

Original Article

Monitoring Cardiovascular Disease in Métis Citizens Across Ontario, 2012-2020

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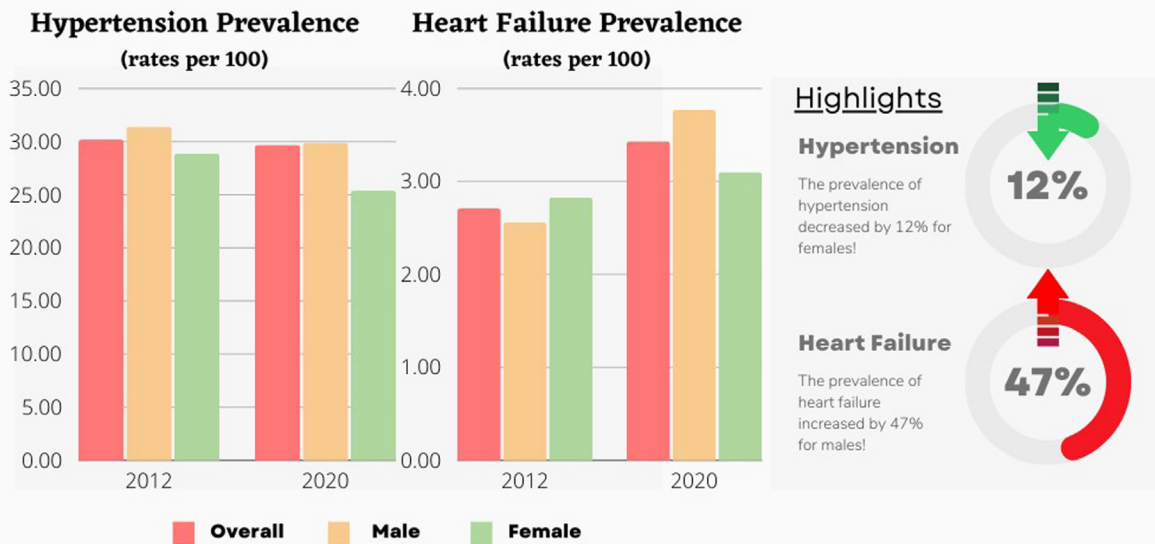
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Differences in Hypertension and Heart Failure Prevalence Over a 9-Year Period in Métis citizens of the Métis Nation of Ontario



*Prevalence rates are age-adjusted using 2020 as the standard population

ABSTRACT

Background: Population-based analyses of Métis-specific health outcomes in Canada are limited. This study aimed to address this gap and examine cardiovascular disease outcomes in citizens of the Métis Nation of Ontario (MNO) over a 9-year period.

Methods: Under a data governance and sharing agreement between the MNO and ICES, registered MNO citizens aged ≥ 20 years were linked to administrative health data in Ontario. Existing algorithms were used to determine the burden of heart failure and hypertension. In the most recent year, prevalence rates were compared for income quintiles, age, and sex.

Results: Age-adjusted prevalence rates of hypertension decreased, and age-adjusted prevalence rates of heart failure increased in MNO citizens from 2012 to 2020. A larger decrease in prevalence of hypertension was observed for female citizens, by 12% from 28.9 per 100 (confidence interval [CI]: 27.6-30.2) in 2012 to 25.4 per 100 (CI: 24.5-26.3) in 2020. As for heart failure, the age-adjusted prevalence rates for male citizens had the largest increase, by 47% from 2.6 per 100 (CI: 2.1-3.1) in 2012 to 3.8 per 100 (CI: 3.3-4.2) in 2020. Hypertension and heart failure were more prevalent in male citizens, those of advanced age, and those living in areas within the lowest income quintile.

Conclusions: This study is the first in nearly 10 years to investigate trends in cardiovascular outcomes among MNO citizens. Understanding this burden is critical to the MNO's ability to guide program and policy planning, as well as to advocate within and beyond the health system for Métis-specific needs.

RÉSUMÉ

Contexte : Les analyses basées sur la santé des citoyens métis sont limitées au Canada. Cette étude visait à combler cette lacune et à examiner les résultats des maladies cardiovasculaires chez les citoyens de la Nation métisse de l'Ontario (NMO) sur une période de 9 ans.

Méthodes : Dans le cadre d'un accord de gouvernance et de partage des données entre la NMO et ICES, les citoyens inscrits de la NMO âgés de 20 ans et plus ont été reliés aux données de santé administrative en Ontario. Des algorithmes existants ont été utilisés pour déterminer le fardeau de l'insuffisance cardiaque et de l'hypertension. Au cours de l'année la plus récente, les taux de prévalence ont été comparés pour les quintiles de revenu, ainsi que pour les sous-groupes selon l'âge et le sexe.

Résultats : Les taux de prévalence ajustés selon l'âge de l'hypertension ont diminué tandis que les taux de prévalence ajustés selon l'âge de l'insuffisance cardiaque ont augmenté chez les citoyens de la NMO de 2012 à 2020. Une plus forte diminution de la prévalence de l'hypertension a été observée chez les femmes, de 12 % passant de 28,9 pour 100 (IC : 27,6-30,2) en 2012 à 25,4 pour 100 (IC : 24,5-26,3) en 2020. En ce qui concerne l'insuffisance cardiaque, les taux de prévalence ajustés selon l'âge chez les hommes ont connu la plus forte augmentation, de 47 % passant de 2,6 pour 100 (IC : 2,1-3,1) en 2012 à 3,8 pour 100 (IC : 3,3-4,2) en 2020. L'hypertension et l'insuffisance cardiaque étaient plus prévalentes chez les hommes, les personnes âgées et celles vivant dans des zones du quintile de revenu le plus bas.

Conclusion : Il s'agit de la première étude en presque 10 ans à examiner les tendances des résultats cardiovasculaires chez les citoyens de la Nation métisse de l'Ontario. Comprendre ce fardeau est crucial pour la NMO afin de guider la planification des programmes et des politiques, ainsi que la défense des besoins spécifiques aux Métis au sein du système de santé.

