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Kidney Disease Among Registered Métis Citizens of Ontario: A Population-Based Cohort Study

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Abstract

Background: Indigenous peoples in Canada have higher rates of kidney disease than non-Indigenous Canadians. However, little is known about the risk of kidney disease specifically in the Métis population in Canada.

Objective: To compare the prevalence of chronic kidney disease and incidence of acute kidney injury and end-stage kidney disease among registered Métis citizens in Ontario and a matched sample from the general Ontario population.

Design: Population-based, retrospective cohort study using data from the Métis Nation of Ontario's Citizenship Registry and administrative databases.

Setting: Ontario, Canada; 2003-2013.

Patients: Ontario residents ≥18 years.

Measurements: Prevalence of chronic kidney disease and incidence of acute kidney injury and end-stage kidney disease. Secondary outcomes among patients hospitalized with acute kidney injury included non-recovery of kidney function and mortality within 1 year of discharge.

Methods: Database codes and laboratory values were used to determine study outcomes. Métis citizens were matched (1:4) to Ontario residents on age, sex, and area of residence. The analysis included 12 229 registered Métis citizens and 48 916 adults from the general population.

Results: We found the prevalence of chronic kidney disease was slightly higher among Métis citizens compared with the general population (3.1% vs 2.6%, $P = 0.002$). The incidence of acute kidney injury was 1.2 per 1000 person-years in both Métis citizens and the general population ($P = 0.54$). Of those hospitalized with acute kidney injury, outcomes were similar among Métis citizens and the general population except 1-year mortality, which was higher for Métis citizens (24.5% vs 15.3%, $P = 0.03$). The incidence of end-stage kidney disease did not differ between groups (<3.0 per 10 000 person-years, $P = 0.73$).

Limitations: The Métis Nation of Ontario Citizenship Registry only captures about 20% of Métis people in Ontario. Administrative health care codes used to identify kidney disease are highly specific but have low sensitivity.

Conclusions: Rates of kidney disease were similar or slightly higher for Métis citizens in Ontario compared with the matched general population.

Abrégé

Contexte: Les autochtones du Canada présentent des taux plus élevés d'insuffisance rénale que les Canadiens non autochtones. Cependant, on en sait encore très peu au sujet des risques de maladies rénales spécifiques aux populations de Métis au Canada.

Objectif: L'étude visait à comparer la prévalence de l'insuffisance rénale chronique et l'incidence de l'insuffisance rénale aigüe ou terminale parmi les citoyens métis inscrits en Ontario avec un échantillon apparié de la population non autochtone de l'Ontario.

Modèle d'étude: Il s'agit d'une étude de cohorte rétrospective basée sur la population qui a utilisé les données du registre de citoyenneté de la nation métisse de l'Ontario et les bases de données administratives.

Cadre de l'étude: L'étude a été menée en Ontario, au Canada, entre 2003 et 2013.

Patients: La cohorte était constituée d'adultes résidants de l'Ontario.

Mesures: La prévalence de l'insuffisance rénale chronique et l'incidence de l'insuffisance rénale aigüe ou terminale ont été mesurées. Les critères d'évaluation secondaires observés chez les patients hospitalisés pour insuffisance rénale aigüe incluaient le non-recouvrement de la fonction rénale et la mortalité du patient dans l'année suivant la sortie de l'hôpital.
Méthodologie: Les codes des bases de données et les valeurs de laboratoire ont été utilisés pour déterminer les résultats de l'étude. Les citoyens métis ont été appariés (1:4) à des résidents non autochtones de l'Ontario en tenant compte de l'âge, du sexe et de la région de résidence. L'analyse a porté sur un total de 12 229 citoyens métis inscrits et 48 916 adultes de la population générale.
Résultats: Nous avons constaté que la prévalence de l'insuffisance rénale chronique était légèrement plus élevée chez les citoyens métis par rapport à la population générale (3.1% contre 2.6%, $P = 0.002$). L'incidence de l'insuffisance rénale aigüe a été de 1.2 pour 1000 années-personnes tant pour les citoyens métis que pour l'ensemble de la population ($P = 0.54$). Parmi les personnes hospitalisées pour insuffisance rénale aigüe, les résultats étaient similaires pour les citoyens métis et la population générale sauf en ce qui a trait à la mortalité du patient dans l'année suivant l'hospitalisation, qui s'est avérée plus élevée chez les citoyens métis (24.5% contre 15.3%, $P = 0.03$). Quant à l'incidence de l'insuffisance rénale terminale, aucune différence n'a été observée entre les deux groupes (<3.0 pour 10 000 années-personnes, $P = 0.73$).
Limites de l'étude: Le registre des citoyens de la nation métisse de l'Ontario ne répertorie que 20% environ des Métis résidant en Ontario. Les codes administratifs du système de santé qui servent à repérer les cas d'insuffisance rénale sont très spécifiques, mais présentent une faible sensibilité.
Conclusion: Les taux d'insuffisance rénale se sont avérés similaires ou légèrement plus élevés pour les citoyens métis par rapport à la population générale en Ontario.

Keywords
Métis Nation of Ontario, Métis Health, chronic kidney disease, acute kidney injury, end-stage kidney disease

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What was known before

Indigenous people living in Canada have rates of kidney disease that are 3 times higher than the non-Indigenous Canadian population, yet no studies have specifically examined patterns of kidney disease among Métis citizens living in Ontario.

What this adds

The risk of kidney disease may be similar or slightly higher among Métis citizens of Ontario compared with the general population matched on age, sex, and area of residence.

Background

Indigenous peoples living in Canada have rates of kidney disease that are 3 times higher than non-Indigenous Canadians.[1] The reasons for this are complex and multifactorial, but may include a genetic predisposition[2] and limited access to culturally appropriate primary health care.[1] As well, a history of disadvantage in Canadian society may have contributed to a higher prevalence of low birth weight, which is associated with reduced nephron endowment,[3-5] postinfectious glomerulonephritis,[6,7] obesity, early-onset diabetes, and increased vascular disease.[1]

Métis people are a unique Indigenous community with their own values, beliefs, traditions, culture, language, territory, and history. There are approximately 86 000 Métis people living in Ontario, which comprise about 30% of the total Indigenous population in Canada.[8] The Métis are the fastest growing Indigenous population in Canada.[9] Historically, Métis people are descendants of Aboriginal women and European men. To our knowledge, no prior reports have examined the patterns of kidney disease among Métis people residing in Canada. At the

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request of the Métis Nation of Ontario (MNO), we developed a research partnership to examine kidney disease and related outcomes in this unique population. Our objective was to compare the prevalence of chronic kidney disease, the incidence of acute kidney injury, and end-stage kidney disease among registered Métis citizens of Ontario with the general Ontario population matched on age, sex, and geographic area of residence. We also examined 1-year outcomes among those hospitalized with acute kidney injury.

