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A Retrospective Study of Chronic Kidney Disease Burden in Saskatchewan's First Nations People

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Abstract

Background: Chronic kidney disease is more prevalent among First Nations people than in non-First Nations people. Emerging research suggests that First Nations people are subject to greater disease burden than non-First Nations people.
Objective: We aimed to identify the severity of chronic kidney disease and quantify the geographical challenges of obtaining kidney care by Saskatchewan's First Nations people.
Design: This study is a retrospective analysis of the provincial electronic medical record clinical database from January 2012 to December 2013.
Setting: The setting involved patients followed by the Saskatchewan provincial chronic kidney care program, run out of two clinics, one in Regina, SK, and one in Saskatoon, SK.
Patients: The patients included 2478 individuals (379 First Nations and 2099 non-First Nations) who were older than 18 years old, resident in Saskatchewan, and followed by the provincial chronic kidney care program. First Nations individuals were identified by their Indigenous and Northern Affairs Canada (INAC) Number.
Measurements: The demographics, prevalence, cause of end-stage renal disease, severity of chronic kidney disease, use of home-based therapies, and distance traveled for care among patients are reported.
Methods: Data were extracted from the clinical database used for direct patient care (the provincial electronic medical record database for the chronic kidney care program), which is prospectively managed by the health care staff. Actual distance traveled by road for each patient was estimated by a Geographic Information System Analyst in the First Nations and Inuit Health Branch of Health Canada.
Results: Compared with non-First Nations, First Nations demonstrate a higher proportion of end-stage renal disease (First Nations = 33.0% vs non-First Nations = 21.4%, $P < .001$), earlier onset of chronic kidney disease (M_{FN} = 56.4 years, SD = 15.1; M_{NFN} = 70.6 years, SD = 14.7, $P < .001$), and higher rates of end-stage renal disease secondary to type 2 diabetes (First Nations = 66.1% vs non-First Nations = 39.0%, $P < .001$). First Nations people are also more likely to be on dialysis (First Nations = 69.7% vs non-First Nations = 40.2%, $P < .001$), use home-based therapies less frequently (First Nations = 16.2% vs non-First Nations = 25.7%; $P = 003$), and must travel farther for treatment ($P < .001$), with First Nations being more likely than non-First Nations to have to travel greater than 200 km.
Limitations: Patients who are followed by their primary care provider or solely through their nephrologist's office for their chronic kidney disease would not be included in this study. Patients who self-identify as Aboriginal or Indigenous without an INAC number would not be captured in the First Nations cohort.
Conclusions: In Saskatchewan, First Nations' burden of chronic kidney disease reveals higher severity, utilization of fewer home-based therapies, and longer travel distances than their non-First Nations counterparts. More research is required to identify innovative solutions within First Nations partnering communities.

Abrégé

Contexte: La prévalence de l'insuffisance rénale chronique (IRC) est plus élevée chez les autochtones (AUT) que chez les allochtones (ALL); de nouvelles études indiquent que les Premières Nations seraient davantage affligés que les allochtones par le fardeau de la maladie.
Objectifs: Notre objectif était bipartite : i) mesurer la gravité de l'IRC chez les autochtones et; ii) quantifier le défi géographique posé par la distance que les Saskatchewanais autochtones ont à parcourir pour obtenir des soins de santé rénale.