In section 35 of the Constitution Act, Canada acknowledges 3 distinct Aboriginal groups: Inuit, First Nations, and Métis.¹ Health research is limited for Indigenous peoples, especially for disaggregated reporting of individual Indigenous Nations and Indigenous-led research.^{2,3} The Métis are a postcontact Indigenous Nation, born from descendants of mixed European and First Nations heritage, forming contemporary communities, historically linked to the fur trade and various resistances. In what is now Ontario, distinct Métis communities emerged along the fur trade and waterway routes. The Métis Nation of Ontario (MNO) is the sole provincial governing body for all Métis citizens living in Ontario who identify as Métis and has been verified by the MNO registry.⁴ Citizenship verification requires applicants to demonstrate sufficient documentation to support familial ties to a historic Métis community and that they not be registered with another Indigenous Nation (MNO, 2021). The colonial

legacy of data collection of Indigenous people's health information is harmful and homogenizes distinct Indigenous Nations' health outcomes.^{2,3} Therefore, this study utilized an approach that promotes Métis data sovereignty by reporting Métis-specific data using data linkage with the MNO registry, inclusion of Métis researchers as part of the research team, and acting on health needs identified by MNO leadership.³ Disaggregated or Métis-specific health outcomes communicate to Métis communities and healthcare providers in Canada a contextual understanding of population-level needs and enable self-determined actions in terms of health services, policies, and promotion.

Only a limited number of epidemiologic reports focus solely on Métis people.⁵⁻⁷ The few studies that report Métis health outcomes identified that the rate of cardiovascular disease (CVD) is disproportionately higher in Métis citizens within the MNO, the Métis Nation of British Columbia, the Métis Nation of Alberta, and the Manitoba Métis Federation, compared to the rate in the general population of each province.⁸⁻¹² In Ontario specifically, Atzema et al. linked health administrative data held at ICES (formerly the Institute for Clinical and Evaluative Sciences) with the MNO registry to form their sample.⁸ They concluded that between 2006 and 2008, heart failure, atrial fibrillation, and acute coronary syndromes were a more significant burden for Métis,

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See page 866 for disclosure information.

compared to non-Métis, Ontarians.⁸ Understanding the current risk and burden of CVD would be helpful for the MNO in guiding both program and policy planning, and discussions on Métis-specific health legislation, as well as supporting decision-making related to resource allocation. Métis-specific research is essential for the MNO to develop programs that address the health and healthcare needs of Métis citizens. This information also will inform additional research and evaluation projects related to chronic disease prevention.

The last CVD investigation for MNO citizens used data up to 2008, so to address the recent gap in years, we assessed the burden of heart failure and hypertension, between 2012 and 2020, for MNO citizens, continuing the disease surveillance work of Atzema et al.⁸ This study analyzes data with a strengths-based approach,¹³ and therefore, we did not compare the prevalence of CVD between MNO citizens and the general population of Ontario. Although comparison across cohorts (ie, non-Métis vs Métis) is common practice, characterizing the diversity and prevalence of CVD within the MNO citizen population frames the discussion differently.¹³ Given that hypertension is a significant risk factor for further comorbidities, these data can identify cohorts within the MNO for whom intervention for CVD is most needed. Additionally, the CVD data were compared with neighbourhood-level income quintiles, across age and sex, to help inform understanding of the potential differences in the prevalence of heart failure and hypertension.

Methods

Study design

This is a retrospective, population-based cohort study. Since 2009, the MNO and ICES have worked together to utilize the administrative health data accessible to ICES by linking it to Métis citizens in Ontario under a data governance and sharing agreement. ICES is an independent, nonprofit research institute funded by an annual grant from the Ontario Ministry of Health and the Ministry of Long-Term Care. As a prescribed entity under Ontario's privacy legislation, ICES is authorized to collect and use healthcare data for the purposes of health system analysis, evaluation, and decision support. Secure access to these data is governed by policies and procedures approved by the Information and Privacy Commissioner of Ontario. The MNO holds the only recognized registry of Métis citizens in Ontario. Upon registration as a citizen, MNO citizens agree to the use of their information by the MNO for research and evaluation purposes to benefit the community. Through the data governance and sharing agreement, all Métis citizens are linked to their administrative health data via their Ontario Health Insurance Plan (OHIP) number, while maintaining their individual privacy and confidentiality, to examine health outcomes and service use in Ontario. All Ontario residents (population 14.5 million) have publicly funded coverage for medically necessary services tracked using their OHIP number. The data governance and sharing agreement recognizes the MNO's ownership and control over the MNO registry data in line with Indigenous data sovereignty principles.⁴ Approval from the MNO was received for the project before the MNO registry data were accessed. The use of the data in this project is authorized

under section 45 of Ontario's Personal Health Information Protection Act and does not require review by a research ethics board.

Data sources

Registered Persons Database. The Registered Persons Database (RPDB) provides individual demographic information on residents of Ontario provided with an OHIP number by the Ministry of Health.

Hypertension-derived cohort. The Ontario Hypertension Dataset at ICES contains all Ontario patients with hypertension identified since 1991. The dataset was created using hospital-discharge abstracts from the Canadian Institute for Health Information and same-day surgery databases, the physician service claims from the OHIP database, and the demographic information of persons eligible for healthcare coverage in Ontario from the RPDB.^{14,15} Patients enter the cohort when they meet the case definition that reflects a combination of code identifiers that meet the conditions of chronic high blood pressure that have been previously validated.^{14,15} The case definition includes one hospital admission and/or same-day surgery record with a hypertension diagnosis (International Classification of Diseases, version 9 diagnosis codes 401x, 402x, 403x, 404x, and 405x; International Classification of Disease, version 10 diagnosis codes I10, I11, I12, I13, I15) or an OHIP claim with a hypertension diagnosis (diagnosis codes include 401, 402, 403, 404, and 405) followed by either an OHIP claim or a hospital admission and/or same-day surgery record with a hypertension diagnosis within 2 years. If the hypertension record is between 120 days before and 180 days after a gestational admission date, the hypertension was regarded as gestational hypertension and was excluded.^{14,15} Each recorded incidence of hypertension must have had the following, or it was excluded: 2 OHIP claims no more than 2 years apart; 1 Canadian Institute for Health Information or Discharge Abstract Database claim after 1991; and 1 OHIP claim that is followed by a Canadian Institute for Health Information or Discharge Abstract Database claim within 2 years to meet the criteria. Incident and prevalent cases of hypertension are flagged each year in the dataset.