Methods

Design and Setting

Ontario has a population of 13 million individuals with universal health care covering both emergency and preventive care. The MNO is a Métis-specific governance body that was established in 1993 to represent Métis citizens and communities in Ontario. The MNO maintains a citizenship registry which currently captures approximately 18 000 individuals or 20% of the provincial Métis population. To apply as a citizen, one must meet the Métis National Council's National Definition for Citizenship within the Métis Nation: "Métis means a person who self-identifies as Métis, is distinct from other Aboriginal peoples, is of historic Métis Nation ancestry, and is accepted by the Métis Nation."[10]

We conducted a retrospective, population-based cohort study using the MNO citizenship registry, current as of 2009, which we linked to Ontario's administrative data held at the Institute for Clinical Evaluative Sciences (ICES). This research was commissioned by the MNO and was conducted through the provincial ICES Kidney, Dialysis and Transplantation Research Program. This research uses the recommended policies for the ethical conduct of research involving Indigenous peoples.[11] It is offered in a spirit of respect. Data sets were linked using unique encoded identifiers and analyzed at ICES Western, London, Ontario, Canada. This study was pre-approved by the institutional review board at Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada. The reporting of this study follows the checklist of recommendations for reporting of observational studies using the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement (see Appendix A).[12]

Data Sources

We used the MNO citizenship registry to create a cohort of registered Métis citizens in Ontario who were alive as of April 1, 2003. We used 7 other linked databases held at ICES to examine study outcomes during follow-up (April 1, 2003, to March 31, 2012). The Canadian Institute for Health Information (CIHI) Discharge Abstract Database and the National Ambulatory Care Reporting System Database contain diagnostic and procedural information for all hospital admissions and emergency department visits in Ontario. The Ontario Health Insurance Plan (OHIP) Claims Database captures physician billing claims for inpatient, outpatient, and laboratory services rendered to all persons in Ontario. The Registered Persons Database includes birth, death, and demographic information for all Ontario residents. The Ontario portion of the Canadian Organ Replacement Register (CORR) contains information on all organ transplantation types and dialysis. We also linked laboratory data from 2 sources to obtain kidney function laboratory test results (serum creatinine) for our cohort. The Dynacare Database includes outpatient laboratory tests for a large commercial lab provider with locations across Ontario. Twelve hospitals in Southwestern Ontario share a common electronic medical record (Cerner, Missouri, USA) which contains inpatient, emergency department, and outpatient laboratory testing.

Cohort Selection

We performed initial data cleaning to exclude individuals with invalid identifiers or with missing date of birth or sex (Figure 1). We also excluded non-Ontario residents, individuals who were younger than 18 years as of April 1, 2003, and patients with previous end-stage kidney disease (defined as chronic dialysis 1 year before April 1, 2003, or a kidney transplant in the 5-year period before April 1, 2003). To assess the incidence of acute kidney injury during follow-up, we further excluded patients with evidence of pre-existing chronic kidney disease (defined as 1 or more codes for chronic kidney disease in the year before April 1, 2003; codes provided in Appendix B).

We matched eligible Métis citizens to individuals from the general Ontario population, using a 1-to-4 ratio, on age (±2 years), sex, census dissemination area (a proxy for geographical location of residence describing populations of 400 to 700 individuals), and evidence of a baseline outpatient serum creatinine measurement in the year prior to April 1, 2003. To avoid overmatching, we did not match on diabetes or other comorbidities because these conditions may be a mechanism of kidney disease in some individuals. Hereafter, the matched sample from the general Ontario population is referred to as the general population.

Measures and Outcomes

Baseline characteristics. We measured the following demographic characteristics in both cohorts: sex, income quintile, geographic location, and age. We also gathered baseline information on health care use in the year before April 1, 2003 (nephrologist visits, primary care visits, and hospitalizations), and presence of comorbidities in the 5 years before April 1, 2003 (diabetes, myocardial infarction and stroke).

Chronic kidney disease. We defined the prevalence of chronic kidney disease in 2 ways: (1) point prevalence at baseline estimated using outpatient serum creatinine in the