Type d'étude: L'étude est une analyse rétrospective de la base de données provinciale des dossiers médicaux informatisés pour la période s'échelonnant de janvier 2012 à décembre 2013.
Cadre: L'étude concerne les patients suivis dans deux cliniques saskatchewanaises (une à Régina et une autre à Saskatoon) participant au programme provincial de soins des maladies rénales chroniques.
Sujets: L'étude porte sur 2 478 patients adultes (379 autochtones et 2 099 allochtones) résidents de la Saskatchewan et suivis par le programme provincial de soins des maladies rénales chroniques. Les membres des Premières Nations ont été identifiés par leur numéro de Certificat de statut Indien (CSI) émis par le ministère des Affaires Autochtones et du Nord Canada (AADNC*).
Mesures: Ont été colligées les données démographiques des patients, la prévalence de la maladie, les causes de l'insuffisance rénale terminale (IRT), la gravité de l'atteinte, le recours ou non à des traitements à domicile, et la distance à parcourir pour obtenir des soins.
Méthodologie: Les données ont été extraites de la base de données cliniques utilisée pour les soins directs aux patients (dossiers médicaux informatisés du programme de soin des maladies rénales chroniques), gérée prospectivement par le personnel soignant. La distance parcourue par le patient pour obtenir des soins a été estimée par un analyste du système d'informations géographiques de la Direction générale de la santé des Premières Nations et des Inuits, de Santé Canada.
Résultats: Comparativement aux patients allochtones, les patients autochtones : présentaient une plus grande prévalence d'IRT (33,0 % vs 21,4 %; $p < 0{,}001$); présentaient un déclenchement plus précoce de la maladie (âge moyen$_{AUT}$: 56,4 ans [*SD*=15,1]; âge moyen$_{ALL}$: 70,6 ans [*SD*=14,7]; $p < 0{,}001$) et un taux plus élevé d'IRT consécutive à un diabète de type 2 (66,1 % vs 39,0 %; $p < 0{,}001$); étaient plus susceptibles d'être dialysés (69,7 % vs 40,2 %; $p < 0{,}001$); recouraient moins à des traitements à domicile (AUT : 16,2 %; ALL : 25,7 %; $p = 0{,}003$); et étaient contraints de se déplacer davantage pour suivre leurs traitements ($p < 0{,}001$) — notamment, les autochtones étaient plus susceptibles de devoir parcourir au-delà de 200 km pour obtenir des soins.
Limites: Les patients qui recevaient leurs traitements chez leur fournisseur de soins primaires ou uniquement via le cabinet de leur néphrologue n'étaient pas inclus dans l'étude. Les patients s'identifiant comme autochtones, mais ne possédant pas de numéros de CSI, n'ont pu être répertoriés aux fins de l'étude.
Conclusion: En Saskatchewan, le fardeau différentiel que représente l'IRC chez les gens issus des Premières Nations se traduit par une atteinte plus sévère, par un moindre recours aux traitements à domicile et par de plus grandes distances à parcourir pour obtenir des soins. Des recherches supplémentaires sont requises pour proposer des solutions innovantes aux communautés partenaires des Premières Nations.

Keywords
First Nation, chronic kidney disease, dialysis modality, travel burden, quality of life

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What was known before

First Nation people have higher incidence and prevalence of chronic kidney disease than non-First Nation people. In other provinces, this is also reflected in higher burden of disease indicated by higher rates of severe disease. In addition, recent gross estimates of travel burden suggest that First Nation people travel longer distances for care.

What this adds

This is the first study in Saskatchewan to highlight that the First Nations people of Saskatchewan are burdened with higher severity of chronic kidney disease than non-First Nation people. Furthermore, using geomatically derived estimates of actual distance via highway, this study supports that First Nations people are also burdened with traveling longer distances for kidney care.

Introduction

Chronic kidney disease (CKD), and its related comorbidities, is more prevalent among First Nations than non-First Nations people, and at diagnosis, First Nations people present with more advanced disease.[1-3] Among CKD patients who progress to end-stage renal disease, treatment choices impacting quality of life can contribute to disease

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burden. Patients with end-stage renal disease choose a renal replacement therapy, ie, dialysis or transplantation, or, alternatively, choose a palliative care approach. Dialysis therapies include peritoneal dialysis or hemodialysis and may be delivered in a skilled nursing facility at an urban center ("in-center"), in an affiliated rural center (satellite), or, if qualified, within the patient's home. Patients utilizing home peritoneal dialysis are more satisfied with treatment and minimize their transportation and treatment time.[4-7] First Nations people appear less likely to initiate home peritoneal dialysis,[8] but the reasons for this are unclear. Chronic kidney disease burden may also be reflected in First Nations' access to care; however, a formal analysis of the burden of travel due to CKD has not yet been completed in Saskatchewan. Previous literature suggests that First Nations travel farther than non-First Nations to access care from primary care providers,[1] yet kidney health services are concentrated in urban areas, with 75% of hemodialysis patients receiving in-center hemodialysis in Regina or Saskatoon.[9] Understanding the burden of CKD in First Nations people is important to delivering quality, culturally competent care to First Nations people.

Our current understanding of the burden of CKD in aboriginal and indigenous communities in Canada reveals that severe CKD is nearly 2-fold higher in neighboring prairies provinces of Manitoba and Alberta.[10,11] As expected, the main risk factors for CKD include diabetes and hypertension. International literature reveals similar findings in several Native American populations[12,13] as well as Australian indigenous populations.[14] Interestingly, differences in rates of CKD and comorbid risk factors do occur within regional boundaries of the Northern Territory of Australia.[14] This would suggest that it is important to identify regional differences as potential solutions may need to address these differences. Within Canada, contemporary studies of CKD burden in Saskatchewan have been limited.