Heart failure-derived cohort. The Congestive Heart Failure Database contains all Ontario individuals with heart failure identified since 1991. The database was created using the following: hospital discharge abstracts from the Discharge Abstract Database, same-day surgery, and Ontario Mental Health Reporting System databases; the physician service claims from the OHIP database; records from the National Ambulatory Care Reporting System database; and the information regarding the demographics of persons eligible for healthcare coverage in Ontario from the RPDB.¹⁶ Persons enter the heart failure database as incident and/or prevalent cases when they are defined as having heart failure according to the case definition. Patients were included as a case of heart failure if they had one hospital admission (either from the Discharge Abstract Database or from the Ontario Mental Health Reporting System) with heart failure as the most

responsible diagnosis or any OHIP billing claim for heart failure or National Ambulatory Care Reporting System emergency department record with heart failure as the main diagnosis, followed within 1 year by a second record with a heart failure diagnosis from any source.¹⁶ Heart failure is rare in individuals aged < 40 years.¹⁶ This was true for our study population, as fewer than 40 cases of heart failure occurred in MNO citizens aged < 40 years, over the entire study period. As a result, records from when individuals were aged < 40 years were excluded from the derived cohort.¹⁶

Postal code conversion file. The postal code conversion file (conversion file) is a digital file that provides a correspondence between the Canada Post Corporation (Ottawa, Ontario, Canada) 6-character postal code and Statistics Canada's standard geographic areas for which census data and other statistics are produced. ICES has applied the conversion file (version 7B) to Ontario postal codes to create a linkable dataset to census geographies. For this study, the variable of interest is the income quintile to approximate area-level socioeconomic status. Statistics Canada constructed the neighbourhood income quintiles available in the conversion file using census profile data available at the dissemination-area level. MNO citizens in the registry were linked to the RPDB to obtain their most recent postal code and then connected to the conversion file database to get area-level income quintile for each MNO citizen.

Outcome measures

ICES-derived cohorts, heart failure, and hypertension were used to calculate age-adjusted incidence and prevalence rates for the period 2012-2020; rates were standardized using age distribution of the 2020 cohort. Age-adjusted rates by sex and income quintiles were reported for the affected cases in the population and compared to unaffected cases. Any cell counts

≤ 5 per 100 in the population were suppressed. Age was calculated using each MNO citizen's date of birth, and then categorized for each CVD outcome. Age groups were separated into 2 groups for heart failure (age 40-64 years and ≥ 65 years) and 3 groups for hypertension (age 20-39 years, age 40-64 years, and age ≥ 65 years). The younger cohort for heart failure (age 40-65 years) did not have reportable data, so it was excluded. Sex was obtained from the RPDB and assigned as being either male or female; note that RPDB data are limited to binary sex characteristics. A neighbourhood income quintile from 1 (lowest) to 5 (highest) was determined.

Data analysis

Incidence rates are characterized as the number of new and/or incident cases divided by all eligible MNO citizens in each year. Prevalence is characterized as the cumulative number of incident cases over time, divided by all eligible MNO citizens in each year. Over the entire study period (2012-2020), bivariate analyses were used to compare MNO citizens with vs without a diagnosis of heart failure and hypertension by age, sex, and income quintile. Standardized differences¹⁷ were estimated according to Austin,¹⁸ and any statistically significant ($P \leq 0.05$) differences were recorded. All analyses were completed in SAS 9.4 (SAS Institute, Cary, NC).

Results

Of 30,622 records of MNO citizens in the registry as of November 2022, aged between 20 and 105 years, a total of 29,319 were successfully linked to the RPDB to create the cohorts for examining hypertension and heart failure (Fig. 1). Of the 29,319 citizens successfully linked, the hypertension cohort included 23,163 eligible citizens (Fig. 1A). Sex was evenly distributed in the population. In 2020, a total of 6412 MNO citizens (28%) had hypertension, including 3463 cases (30%) in males, and 2950 (25%) in females (Table 1). The

