minority Health. 2019 Aug;21(4):801–10.

27. Snow WM, Murray R, Ekuma O, Tyas SL, Barnes GE. Alcohol use and cardiovascular health outcomes: A comparison across age and gender in the Winnipeg Health and Drinking Survey Cohort. Age and Ageing. 2009 Mar;38(2):206–12.

28. Larsson SC, Burgess S, Mason AM, Michaëlsson K. Alcohol Consumption and Cardiovascular Disease. Circulation: Genomic and Precision Medicine. 2020 Jun;13(3):e002814.

29. Orzel B, Keats M, Cui Y, Grandy S. Regional Comparisons of Associations Between Physical Activity Levels and Cardiovascular Disease: The Story of Atlantic Canada. CJC Open. 2021 May;3(5):631–8.

30. Ali JS, McDermott S, Gravel RG. Recent Research on Immigrant Health from Statistics Canada’s Population Surveys. Canadian Journal of Public Health. 2004 May;95(3):I9–13.

31. Pérez CE. Health status and health behaviour among immigrants. Health Reports. 2002 Jul;13:1–3.

32. Koya DL, Egede LE. Association Between Length of Residence and Cardiovascular Disease Risk Factors Among an Ethnically Diverse Group of United States Immigrants. Journal of General Internal Medicine. 2007 Jun;22(6):841–6.

33. Chiu M, Austin PC, Manuel DG, Tu JV. Cardiovascular Risk Factor Profiles of Recent Immigrants vs Long-term Residents of Ontario: A Multi-ethnic Study. Canadian Journal of Cardiology. 2012 Jan;28(1):20–6.

34. Singh GK, Siahpush M. Ethnic-Immigrant Differentials in Health Behaviors, Morbidity, and Cause-Specific Mortality in the United States: An Analysis of Two National Data Bases. Human Biology. 2002;74(1):83–109.

35. Creatore MI, Moineddin R, Booth G, Manuel DH, DesMeules M, McDermott S, et al. Age- and sex-related prevalence of diabetes mellitus among immigrants to Ontario, Canada. Canadian Medical Association Journal. 2010 May;182(8):781–9.

36. Manuel DG, Bennett C, Perez R, Wilton AS, Rohit Dass A, Laporte A, et al. Burden of health behaviours and socioeconomic position on health care expenditure in Ontario. F1000Research. 2019;8:303.

37. Ng E, Wilkins R, Gendron F, Berthelot J-M. Dynamics of Immigrants’ Health in Canada: Evidence from the National Population Health Survey. Healthy today, healthy tomorrow? Findings from the National Population Health Survey. 2005 Feb;(2):1–2.