Using Saskatchewan's Chronic Kidney Disease Program and the provincial clinical hemodialysis databases, which are used for direct patient care and have a large number of variables related to processes of care, we proposed to investigate relevant epidemiological data to understand key differences in CKD between First Nations and non-First Nations populations. The aim of this study was to clarify the current landscape of CKD burden in First Nations people using demographic data and exploring access to care via dialysis modality and estimates of travel distances. Our primary research question was whether there was an overall difference between First Nations and non-First Nations people in Saskatchewan with respect to disease burden of CKD. Based on the previous literature[15] and clinical experience, we hypothesized that First Nations people would carry a higher disease burden, as defined by stage of CKD, choice of dialysis modality, and required travel distances for dialysis. Using a clinical database, which is used and maintained by trained practitioners in direct patient care, we would anticipate that our data would more accurately reflect the true disease burden than an administrative billing database which informs the current literature. Furthermore, previous studies have analyzed distances traveled via "as-the-crow flies"[16] whereas our study used geomatical methods to estimate actual ground travel; therefore, our study presents a more realistic picture of travel burden. For the purposes of this study, we were predominantly concerned with the overall differences in disease burden on the First Nations communities, rather than specific contributory factors to the development and progression of CKD.

Methods

Study Design

This observational, cross-sectional design study included all individuals receiving care for CKD in Saskatchewan over a 2-year period. This study received ethics approval through the Federation of Saskatchewan Indians Nations (FSIN; now Federation of Sovereign Indian Nations) and research ethics approval from the Regina Qu'Appelle Health Region (RQHR) and the University of Saskatchewan (including Saskatoon Health Region) via Saskatchewan's provincial harmonized research ethics review process.

This study was performed in cooperation with FSIN and it is in keeping with the First Nations Principles of Ownership, Control, Access and Possession, OCAP®. (OCAP® is a registered trademark of the First Nations Information Governance Centre, www.FNIGC.ca/OCAP.)

Inclusion criteria were age older than 18 years; receiving kidney care in the province between January 1, 2012, and December 31, 2013; having CKD with a valid *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*, 1996); and residence within the province of Saskatchewan. Exclusion criteria were diagnosis of acute kidney injury, incomplete or inaccurate *ICD-9-CM*, or those codes that did not reliably specify the chronicity of kidney disease. See Appendix A for a flowchart demonstrating application of the inclusion/exclusion criteria, and Appendices B-C and D-E for the included and excluded *ICD-9-CM* codes, respectively.

ICD (*International Classification of Diseases*) Codes were used to establish the diagnosis of CKD and then individuals were staged via estimated glomerular filtration rate (eGFR) status and First Nations status.

Data Sources

Collected data included demographic characteristics (age, gender), disease characteristics (stage of CKD, use of dialysis), comorbid disease, and an estimate of distance traveled for treatment. For this study, First Nations people

Table 1. Demographic Data and Indicators of Disease Burden of CKD in Saskatchewan (N = 2478).

	First Nations (n = 379)	Non-First Nations (n = 2099)	χ^2 or t (P)
Gender (male), N (%)	205 (54.1)	1256 (59.9)	$\chi^2_1 = 4.428$ (.035)
Mean age, years (SD)	56.4 (15.1)	70.6 (14.7)	$t_{2476} = -17.162$ (.001, two-tailed)
Population in Saskatchewan, 2011	103 205[a]	905 550[b]	
CKD secondary to type 2 diabetes, N (%)	250 (66.1)	818 (39.0)	$\chi^2_1 = 95.375$ (.001)
Patients receiving any dialysis modality,[c] N (%)	264 (69.7)	844 (40.2)	$\chi^2_1 = 112.612$ (.001)
Patients who received renal transplant, N (%)	6 (1.7)	22 (1.4)	$\chi^2_1 = 0.212$ (.645)
Age at death, years (SD)	61.9 (13.3)	75.6 (11.6)	$t_{2052} = -15.422$ (.001)

Note. Percentages may not equal 100% due to rounding; where total N does not equal 2478, this is due to missing data points. CKD = chronic kidney disease.
[a]Statistics Canada.[17]
[b]Statistics Canada.[17] Calculated from total population of 1 008 760—First Nation population of 103 205 = 905 550, this value would include those who identify as Metis, Inuit, or with dual aboriginal identities.
[c]Includes conventional hemodialysis, satellite or home hemodialysis, etc.

were defined as Registered First Nations with an Indigenous and Northern Affairs Canada (INAC) Number; all others were defined as non-First Nations. Data were collected at the start of the study period on January 01, 2012, and again at the end of the study period on December 31, 2013.