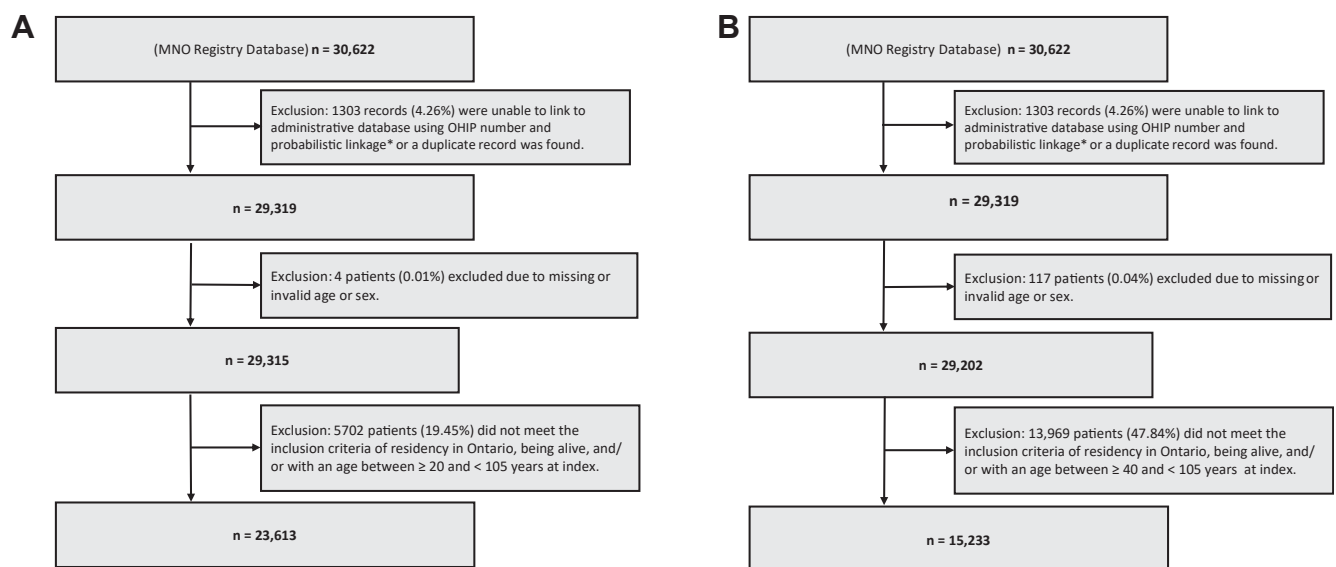


Figure 1. Study flow diagram of 2020 cohort selection for (A) hypertension and (B) heart failure. *Probabilistic linkage was used to link 29,319 records to administrative data. The variables used for linkage were first name, last name, date of birth, sex, and postal code. MNO, Métis Nation of Ontario; OHIP, Ontario Health Insurance Plan.

Table 1. Bivariate analysis of the hypertension cohort among Métis citizens of Ontario in 2020

Variable	Overall			Male citizens			Female citizens		
	No hypertension n = 16,751	Hypertension n = 6412	Standard difference	No hypertension n = 8111	Hypertension n = 3462	Standard difference	No hypertension n = 8640	Hypertension n = 2950	Standard difference
Age, y									
20–39	7634 (45.6)	296 (4.6)	1.072	3682 (45.4)	164 (4.7)	1.062	3952 (45.7)	132 (4.5)	1.082
40–64	7849 (46.9)	3251 (50.7)	0.077	3823 (47.1)	1855 (53.6)	0.129	4026 (46.6)	1396 (47.3)	0.015
65–104	1268 (7.6)	2865 (44.7)	0.932	606 (7.5)	1443 (41.7)	0.866	662 (7.7)	1422 (48.2)	1.013
Region									
Out of province	324 (1.9)	39 (0.6)	0.119	157 (1.9)	23 (0.7)	0.112	167 (1.9)	16 (0.5)	0.126
1	1826 (10.9)	517 (8.1)	0.097	912 (11.2)	285 (8.2)	0.102	914 (10.6)	232 (7.9)	0.094
2	932 (5.6)	357 (5.6)	0	424 (5.2)	188 (5.4)	0.009	508 (5.9)	169 (5.7)	0.006
3	933 (5.6)	381 (5.9)	0.016	484 (6.0)	214 (6.2)	0.009	449 (5.2)	167 (5.7)	0.02
4	1116 (6.7)	450 (7.0)	0.014	541 (6.7)	255 (7.4)	0.027	575 (6.7)	195 (6.6)	0.002
5	1934 (11.5)	1051 (16.4)	0.14	1008 (12.4)	643 (18.6)	0.17	926 (10.7)	408 (13.8)	0.095
6	1948 (11.6)	662 (10.3)	0.042	952 (11.7)	354 (10.2)	0.048	996 (11.5)	308 (10.4)	0.035
7	3589 (21.4)	1522 (23.7)	0.055	1709 (21.1)	805 (23.3)	0.053	1880 (21.8)	717 (24.3)	0.06
8	1930 (11.5)	602 (9.4)	0.07	904 (11.1)	298 (8.6)	0.085	1026 (11.9)	304 (10.3)	0.05
9	2219 (13.2)	831 (13.0)	0.009	1020 (12.6)	397 (11.5)	0.034	1199 (13.9)	434 (14.7)	0.024
Income quintile									
Missing data	31 (0.2)	10 (0.2)	0.007	17 (0.2)	4 (0.1)	0.023	14 (0.2)	6 (0.2)	0.01
1 (lowest)	3069 (18.3)	1312 (20.5)	0.054	1522 (18.8)	661 (19.1)	0.008	1547 (17.9)	651 (22.1)	0.104
2	3561 (21.3)	1494 (23.3)	0.049	1741 (21.5)	817 (23.6)	0.051	1820 (21.1)	677 (22.9)	0.045
3	3263 (19.5)	1273 (19.9)	0.009	1557 (19.2)	711 (20.5)	0.034	1706 (19.7)	562 (19.1)	0.018
4	3355 (20.0)	1214 (18.9)	0.028	1610 (19.8)	682 (19.7)	0.004	1745 (20.2)	532 (18.0)	0.055
5 (highest)	3472 (20.7)	1109 (17.3)	0.088	1664 (20.5)	587 (17.0)	0.091	1808 (20.9)	522 (17.7)	0.082

Values are n (%), unless otherwise indicated. Among the hypertension cohort, a total of 41 cases had missing or invalid area-level income information (21 male citizens, 20 female citizens).

distributions of age ($P < 0.0001$) and income quintile ($P < 0.0001$) were significantly different for citizens with vs without hypertension overall. Most MNO citizens with hypertension (50.7%) were aged between 40 and 64 years.