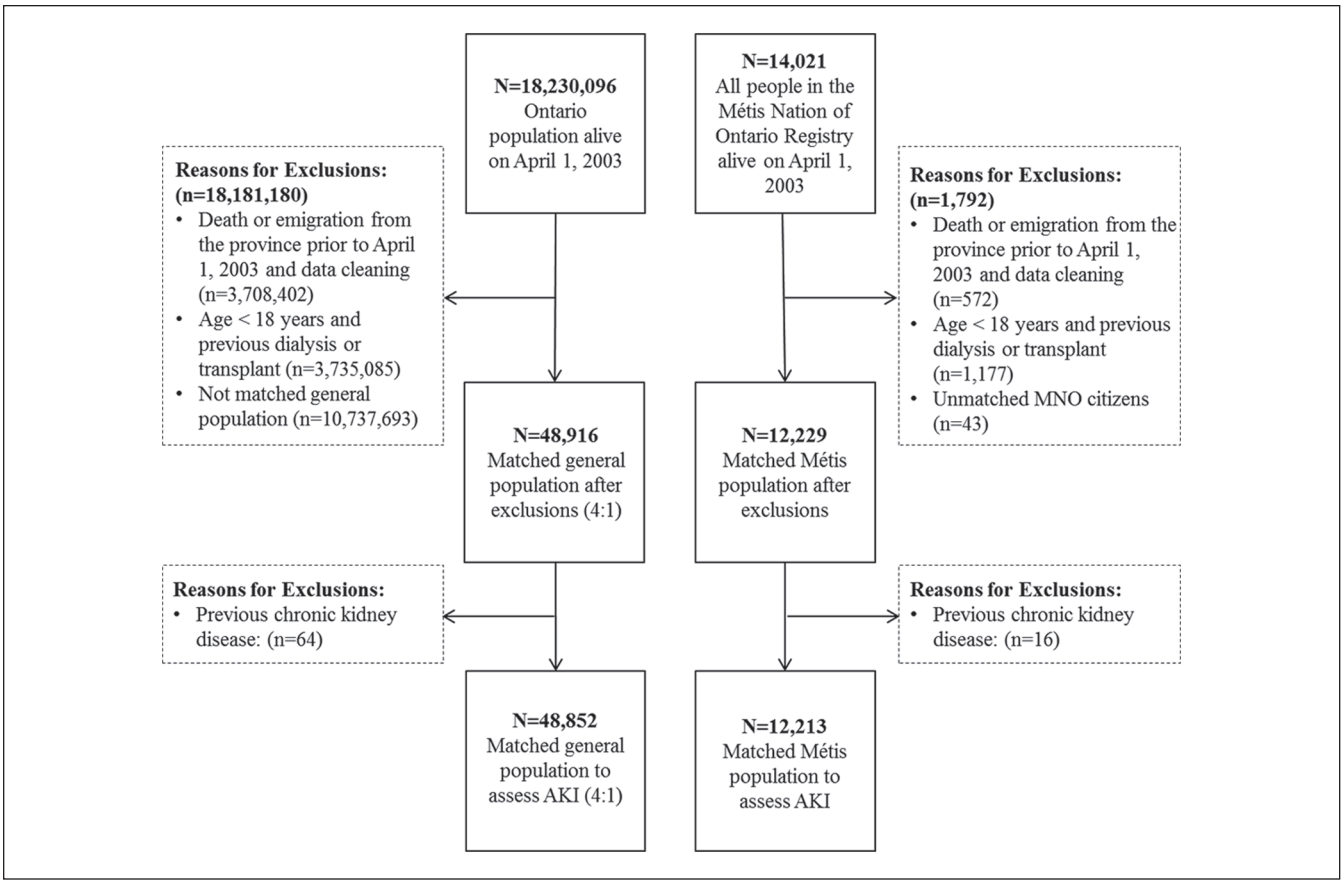

Figure 1. Flow diagram of cohort build.
Note. MNO = Métis Nation of Ontario; AKI = Acute Kidney Injury.

year before April 1, 2003, and (2) period prevalence during follow-up (April 1, 2003, to March 31, 2012) using diagnostic codes. Prevalence at baseline was estimated by looking for at least one serum creatinine value in the previous year (if a person had multiple tests, then we used the most recent value). Estimated glomerular filtration rate (eGFR) was calculated using the Chronic Kidney Disease Epidemiology Collaboration equation.[13] This calculation assumed no individuals were of black race because we lacked data on this variable; however, less than 5% of Ontarians are black.[9] Severity of chronic kidney disease was defined as mild ($60 > eGFR \geq 45mL/min/1.73\ m^2$) or moderate to severe ($eGFR < 45mL/min/1.73\ m^2$). Given the low number of patients with albuminuria measurements in our data sets, we did not use albumin-to-creatinine ratios to define chronic kidney disease.

The prevalence of chronic kidney disease during follow-up was estimated based on the presence of at least one validated administrative diagnostic code (codes provided in Appendix B).[14] We originally planned to assess outcomes for chronic kidney disease, including end-stage kidney disease; however, event rates were too small to report.

Acute kidney injury. The incidence of acute kidney injury during follow-up was estimated after excluding those with one or more codes for chronic kidney disease in the year before April 1, 2003. Acute kidney injury was defined in 2 ways: (1) a rise in serum creatinine >50% or >27 μmol/L from an outpatient baseline value[15] and (2) the presence of a diagnostic code in hospital for acute kidney injury. For the first definition, we identified all patients with a serum creatinine value measured during follow-up (either in the emergency department or as an inpatient); we then selected the highest creatinine value and compared this with the most recent value taken during the year before April 1, 2003.

For the second definition, we defined acute kidney injury using validated administrative diagnostic codes in hospital (Appendix B).[16]

One-year outcomes after acute kidney injury. Among patients with acute kidney injury defined using diagnostic codes, we examined the following outcomes (up to March 31, 2013): (1) duration of hospital stay, (2) death during hospitalization, (3) short-term dialysis during hospitalization, (4) death within 1 year of hospital discharge, and (5) nonrecovery of kidney function requiring chronic dialysis within

1 year of hospital discharge. The codes used to define these outcomes are provided in Appendix B.

End-stage kidney disease. We defined the incidence of end-stage kidney disease as evidence of at least 1 treatment code for chronic dialysis or kidney transplantation (codes in Appendix B) during follow-up (April 1, 2003 to March 31, 2012).

Statistical Analysis

We compared baseline characteristics between Métis citizens and the general population using standardized differences.[17] The incidence of study outcomes (acute kidney injury and end-stage kidney disease) were calculated as time to first event between April 1, 2003, and March 31, 2012. The prevalence of chronic kidney disease was defined by the presence of at least one code between April 1, 2003, and March 31, 2012. The risk of incident acute kidney injury and end-stage kidney disease for Métis citizens relative to the general population was assessed using Cox proportional hazards regression, stratified on the matched sets. The risk of prevalent chronic kidney disease was assessed using a modified Poisson regression, accounting for matched sets. In a secondary analysis, binary outcomes in follow-up after an in-hospital acute kidney injury episode were evaluated using chi-square tests. For these secondary outcomes, the matched nature of the data was not accounted for, as the low number of acute kidney injury hospitalizations did not permit matched analyses in this subset of individuals. The length of stay of the hospitalization with acute kidney injury was compared between the Métis citizens and general population groups using Wilcoxon signed-rank test. All analyses were conducted using SAS Version 9.3 (SAS Institute, Cary, NC). In all analyses, we interpreted 2-tailed *P* values less than 0.05 as statistically significant.