All kidney health care in Saskatchewan is coordinated through the Saskatoon and Regina nephrology programs. Staff at both locations prospectively manage the clinical CKD and hemodialysis databases, which include all patients enrolled in the CKD and renal replacement programs (including in-center hemodialysis, satellite hemodialysis, peritoneal dialysis, home hemodialysis, and transplant services). Data were extracted from these databases by kidney program staff and de-identified.

Distance traveled by each client to access services was estimated courtesy of a Geographic Information System analyst in the First Nations and Inuit Health Branch (FNIHB) of Health Canada, Alberta Region. This analyst calculated actual distance traveled by road via the shortest distance possible between a patient's home residence (based on postal code) and their treatment location.

Statistical Analyses

Inferential statistics (chi-squares, independent-samples t tests, analysis of variance [ANOVA]) were used to determine whether significant differences existed between First Nations and non-First Nations. Unless otherwise stated, the valid percentage is used where missing data are present.

Results

Demographics and CKD Features

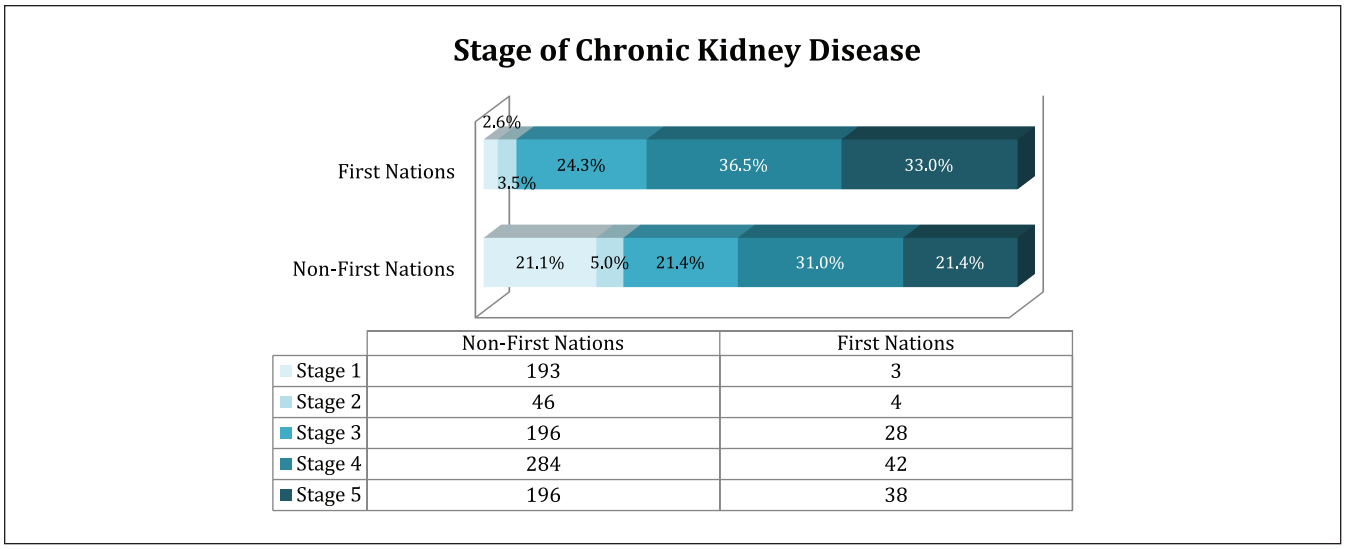
There were significant differences in sex distribution and age in First Nations versus non-First Nations (Table 1). Although there were a higher proportion of men with CKD than women in both groups, this difference was more pronounced in the non-First Nations group. Women represented a higher proportion of the CKD population within First Nations than non-First Nations. Among people with CKD, First Nations people are, on average, 14 years younger than non-First Nations.

Type 2 diabetes was the leading cause of CKD in First Nations people, significantly more frequently than for non-First Nations (Table 1). We explored other causes of CKD, such as glomerular disease, but the rate of CKD due to glomerular causes was not statistically significant between First Nations and non-First Nations, potentially due to small sample size.