As for the heart failure cohort, 15,233 citizens aged 40–105 years were successfully linked to the RPDB (Fig. 1B), and 530 MNO citizens (3.5%) had a diagnosis of heart failure in 2020

(Table 2). In the heart failure cohort, 51% of citizens were male. In total, 3.8% of male citizens and 3.1% of female citizens (Table 2) had a diagnosis of heart failure. In the overall sample, 72.6% of MNO citizens diagnosed with heart failure were aged ≥ 65 years, compared to those not diagnosed with heart failure (25.5%; $P < 0.0001$). The distribution of MNO citizens with heart failure, by income quintile, was

Table 2. Bivariate analysis of the heart failure (HF) cohort among Métis citizens of Ontario in 2020

Variable	Overall			Male citizens			Female citizens		
	No HF n = 14,703	HF n = 530	Standard difference	No HF n = 7430	HF n = 297	Standard difference	No HF n = 7273	HF n = 233	Standard difference
Age, y									
40–64	10,955 (74.5)	145 (27.4)	1.07	5578 (75.1)	100 (33.7)	0.914	5377 (73.9)	45 (19.3)	1.308
65–104	3748 (25.5)	385 (72.6)	1.07	1852 (24.9)	197 (66.3)	0.914	1896 (26.1)	188 (80.7)	1.308
Region									
Out of province	192 (1.3)	7 (1.3)	0.001	104–108*	1–5*	0.006	86–90*	1–5*	0.008
1	1491 (10.1)	31 (5.8)	0.159	766–769*	14–18*	0.199	723–727*	15–19*	0.111
2	838 (5.7)	29 (5.5)	0.01	401–405*	16–20*	0.027	434–438*	9–13*	0.056
3	842 (5.7)	52 (9.8)	0.153	448 (6.0)	32 (10.8)	0.172	394 (5.4)	20 (8.6)	0.124
4	1017 (6.9)	38 (7.2)	0.01	528 (7.1)	21 (7.1)	0.001	489 (6.7)	17 (7.3)	0.022
5	2082 (14.2)	93 (17.5)	0.093	1197 (16.1)	58 (19.5)	0.089	885 (12.2)	35 (15.0)	0.083
6	1626 (11.1)	42 (7.9)	0.107	824 (11.1)	22 (7.4)	0.127	802 (11.0)	20 (8.6)	0.082
7	3275 (22.3)	129 (24.3)	0.049	1613 (21.7)	69 (23.2)	0.036	1662 (22.9)	60 (25.8)	0.068
8	1465 (10.0)	47 (8.9)	0.038	678 (9.1)	27 (9.1)	0.001	787 (10.8)	20 (8.6)	0.076
9	1875 (12.8)	62 (11.7)	0.032	867 (11.7)	31 (10.4)	0.039	1008 (13.9)	31 (13.3)	0.016
Income quintile									
Missing data	24 (0.2)	2 (0.4)	0.041	14 (0.2)	0 (0.0)	0.061	10 (0.1)	2 (0.9)	0.103
1 (lowest)	2826 (19.2)	142 (26.8)	0.181	1444 (19.4)	69 (23.2)	0.093	1382 (19.0)	73 (31.3)	0.287
2	3190 (21.7)	132 (24.9)	0.076	1651 (22.2)	74 (24.9)	0.064	1539 (21.2)	58 (24.9)	0.089
3	2878 (19.6)	91 (17.2)	0.062	1461 (19.7)	61 (20.5)	0.022	1417 (19.5)	30 (12.9)	0.18
4	2871 (19.5)	98 (18.5)	0.026	1464 (19.7)	57 (19.2)	0.013	1407 (19.3)	41 (17.6)	0.045
5 (highest)	2914 (19.8)	65 (12.3)	0.207	1396 (18.8)	36 (12.1)	0.185	1518 (20.9)	29 (12.4)	0.228

Values are n (%), unless otherwise indicated. Within the heart failure cohort of 2020 for all Métis of Ontario citizens, a total of 26 cases had missing or invalid area-level income information (14 male citizens, 12 female citizens).

* Denotes a range given to suppress small cells (< 5).