Results

A flow diagram of the cohort selection is shown in Figure 1. As of April 1, 2003, there were 14 021 Métis citizens in the MNO registry. After applying exclusion criteria, a total of 12 229 registered Métis citizens were successfully matched to 48 916 adults from the general population. Individuals were followed for a median of 9.0 years (interquartile range [IQR], 9.0-9.0). Reasons for ending the observation time included death (4.0% overall; 3.7% Métis and 4.1% general population), emigration (6.0% overall; 4.2% Métis and 6.5% general population), kidney transplant (0.4% overall; 0.4% Métis and 0.4% general population), and reaching the study accrual end date of March 31, 2012 (88.5% overall; 90.7% Métis and 88.0% general population). The total observation time was 521 700 person-years (105 595 Métis and 416 105 general population).

Baseline characteristics are shown in Table 1. As a result of matching, most baseline characteristics were similar between groups. In both groups, the median age was 41 years (IQR, 30-51), 46% were female, and a similar proportion resided in each of the 14 Local Health Integration Networks in Ontario. However, compared with the general population, Métis citizens had a higher number of primary care visits in the year preceding cohort entry (median 3 [IQR, 1-6] vs 2 [IQR, 0-5]).

Chronic Kidney Disease

In the year before April 1, 2003, approximately 5% of individuals in our study cohort had at least one laboratory test for serum creatinine (576 Métis citizens and 2304 in the general population) (Table 2). Among these individuals, the baseline prevalence of chronic kidney disease (defined as an eGFR below 60 mL/min/1.73 m^2) was 6.1% and 4.3%, respectively (relative risk [RR], 1.45; 95% confidence interval [CI], 1.04-2.02; $P = 0.03$). When stratified by severity of chronic kidney disease, we found similar estimates but these were not statistically significant. The prevalence of chronic kidney disease during follow-up (as defined using validated administrative health care codes in the entire cohort) was 3.1% among Métis citizens and 2.6% in the general population (RR 1.19; 95% CI, 1.07-1.32; $P = 0.002$).

Acute Kidney Injury

Similar to the assessment of chronic kidney disease above, approximately 5% of the cohort had baseline serum creatinine values in the year prior to April 1, 2003. When defined using inpatient or emergency department laboratory tests, the incidence of acute kidney injury during follow-up was 1.6 per 1000 person-years among Métis citizens, a rate not statistically different than the 1.2 per 1000 person-years observed in the general population ($P = 0.89$). Similarly, when defined using inpatient diagnosis codes, the incidence of acute kidney injury was not significantly different between groups (1.2 per 1000 person-years among Métis citizens versus 1.2 among the general population; $P = 0.54$).

Outcomes for individuals who were hospitalized with acute kidney injury (defined using diagnostic codes) are shown in Table 3. Most outcomes did not differ between groups, including duration of hospital stay, death during hospitalization, short-term dialysis during hospitalization, and non-recovery of kidney function requiring dialysis. However, death within 1 year of hospital discharge was significantly higher among Métis citizens compared with the general population (26 of 106; 24.5% vs 59 of 386; 15.3%, respectively; $P = 0.03$).

End-Stage Kidney Disease

The incidence of end-stage kidney disease during follow-up was similar between groups: 2.2 per 10 000 person-years

Table 1. Baseline Characteristics of Individuals in the Métis Citizenship Registry and the Matched General Population of Ontario.

	Registered Métis (n = 12229)	General population (n = 48916)	Standardized difference[a]
Demographics			
Mean age, years (SD)	41.8 (14.7)	41.8 (14.7)	0%
Median age, years (IQR)	41 (30-51)	41 (30-51)	
Age category, n (%)			
18-30	3247 (26.6%)	12985 (26.5%)	0%
31-40	2601 (21.3%)	10408 (21.3%)	0%
41-50	3106 (25.4%)	12421 (25.4%)	0%
51-60	1833 (15.0%)	7332 (15.0%)	0%
61-70	1021 (8.3%)	4086 (8.4%)	0%
71-80	361 (3.0%)	1443 (2.9%)	0%
>80	60 (0.5%)	241 (0.5%)	0%
Women, n (%)	5627 (46.0%)	22508 (46.0%)	0%
Income quintile, n (%)[b]			
1 (lowest)	2871 (23.5%)	10520 (21.5%)	5%
2	2524 (20.6%)	9779 (20.0%)	2%
3	2621 (21.4%)	10368 (21.2%)	1%
4	2209 (18.1%)	9250 (18.9%)	2%
5 (highest)	2004 (16.4%)	8999 (18.4%)	5%
LHIN, n (%)[c]			
Erie St. Clair	313 (2.6%)	1251 (2.6%)	0%
South West	428 (3.5%)	1672 (3.4%)	0%
Waterloo Wellington	277 (2.3%)	1129 (2.3%)	0%
Hamilton Niagara Haldimand Brant	673 (5.5%)	2663 (5.4%)	0%
Central West	150 (1.2%)	620 (1.3%)	0%
Mississauga Halton	202 (1.7%)	817 (1.7%)	0%
Toronto Central	295 (2.4%)	1089 (2.2%)	1%
Central	275 (2.2%)	1257 (2.6%)	2%
Central East	593 (4.8%)	2421 (4.9%)	1%
South East	339 (2.8%)	1368 (2.8%)	0%
Champlain	650 (5.3%)	2582 (5.3%)	0%
North Simcoe Muskoka	2233 (18.3%)	8844 (18.1%)	1%
North East	3813 (31.2%)	15355 (31.4%)	1%
North West	1988 (16.3%)	7848 (16.0%)	1%
Rural status[d]	3719 (30.4%)	14909 (30.5%)	0%
Comorbidities, n (%)[e]			
Diabetes	1067 (8.7%)	3552 (7.3%)	5%
Myocardial infarction	122 (1.0%)	361 (0.7%)	3%
Stroke	55 (0.4%)	175 (0.4%)	2%
Health care use[f]			
Previous visit to nephrologist, n (%)	61 (0.5%)	234 (0.5%)	0%
Primary care provider visits			
Mean (SD)	4.8 (6.2)	3.9 (5.9)	14%
Median (IQR)	3 (1-6)	2 (0-5)	
Previous hospitalizations			
Mean (SD)	0.1 (0.4)	0.1 (0.4)	3%
Median (IQR)	0 (0-0)	0 (0-0)	
0	11404 (93.3%)	45928 (93.9%)	3%
1-2	758 (6.2%)	2757 (5.6%)	2%
3-4	58 (0.5%)	188 (0.4%)	1%
>5	9 (0.1%)	43 (0.1%)	1%

Note. IQR = interquartile range; LHIN = Local Health Integration Network.