In this snapshot of relative disease burden, First Nations people presented with more severe cases of CKD (defined as stage 5) overall than did non-First Nations people (Figure 1). A post hoc analysis of the adjusted residuals (AdjR) demonstrates that First Nations are underrepresented in the CKD 1 stage (AdjR = −4.0) and overrepresented in the CKD 5 stage (AdjR = 2.3). A significantly higher proportion of First Nations patients received dialysis of any type.

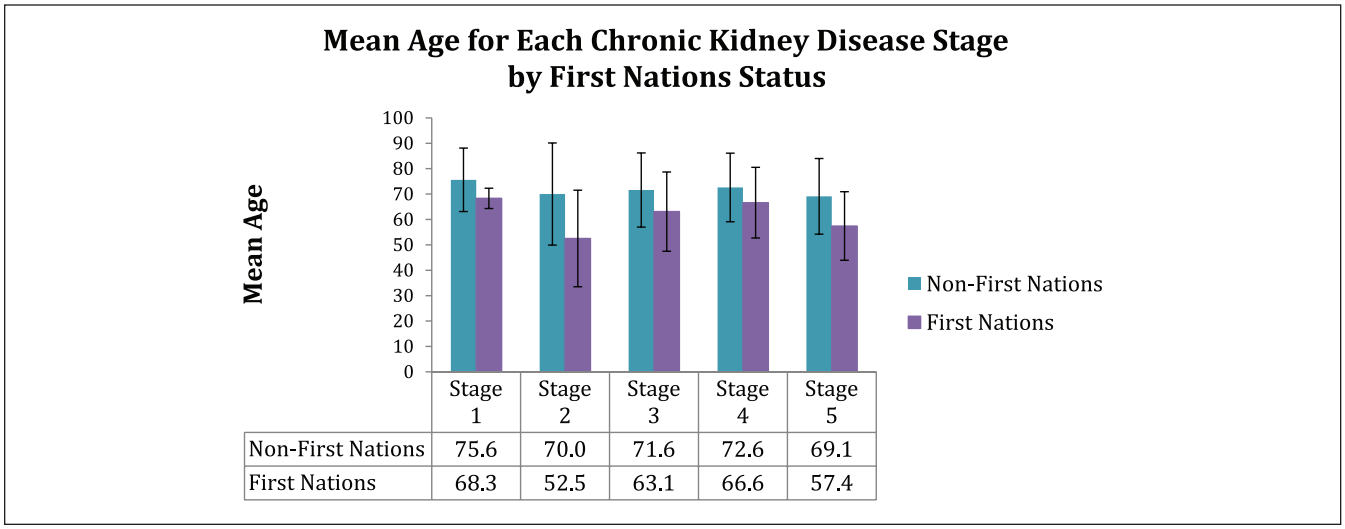
A 2 (First Nations status) × 5 (chronic kidney disease stage) factorial ANOVA showed a significant main effect for CKD stage, $F_{4,1020} = 4.407$, $P = .002$ with regard to patient age (Figure 2). Post hoc analyses revealed that there were significant differences ($P < .05$) between stage 1 and all other stages, as well as between stages 4 and 5. There was also a significant main effect for First Nations status, $F_{1,1020} = 18.160$, $P < .001$. The interaction between First Nations status and CKD stage was nonsignificant, $F_{4,1020} = 1.026$, $P = .393$.

A higher proportion of First Nations people are on any form of dialysis, but there was no difference in rates of kidney transplantation between First Nations and non-First Nations people (Table 1). The average age of death for



	Non-First Nations	First Nations
Stage 1	193	3
Stage 2	46	4
Stage 3	196	28
Stage 4	284	42
Stage 5	196	38

Figure 1. Distribution of chronic kidney disease stages among First Nations and non-First Nations patients in Saskatchewan followed by the Saskatchewan chronic kidney disease program (comparing stage 5 First Nations people and non-First Nations people demonstrated significant differences [$\chi^2_4 = 26.295$, $P < .001$]).
Note. Chronic kidney disease stage data were available for 115 out of 379 First Nations patients (30.3%) and for 915 out of 2099 non-First Nations patients (43.6%).



	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Non-First Nations	75.6	70.0	71.6	72.6	69.1
First Nations	68.3	52.5	63.1	66.6	57.4

Figure 2. Mean age of First Nations and non-First Nations patients at each stage of chronic kidney disease at end of study.
Note. Error bars represent the standard deviation.