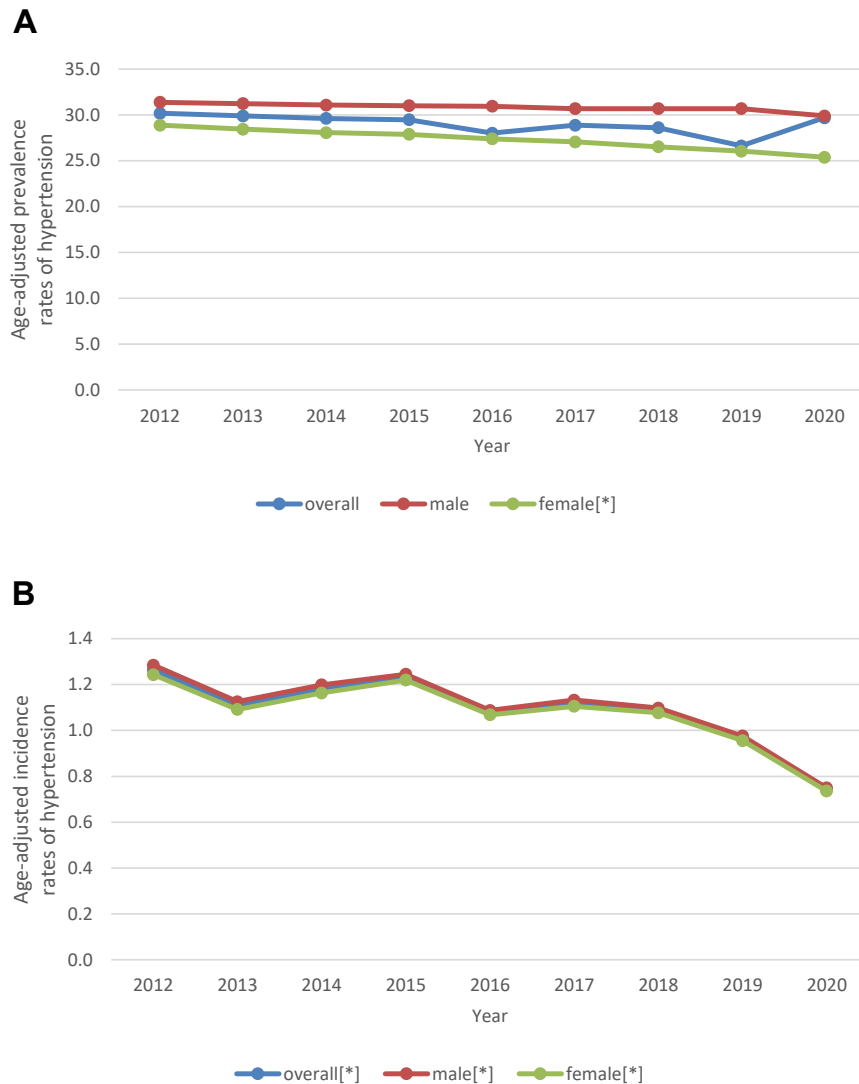


Figure 2. Age-adjusted rates of hypertension within citizens of the Métis Nation of Ontario (MNO) between 2012 and 2020. **(A)** Prevalent and **(B)** incident rates of hypertension in MNO citizens. The data on the y-axis represent age-adjusted hypertension rates per 100 MNO citizens. Each figure contains trends for 3 subcohorts: overall population, male population, and female population. *Statistically significant difference between 2012 vs 2020.

significantly different from that for citizens not diagnosed with heart failure ($P < 0.0001$). This statistically significant difference was seen when income quintiles were compared between only male and only female citizens with and without heart failure.

Disease trends

Incident cases of hypertension for all MNO citizens showed a decrease from 1.3 per 100 (confidence interval [CI]: 1.1-1.4) citizens in 2012 to 0.7 per 100 (CI: 0.6-0.9) in 2020 (Fig. 2B). As for prevalence, the overall burden of hypertension remained stable, going from 30.2 per 100 (CI: 29.3-31.1) in 2012 to 29.7 per 100 (CI: 28.7-30.7) individuals in 2020 (Fig. 2A). For female citizens, both prevalent and incident cases of hypertension decreased. Prevalence decreased by 12%, from 28.9 per 100 (CI: 27.6-30.2) in 2012 to 25.4 per 100 (CI: 27.6-30.2) in 2020. Incidence decreased by 41%,

from 1.2 per 100 (CI: 1.1-1.4) in 2012 to 0.7 per 100 (CI: 0.6-0.9) in 2020. In the same time period, the incidence of hypertension for male citizens decreased by 42%, from 1.3 per 100 (CI: 1.1-1.5) to 0.7 per 100 (CI 0.6-0.9). Interestingly, from 2012 to 2020, male citizens in the lowest income bracket showed a 4.8% decrease in age-adjusted prevalence rates of hypertension, whereas male citizens with the highest income as of 2020 have nearly the same prevalence and demonstrated a relatively lesser decrease of 1.4% (Fig. 3A). Income quintile did not influence the age-adjusted prevalence of hypertension in females (Fig. 3B).

Heart failure incidence remained stable for all MNO citizens, going from 0.3 per 100 (CI: 0.2-0.5) in 2012 to 0.4 per 100 (CI: 0.3-0.5) in 2020 (Fig. 4B). The overall burden of heart failure in the MNO population increased from 2.7 per 100 in 2012 (CI: 0.2-0.5) to 3.4 per 100 (CI: 3.1-3.7) in 2020 (Fig. 4A). Rates of heart failure in male citizens increased by 47%, from 2.6 per 100 (CI: 2.1-3.1) in 2012 to



Figure 3. Age-adjusted prevalence rates of hypertension by area-level income quintiles of citizens of the Métis Nation of Ontario (MNO) between 2012 and 2020. **(A)** Male-specific rates; **(B)** female-specific rates. The data on the y-axis represent age-adjusted hypertension rates per 100 MNO citizens. Note that the first income quintile is the lowest income bracket, and the fifth income quintile is the highest income bracket.

3.8 per 100 (CI: 3.3-4.2) in 2020. In contrast, rates for female citizens increased by 9%, from 2.8 (CI: 2.3-3.5) to 3.1 (CI: 2.7-3.5). Examination of income quintiles showed clearly that both male citizens (Fig. 5A) and female citizens (Fig. 5B) living in areas with lower income (quintiles 1 and 2) had consistently higher prevalence rates between 2012 and 2020.

Discussion

Nearly a decade has passed since Atzema et al. (2015) examined CVD trends in MNO citizens.⁸ Here, we report that MNO citizens continue to experience an increasing burden of heart failure. In contrast, from 2012 to 2020, the incidence of hypertension decreased. However, our data show that as of 2020, the prevalence of hypertension is still high, with roughly 3 in 10 MNO citizens diagnosed with hypertension (Table 1). Additionally, age and income quintile were significantly different for MNO citizens with vs without heart failure and with vs without hypertension. This

significant difference was also shown for both male and female citizens.

The incidence and overall burden of heart failure have increased steadily from 2012 to 2020, especially for men, for whom prevalence rates of heart failure increased by 47%. This finding is particularly alarming given the serious nature of heart failure. Both hypertension and heart failure were more prevalent in older individuals and male individuals. Our bivariate analysis for heart failure validated a gradient on which prevalence was highest in lower area-level income quintiles and lowest in higher area-level income quintiles. Our analyses echo similar findings that additional factors, including but not limited to income, education, and employment, influence the health status of Métis citizens across Canada.¹² In addition, excessive alcohol consumption, poor diets and/or lack of access to healthy food, leading to obesity, and long-term smoking are contributing factors.¹² Martens et al. discussed the prevalence rates of diabetes in citizens of the Manitoba Métis Federation,¹⁰ and after being