[a]Standardized differences are less sensitive to sample size than traditional hypothesis tests. They provide a measure of the difference between groups divided by the pooled SD; a value greater than 10% is interpreted as a meaningful difference between groups.

[b]Income was categorized into fifths of average neighborhood income on April 1, 2003.

[c]Those with missing LHINs were entered into the largest LHIN (North East).

[d]Rural was defined as population < 10000.

[e]Comorbidities were assessed by administrative database codes in the previous 5 years from April 1, 2003.

[f]Health care use was assessed in the previous 1 year from April 1, 2003.

Table 2. Prevalence and Severity of Chronic Kidney Disease Among Those With at Least One Serum Creatinine Test in the Year Before April 1, 2003.

	Registered Métis	General population	Relative risk	95% confidence interval	*P* value
At least one serum creatinine test in the year before April 1, 2003					
Total	n = 576	n = 2304			
Prevalence of chronic kidney disease, n (%)	35 (6.1%)	99 (4.3%)	1.45	1.04-2.02	0.03
Severity of chronic kidney disease, n (%)					
Mild (stage 3a): eGFR 45-59 mL/min/17.3 m^2	26 (4.5%)	71 (3.1%)	1.52	0.99-2.34	0.05
Moderate to severe (stage 3b-5): eGFR below 44 mL/min/1.73 m^2	9 (1.6%)	28 (1.2%)	1.24	0.61, 2.55	0.55
At least one validated administrative health care code in follow-up					
Total	n = 12229	n = 48916			
Prevalence of chronic kidney disease, n(%)	381 (3.1%)	1283 (2.6%)	1.19	1.07-1.32	0.002

Note. eGFR = estimated glomerular filtration rate.

Table 3. Outcomes of Individuals Hospitalized With Acute Kidney Injury.[a]

	Registered Métis	General population	
	n = 131	n = 484	*P* value
Hospital length of stay, days			
Mean (SD)	13.5 (19.5)	14.4 (19.7)	0.44[b]
Median (IQR)	7 (4-15)	9 (4-17)	
Died during hospitalization, n (%)	25 (19.1%)	98 (20.2%)	0.77
Short-term dialysis during hospitalization, n (%)	8 (6.1%)[c]	33 (6.8%)[d]	0.77
Died within 1 year of hospital discharge, n (%)	26 (24.5%)[c]	59 (15.3%)[d]	0.03
Nonrecovery of kidney function requiring chronic dialysis, n (%)	6 (5.7%)[c]	16 (4.1%)[d]	0.50

Note. IQR = interquartile range.
[a]Hospitalization with acute kidney injury, as defined by validated administrative codes.
[b]*P* value based on Wilcoxon signed-rank test for continuous data that are not normally distributed.
[c]Percentage of 106 survivors.
[d]Percentage of 386 survivors.

among Métis citizens and 2.4 per 10 000 person-years among the general population ($P = 0.73$).

Sensitivity Analyses

To examine whether matching on geographic location influenced our results, we removed this criterion in sensitivity analyses, but found no appreciable change in the results (data not shown).

Discussion

This research represents the first population-based study of kidney disease among registered Métis citizens of Ontario. We found that rates of acute kidney injury and end-stage kidney disease were similar for Métis citizens in Ontario and a matched general population sample. However, we did find a slightly higher prevalence of chronic kidney disease among Métis citizens compared with the general population (45% and 19% relative increase when using laboratory values and administrative codes to define chronic kidney disease, respectively). The 45% relative increase should be interpreted with caution, because event rates were small and the CI was wide. Furthermore, the absolute risk differences were small (0.5% when using administrative codes and 1.8% when using laboratory values). The chronic kidney disease prevalence in the general population for our study (2.6% and 4.3% defined by administrative codes and laboratory values, respectively) is consistent with a previous study which estimated chronic kidney disease prevalence in the general population of Canada measured by laboratory values as 3.1%.[18]

Several previous studies have used Ontario's administrative health care data to examine the prevalence of chronic diseases in registered Métis citizens compared with the general population. These studies found elevated rates of related diseases such as diabetes and cardiovascular disease among Métis citizens, which aligns with our finding of a slightly higher prevalence of chronic kidney disease.[19-21]

These previous studies on rates of diabetes and cardiovascular disease reported age and sex standardized results,[19,22] where our findings were based on Métis citizens matched to the general population on age, sex, and area of residence.

Importantly, results were unchanged when we removed the matching criterion for area of residence, suggesting that rates of kidney disease are similar between Métis citizens and the age-matched and sex-matched general population in Ontario, regardless of geographic location. This is important because the majority of Métis citizens reside in smaller urban communities in Northern Ontario with potentially less access to health care compared with the general Ontario population.[9]

In this study, rates of hospitalization with acute kidney injury were similar for Métis citizens and the general population. In a secondary analysis, we found that a significantly higher proportion of Métis citizens died within 1 year of hospital discharge; however, it is important to interpret this result with caution given that this secondary analysis was conducted in a very small subsample of the original cohort (106 Métis and 386 individuals from the general population) and spurious findings can arise in multiple subgroup comparisons. As well, the small number of events meant we were unable to retain the matching on baseline characteristics and so these results could be influenced by between-group differences in age, sex, and area of residence or also by higher comorbidities among Métis citizens, which has been documented in other reports.[8,19,21,22] Nonetheless, even if this result could be explained by differences in baseline risk, from a public health perspective, a potentially higher rate of mortality in this subgroup is a cause for concern and requires further investigation, particularly with respect to follow-up care after acute kidney injury. The Acute Kidney Injury Guidelines set by Kidney Disease Improving Global Outcomes (KDIGO)[23] recommend that patients diagnosed with acute kidney injury be evaluated 3 months after the episode. While we were not able to examine follow-up care in the present study due to small sample sizes, future investigations should examine the overall quality of care and whether appropriate follow-up care occurs after an episode of acute kidney injury.