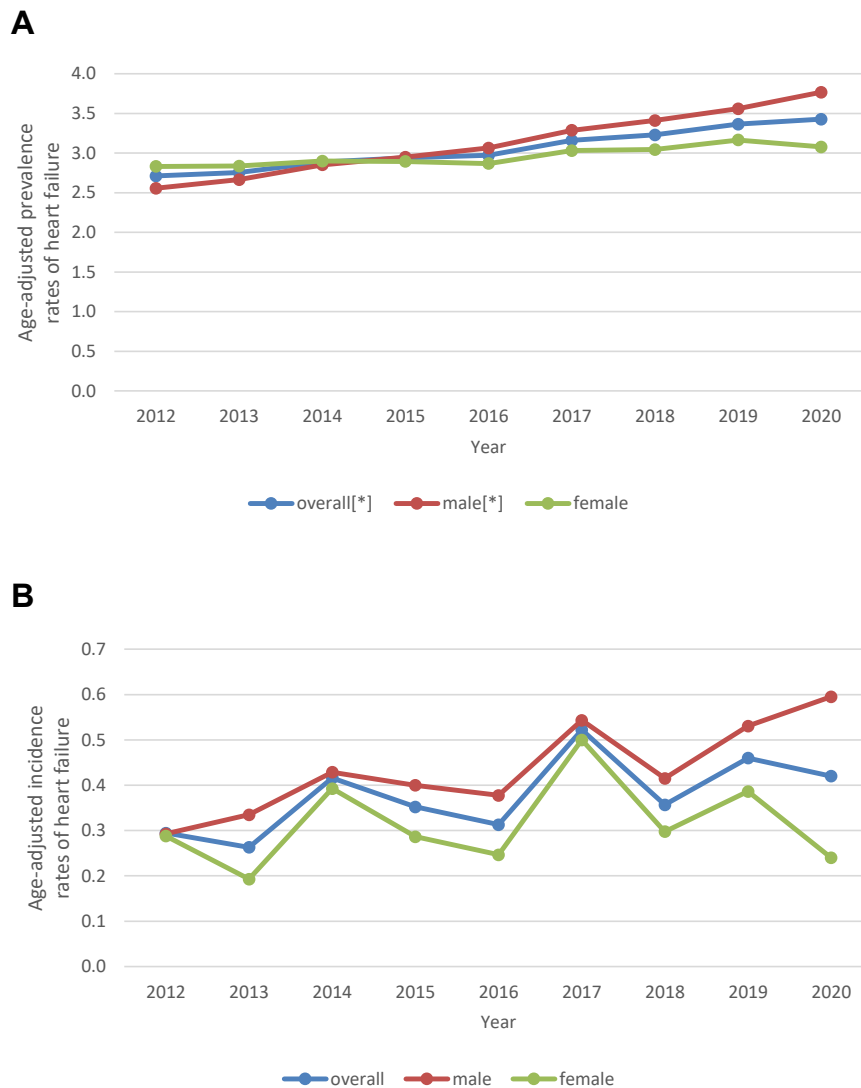


Figure 4. Age-adjusted rates of heart failure within citizens of the Métis Nation of Ontario (MNO) between 2012 and 2020. **(A)** Prevalent and **(B)** incident cases of heart failure in MNO citizens. The data on the y-axis represent age-adjusted heart failure rates per 100 MNO citizens. Each figure contains trends for 3 subcohorts: overall population, male population, and female population. *Statistically significant difference between 2012 vs 2020.

adjusted by various demographics, the burden of disease remained disproportionately higher as compared to that for the rest of the province. Comorbidities, such as obesity and diabetes, substantially increase mortality rates for Métis citizens.¹⁹ This finding is significant, as 75% of mortality in all individuals with diabetes has been attributed to cardiovascular disease.²⁰ Our study did not examine these risk factors or comorbidities; however, they could be examined in future research. An alternative and optimistic interpretation of the increasing burden of heart failure in this population is that it is attributable to earlier diagnosis and/or better treatment and survival in those with heart failure, but this possibility was not assessed in this study.

Holistic health often is overlooked when understanding the population needs of Indigenous peoples.²¹ Métis cultural and spiritual well-being are important for maintaining overall health. Métis social determinants of health range from

traditional social determinants of health, such as income, social status, employment, and education, to culture, colonialism, and relationship to animals, land, and water.²² Factors contributing to the disproportionately higher rates of CVD and related comorbidities that Métis people experience largely are understudied. However, more broadly, inaccessible healthcare services, mistrust of healthcare providers, limited access to traditional medicine, and poor lifestyle habits, influenced by intergenerational trauma and historical and ongoing colonization, that result in continued disparities in social determinants of health are recurring themes in the context of Indigenous health inequities.^{9,19,21,23} Disparities related to accessibility include distance to healthcare centres, social acceptability, healthcare facility capacity, and treatment biases in healthcare environments that treat Indigenous patients less commonly.²⁴ Traditional medicine and spirituality are also large

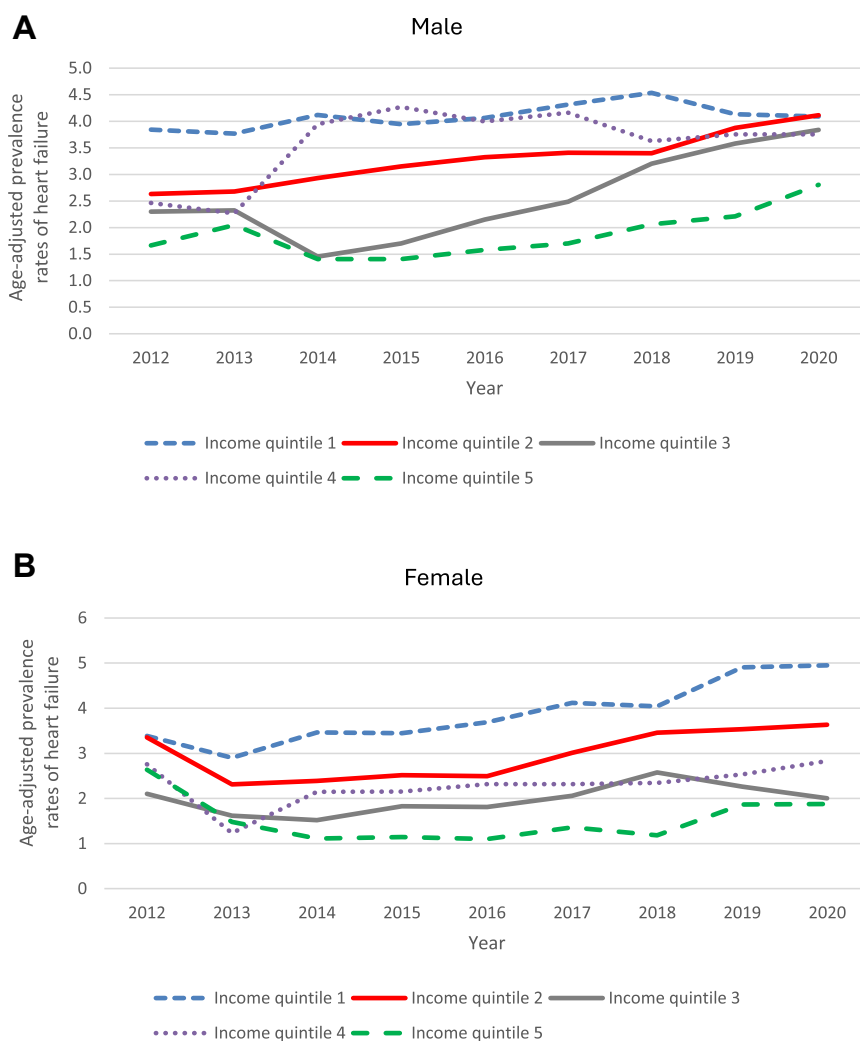


Figure 5. Age-adjusted prevalence rates of heart failure according to area-level income quintiles of citizens of the Métis Nation of Ontario (MNO) between 2012 and 2020. **(A)** Male-specific rates; **(B)** female-specific rates. The data on the y-axis represent age-adjusted heart failure rates per 100 MNO citizens. Note that the first income quintile is the lowest income bracket, and the fifth income quintile is the highest income bracket.

components of Indigenous healing practices, but they rarely are implemented in treatment strategies.²⁴

The above factors take part in creating barriers that lead to inequitable healthcare services for Métis people. These disproportionate CVD outcomes might be preventable if equitable access to healthcare services were incorporated with cultural safety, social acceptability, and policies that take into account wider systemic discrimination and address disparities in the social determinants of health,^{24,25} including the full spectrum of Métis social determinants of health.²⁴ Moving forward, to address these health gaps with a Métis lens, we should look to encourage community-based CVD research. Disease surveillance studies such as this one are important for assessing disease burden and individuals within the population who are at greater risk. But quantitative research does not address social determinants of health, or cultural safety, nor does it repair mistrust with healthcare institutions. Based on quantitative evidence of health disparities, implementing qualitatively derived action items would provide meaningful differences for Métis health outcomes. Future research that

examines Métis-specific cardiovascular health should continue to define at-risk cohorts and the burden of CVD. But, as the literature suggests, Métis-specific health needs require culturally informed approaches. So, to enact change that will improve health outcomes, direct engagement with Métis communities and governments is encouraged.

Strengths and limitations

Our study used large population-level administrative health data, which has numerous advantages, including population coverage, the ability to link with other data sources, and limited selection bias.^{26,27} However, variables included in administrative health data sources are not collected for research purposes, resulting in missing information.²⁷ For example, we did not have individual-level socioeconomic status variables, such as income, education, and employment or gender, available to analyze. In addition, we were unable to account for Métis people in Ontario who are not registered citizens of the MNO. Thus, our findings may not be

generalizable to those who are not registered MNO citizens, and the true prevalence of heart failure and hypertension among all Métis people in Ontario may be lower or higher than what we reported. In addition, our study examined only hypertension and heart failure, the latter of which has several subtypes. Future studies should expand the scope of disease burden, include subtype categorizations and additional socioeconomic status variables, and examine trends by geographic location. One final consideration regarding our data is that the 2020 data may reflect complications derived from the COVID-19 pandemic.

Conclusion

Métis are an Indigenous group recognized by Canada, and are distinct from other Indigenous Nations. They have their own culture, traditions, and way of life. Our data demonstrate that between 2012 and 2020, MNO citizens experienced high rates of heart failure and decreasing rates of hypertension. The increasing burden of heart failure demonstrated by this study also is supported by previous research that reported disproportionately high rates of CVD, as compared to those in the general population. These results may inform MNO program planning concerning CVD, and they add to the growing picture of Métis health in what is now Canada.

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Data Availability

The dataset from this study is held securely in coded form at ICES. Although legal data-sharing agreements between ICES and data providers (eg, healthcare organizations and government) prohibit ICES from making the dataset publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS (email: das@ices.on.ca), and with approval from the Metis Nation of Ontario. The full dataset creation plan and underlying analytic code are available from the authors upon request, with the understanding that the computer programs may rely upon coding templates or macros that are unique to ICES and therefore either are inaccessible or may require modification.

Ethics Statement

The research reported has adhered to relevant ethical guidelines. See *Patient Consent* section for details.

Patient Consent

The authors confirm that patient consent is not applicable to this article. The use of the data in this project is authorized under section 45 of Ontario's Personal Health Information Protection Act (PHIPA) and does not require review by a research ethics board. ICES is a prescribed entity under Ontario's PHIPA. Section 45 of PHIPA authorizes ICES to

collect personal health information, without consent, for the purpose of analysis or compiling statistical information with respect to the management, evaluation, or monitoring of, and the allocation of resources to or planning for all or part of the health system. The use of the data in this project is authorized under section 45 and approved by the ICES Privacy and Legal Office.

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Disclosures

The authors have no competing interests to disclose.

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