Previous research shows that Indigenous people living in Canada have rates of kidney disease that are 2 to 3 times higher compared with the general population.[1,24,25] However, when we looked specifically at the Métis population, we found that registered Métis citizens had rates of kidney disease that were similar, or only slightly higher, compared with a matched sample from the general population. The Métis are a distinct Indigenous people, and it is possible that a potentially lower risk among the Métis population may be explained by genetic or environmental factors or by differences in the way health care is provided, for example, via provincial or federal jurisdictions.[26] As well, Métis do not live on reserves and are more likely to reside in urban centres,[27] which may provide better access to health care. A 2004 CIHI report found that several social and economic indicators of health (including income, employment, and education levels) were lower among First Nations people compared with Métis people.[8] The Métis are the fastest growing Indigenous population in Canada, so it is important to continue further investigation of kidney outcomes in this population.[9]

Limitations

It is important to consider that the Citizenship Registry of the MNO captures only about 20% of the total Métis population in Ontario and may not be representative of the entire Métis population in Ontario. The registry is populated by individuals who choose to register, and registered citizens may differ from nonregistered citizens on important demographic, behavioral, and clinical factors. For example, some Métis may be motivated to register to gain certain benefits, such as access to harvesting and hunting rights, an activity more likely to be pursued by healthier individuals. These selection biases may have affected our rates of kidney disease, and our estimates may not be generalizable to the wider Métis population residing in Ontario.

Administrative data are widely used for the surveillance of chronic diseases because it is an efficient method to obtain measures on the burden of a disease for an entire population. The health administrative data in Ontario are held at ICES, making them readily available and can be linked to many other databases to create cohorts of the entire Ontario population. However, administrative data have limitations including a lack of comprehensive clinical detail, coding errors, and potential biases related to the method of data collection, such as physician claims data. We have previously shown that the administrative health care codes used to identify kidney disease are highly specific but lack sensitivity.[14,16] In other words, there is a low false positive rate, but not all patients with kidney disease will be captured. Specifically, older patients with administrative diagnostic codes for chronic kidney disease had lower eGFR values than individuals without these codes (38 vs 69 mL/min/1.73 m^2).[14] Also, in a previous validation study, we showed that hospitalized patients with a diagnostic code for acute kidney injury had a median increase in serum creatinine of 98 μmol/L (IQR, 43-200) from their prehospitalization baseline value. By contrast, hospitalized patients with no diagnostic code for acute kidney injury had a median serum creatinine increase of 6 μmol/L (IQR, −4-20).[16] While we also assessed kidney disease using laboratory tests for serum creatinine, our hospital laboratory data used to assess acute kidney injury incidence are limited to a subsample of individuals who visit a Cerner hospital in Southwestern Ontario (only 5% of the study cohort). With regard to outpatient values used to identify prevalence of chronic kidney disease and baseline values to assess acute kidney injury, we only used laboratory data from Dynacare, which is 1 of the 3 largest outpatient laboratories in Ontario. Since the laboratory data is not available for all of Ontario, it is underestimating the true burden of acute kidney injury and chronic kidney disease in both populations. We are in the process of acquiring the Ontario Laboratories Information System (OLIS) database, which will have all outpatient laboratory tests completed in Ontario, including proteinuria data. We plan to conduct further analyses on this cohort once OLIS becomes available to use. Another important limitation of both administrative and laboratory data is

that it only captures those who have accessed the health care system. This is an important issue for studies of the Métis population since we know from other studies that Métis citizens are less likely to access physician and/or specialist services compared with the non-Aboriginal population, suggesting a significant potential for both underdiagnosis and undertreatment of chronic disease relative to the general population in Ontario.[28] While it is possible that access may be different between the Métis and general population in our study, it is not likely since the baseline health care use of these 2 groups was similar. Finally, as we cannot identify nonregistered Métis citizens in our data sets, these individuals may have been included in our matched general population sample.

Conclusions

In this 10-year study of kidney disease among registered Métis citizens and a matched sample from the general Ontario population, we found a slightly higher prevalence of chronic kidney disease and similar incidence rates of acute kidney injury and end-stage kidney disease. Although these results are reassuring, further research is needed to replicate findings and inform practice.

Appendix A

Checklist of Recommendations for Reporting of Observational Studies Using the REporting of Studies Conducted Using Observational Routinely-Collected Health Data (RECORD) Statement.[12]

	Item number	STROBE items	RECORD items	Reported
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract. (b) Provide in the abstract an informative and balanced summary of what was done and what was found.	(1.1) The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. (1.2) If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract. (1.3) If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Abstract
Introduction				
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported.		Background
Objectives	3	State specific objectives, including any prespecified hypotheses.		Background
Methods				
Study design	4	Present key elements of study design early in the article.		Methods—Design and Setting
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection.		Methods
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up. (b) For matched studies, give matching criteria and number of exposed and unexposed.	(6.1) The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. (6.2) Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided.	Methods—Chronic Kidney Disease, Acute Kidney Injury, End-Stage Kidney Disease, Figure 1, Appendix B

(continued)

Appendix A. (continued)

	Item number	STROBE items	RECORD items	Reported
			(6.3) If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	(7.1) A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Methods—Chronic Kidney Disease, Acute Kidney Injury, End-Stage Kidney Disease, Appendix B
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group.		Methods—Data Sources, Chronic Kidney Disease, Acute Kidney Injury, End-Stage Kidney Disease
Bias	9	Describe any efforts to address potential sources of bias.		Methods—Cohort Selection
Study size	10	Explain how the study size was arrived at.		Figure 1
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.		Methods—Baseline Characteristics, Table 1
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding. (b) Describe any methods used to examine subgroups and interactions. (c) Explain how missing data were addressed. (d) If applicable, explain how loss to follow-up was addressed. (e) Describe any sensitivity analyses.		Statistical Analysis
Data access and cleaning methods		N/A	(12.1) Authors should describe the extent to which the investigators had access to the database population used to create the study population. (12.2) Authors should provide information on the data cleaning methods used in the study.	Figure 1
Linkage		N/A	(12.3) State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	Methods—Data Sources

(continued)

Appendix A. (continued)

	Item number	STROBE items	RECORD items	Reported
Results				
Participants	13	(a) Report numbers of individuals at each stage of study—for example, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed. (b) Give reasons for nonparticipation at each stage. (c) Consider use of a flow diagram.	(13.1) Describe in detail the selection of the persons included in the study (ie, study population selection), including filtering based on data quality, data availability, and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Figure 1, Results
Descriptive data	14	(a) Give characteristics of study participants (eg, demographic, clinical, social) and information on exposures and potential confounders. (b) Indicate number of participants with missing data for each variable of interest. (c) Summarize follow-up time (eg, average and total amount).		Results—Baseline Characteristics, Chronic Kidney Disease, Acute Kidney Injury, End-Stage Kidney Disease, Table 1
Outcome data	15	Report numbers of outcome events or summary measures over time.		Results—Chronic Kidney Disease, Acute Kidney Injury, End-Stage Kidney Disease, Tables 2, 3
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included. (b) Report category boundaries when continuous variables were categorized. (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period.		Results, Tables 2, 3
Other analyses	17	Report other analyses done (eg, analyses of subgroups and interactions, and sensitivity analyses).		Sensitivity Analyses
Key results	18	Summarize key results with reference to study objectives.		Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	(19.1) Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Discussion—Limitations

(continued)

Appendix A. (continued)

	Item number	STROBE items	RECORD items	Reported
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.		Discussion
Generalizability	21	Discuss the generalizability (external validity) of the study results.		Conclusion
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based.		Acknowledgments
Accessibility of protocol, raw data, and programming code		N/A	(22.1) Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	N/A

Appendix B

Administrative Health Care Codes Used to Define Kidney Disease.

Kidney Disease Type	Source	Code	Description
Chronic Kidney Disease[a]	Defined as evidence of at least one of the chronic kidney disease validated administrative diagnostic codes during the follow-up period		
	CIHI-DAD[b]	E102	Type 1 diabetes mellitus with incipient diabetic nephropathy adequately or inadequately controlled with insulin, diet, oral agents
		E112	Type 2 diabetes mellitus with incipient diabetic nephropathy adequately or inadequately controlled with insulin, diet, oral agents
		E132	Other specified diabetes mellitus with incipient diabetic nephropathy adequately or inadequately controlled with insulin, diet, oral agents
		E142	Unspecified diabetes mellitus with incipient diabetic nephropathy adequately or inadequately controlled with insulin, diet, oral agents
		I12	Hypertensive renal disease
		I13	Hypertensive renal and heart disease
		N08	Glomerular disorders in diseases classified elsewhere
		N18	Chronic renal failure
		N19	Unspecified renal failure
	OHIP diagnosis code	403	Hypertensive renal disease
		585	Chronic renal failure, uremia
Acute Kidney Injury[a]	Defined as evidence of the acute kidney injury validated administrative diagnostic code during the follow-up period		
	CIHI-DAD[b]	N17	Acute renal failure
End-Stage Kidney Disease	End-stage kidney disease defined as evidence of at least one treatment code for chronic dialysis (hemodialysis or peritoneal dialysis) or kidney transplantation during the follow-up period		
End-Stage Kidney Disease - Dialysis	CORR Treatment Code	111	1: Acute Care Hospital, 1: Conventional Hemodialysis, 1: Total Care
		112	1: Acute Care Hospital, 1: Conventional Hemodialysis, 2: Limited Self-Care

(continued)

Appendix B. (continued)

Kidney Disease Type	Source	Code	Description
		113	1: Acute Care Hospital, 1: Conventional Hemodialysis, 3: Total Self-Care
		121	1: Acute Care Hospital, 2: Short Daily Hemodialysis, 1: Total Care
		122	1: Acute Care Hospital, 2: Short Daily Hemodialysis, 2: Limited Self-Care
		123	1: Acute Care Hospital, 2: Short Daily Hemodialysis, 3: Total Self-Care
		131	1: Acute Care Hospital, 3: Slow Nocturnal Hemodialysis, 1: Total Care
		132	1: Acute Care Hospital, 3: Slow Nocturnal Hemodialysis, 2: Limited Self-Care
		133	1: Acute Care Hospital, 3: Slow Nocturnal Hemodialysis, 3: Total Self-Care
		211	2: Chronic Care Hospital, 1: Conventional Hemodialysis, 1: Total Care
		221	2: Chronic Care Hospital, 2: Short Daily Hemodialysis, 1: Total Care
		231	2: Chronic Care Hospital, 3: Slow Nocturnal Hemodialysis, 1: Total Care
		311	3: Community Centre, 1: Conventional Hemodialysis, 1: Total Care
		312	3: Community Centre, 1: Conventional Hemodialysis, 2: Limited Self-Care
		313	3: Community Centre, 1: Conventional Hemodialysis, 3: Total Self-Care
		321	3: Community Centre, 2: Short Daily Hemodialysis, 1: Total Care
		322	3: Community Centre, 2: Short Daily Hemodialysis, 2: Limited Self-Care
		323	3: Community Centre, 2: Short Daily Hemodialysis, 3: Total Self-Care
		331	3: Community Centre, 3: Slow Nocturnal Hemodialysis, 1: Total Care
		332	3: Community Centre, 3: Slow Nocturnal Hemodialysis, 2: Limited Self-Care
		333	3: Community Centre, 3: Slow Nocturnal Hemodialysis, 3: Total Self-Care
		413	4: Home, 1: Conventional Hemodialysis, 3: Total Self-Care
		423	4: Home, 2: Short Daily Hemodialysis, 3: Total Self-Care
		433	4: Home, 3: Slow Nocturnal Hemodialysis, 3: Total Self-Care
		141	1: Acute Care Hospital, 4: CAPD, 1: Total Care
		151	1: Acute Care Hospital, 5: APD, 1: Total Care
		152	1: Acute Care Hospital, 5: APD, 2: Limited Self-Care
		241	2: Chronic Care Hospital, 4: CAPD, 1: Total Care
		242	2: Chronic Care Hospital, 4: CAPD, 2: Limited Self-Care
		252	2: Chronic Care Hospital, 5: APD, 2: Limited Self-Care
		443	4: Home, 4: CAPD, 3: Total Self-Care
		453	4: Home, 5: APD, 3: Total Self-Care
End-Stage Kidney Disease—Kidney Transplant	For evidence of Kidney Transplant; must have the CORR Treatment Code with at least one CORR Transplant Organ Type Code.		
	CORR Treatment Code	171	1: Acute Care Hospital, 7: Transplantation, 1: Total Care
	CORR Transplant Organ Type Code	10	Kidneys/dialysis (includes en bloc transplants)
		11	Kidney: Left

(continued)

Appendix B. (continued)

Kidney Disease Type	Source	Code	Description
		12	Kidney: Right
		18	Kidney: One (from conversion)
		19	Kidney: Two (from conversion)
Non-recovery of acute kidney injury resulting in chronic dialysis	Non-recovery of kidney function and dialysis dependence at 90 days from the date of hospital discharge from acute kidney injury event. This is defined as at least one code of the following between day 76 and Day 104 from hospital discharge date.		
	OHIP Fee code	R849	Dialysis: Hemodialysis—initial and acute
		R850	Dialysis: Hemodialysis—insert of Scribner shunt
		G323	Dialysis: Hemodialysis—acute, repeat (maximum 3)
		G325	Dialysis: Hemodialysis—medical component (including in unit fee)
		G326	Dialysis: Chronic, continuous hemodialysis or hemofiltration
		G330	Peritoneal dialysis—acute (up to 48 h)
		G331	Peritoneal dialysis—repeat, acute (up to 48 h) maximum 3
		G332	Peritoneal dialysis—chronic (up to 48 h)
		G860	Chronic hemodialysis hospital location
		G333	Home/self-care dialysis
		G083	Continuous venovenous hemodialysis
		G091	Continuous arteriovenous hemodialysis
		G085	Continuous venovenous hemofiltration
		G295	Continuous aterivenous hemofiltration initial and acute
		G082	Continuous venovenous hemodialfiltration
		G090	Veneovenous slow continuous ultrafiltration
		G092	Continuous arteriovenous hemodiafiltration
		G093	Hemodiafiltration: Continuous initial and acute (repeatx3)
		G094	Hemodiafiltration: Continuous Chronic
		G861	Chronic peritoneal dialysis hospital location
		G862	Hospital self-care Chronic hemodialysis
		G863	Chronic hemodialysis IHF location
		G864	Chronic Home peritoneal dialysis
		G865	Chronic Home hemodialysis
		G866	Intermittent hemodialysis treatment center
		G294	Arteriovenous slow continuous ultrafiltration init and acute
		G095	Slow Continuous Ultra Filtration: initial and acute (repeat)
		G096	Slow Continuous Ultra Filtration: Chronic
Acute kidney injury requiring short-term dialysis	During hospitalization with acute kidney injury, evidence of at least one acute dialysis code.		
	OHIP Fee code	R849	Dialysis: Hemodialysis—initial and acute
		G323	Dialysis: Hemodialysis—acute, repeat (maximum 3)
		G866	Intermittent hemodialysis treatment center
		G330	Peritoneal dialysis—acute (up to 48 h)
		G331	Peritoneal dialysis—repeat acute (up to 48 h) maximum 3
		G093	Hemodiafiltration—continuous initial and acute (repeatx3)
		G095	Slow Continuous Ultra Filtration—initial and acute (repeat)
		G294	Arteriovenous slow continuous ultrafiltration initial and acute
		G295	Continuous aterivenous hemofiltration initial and acute

Note. CIHI-DAD = Canadian Institute for Health Information's Discharge Abstract Database; OHIP = Ontario Health Insurance Plan; CORR = Canadian Organ Replacement Register; ICD-10 = International Classifications of Diseases, 10th revision.
[a]Chronic kidney disease and acute kidney injury codes have been validated. See the studies of Fleet et al[14] and Hwang et al.[16]
[b]ICD-10 code type was used.

List of Abbreviations

AMOSO, Academic Medical Organization of Southwestern Ontario; CIHI, Canadian Institute for Health Information; CIHI-DAD, Canadian Institute for Health Information's Discharge Abstract Database; CIHR, Canadian Institutes of Health Research; CORR, Canadian Organ Replacement Register; eGFR, estimated glomerular filtration rate; ICD-10, International Classification of Diseases, 10th revision; ICES, Institute for Clinical Evaluative Sciences; IQR, Interquartile range; KDIGO, Kidney Disease Improving Global Outcomes; KDT, Kidney, Dialysis and Transplantation Research Program; LHIN, Local Health Integration Network; LHRI, Lawson Health Research Institute; MNO, Métis Nation of Ontario; MOHLTC, Ontario Ministry of Health and Long-Term Care; OHIP, Ontario Health Insurance Physician Claims Database; RECORD, Reporting of studies Conducted using Observational Routinely-collected health Data Statement; SD, Standard deviation; SSMD, Schulich School of Medicine and Dentistry.

Ethics Approval and Consent to Participate

We conducted all analyses according to a pre-specified protocol that was approved by the institutional review board at Sunnybrook Health Sciences Centre (Toronto, Ontario, Canada). ICES is a designated prescribed entity under Section 45 of the Personal Health Information Protection Act (PHIPA). Participant informed consent was not required for this study.

Consent for Publication

Not applicable.

Availability of Data and Materials

The data set from this study is held securely in coded form at the Institute for Clinical Evaluative Sciences (ICES). While data sharing agreements prohibit ICES from making the data set publicly available, access can be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS. The full data set creation plan is available from the authors upon request.

Authors' Note

S.J.R. is the Senior Policy and Research Analyst at the Métis Nation of Ontario (MNO). A.X.G. is the Program Lead of ICES KDT. This study was conducted by the Institute for Clinical Evaluative Sciences (ICES) Western facility through the ICES Kidney, Dialysis and Transplantation (KDT) Research Program. Parts of this material are based on data and information compiled and provided by CIHI. However, the analyses, conclusions, opinions, and statements expressed herein are those of the author, and not necessarily those of CIHI. The opinions expressed in this publication are those of the authors/researchers and do not necessarily reflect the official views of the Public Health Agency of Canada.

Author Contributions

J.S.H., E.M., D.M.N., S.J.R., S.K., and A.X.G. developed the initial study plan. All authors provided input and approved of the study and analysis plan. E.M. completed all analyses. All authors interpreted the results. J.S.H., E.M., D.M.N., and J.M.S. drafted the initial manuscript and all other authors critically reviewed and revised the manuscript. All authors read and approved the final manuscript.

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Declaration of Conflicting Interests

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