First Nations people with CKD is 13.7 years younger than non-First Nations people (independent samples) (Table 1).

Dialysis Modality and Location; Estimates of Travel

There was a significant difference between First Nations and non-First Nations people with respect to in-center dialysis versus dialysis in a satellite center versus in-home dialysis (Figure 3). A greater proportion of First Nations people received dialysis at a satellite location (AdjR = 3.2), but utilized home dialysis significantly less frequently than did non-First Nations people (AdjR = −2.6). Groups did not differ in their use of in-center urban dialysis (AdjR = ±0.9).

First Nations and non-First Nations differed in distance traveled for all kidney services (Figure 4). First Nations are less likely than non-First Nations to travel 50 km or fewer for kidney services (AdjR = −6.3). Conversely, First Nations are more likely to travel 200 km or greater for

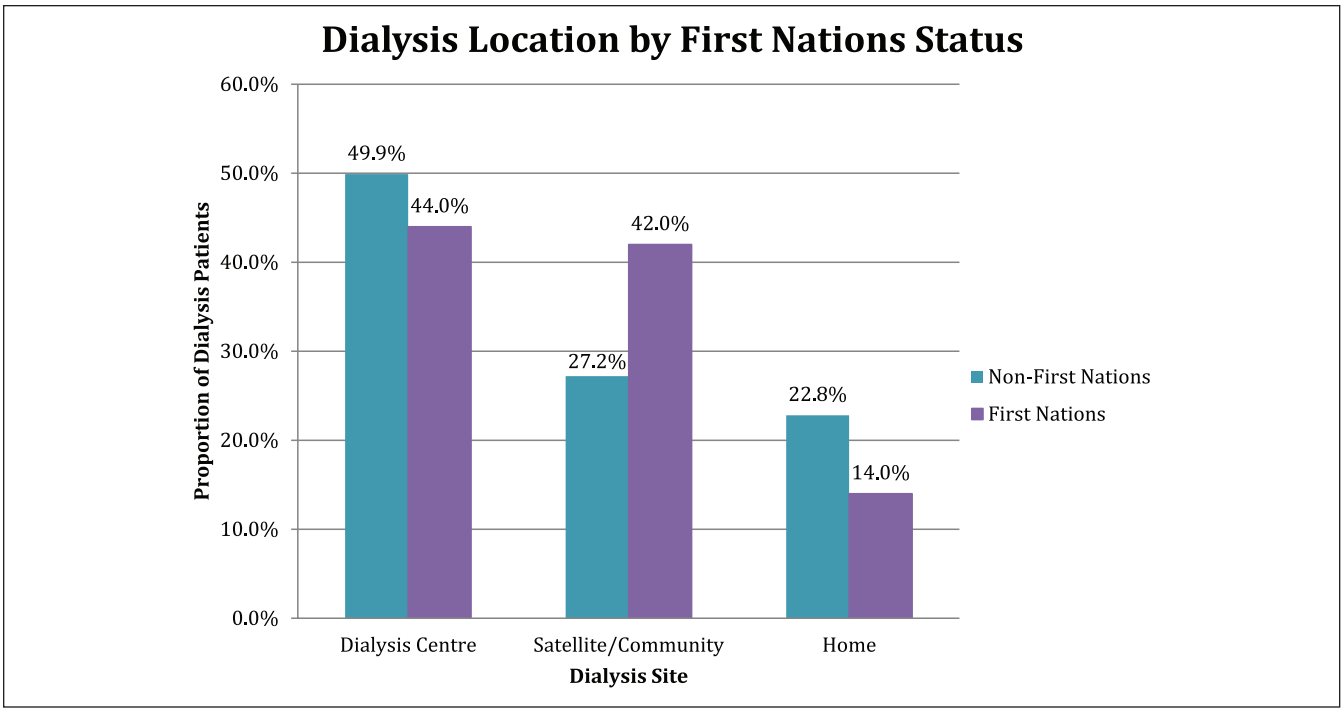


Figure 3. Site of dialysis treatment for First Nations and non-First Nations chronic kidney disease patients.
Note. Significance between in-center and satellite/community/home $\chi^2_2 = 11.898$, $P = .003$.

kidney services (AdjR = 8.6). These findings are also reflected in the difference traveled by First Nations and non-First Nations for dialysis only.

Interpretation

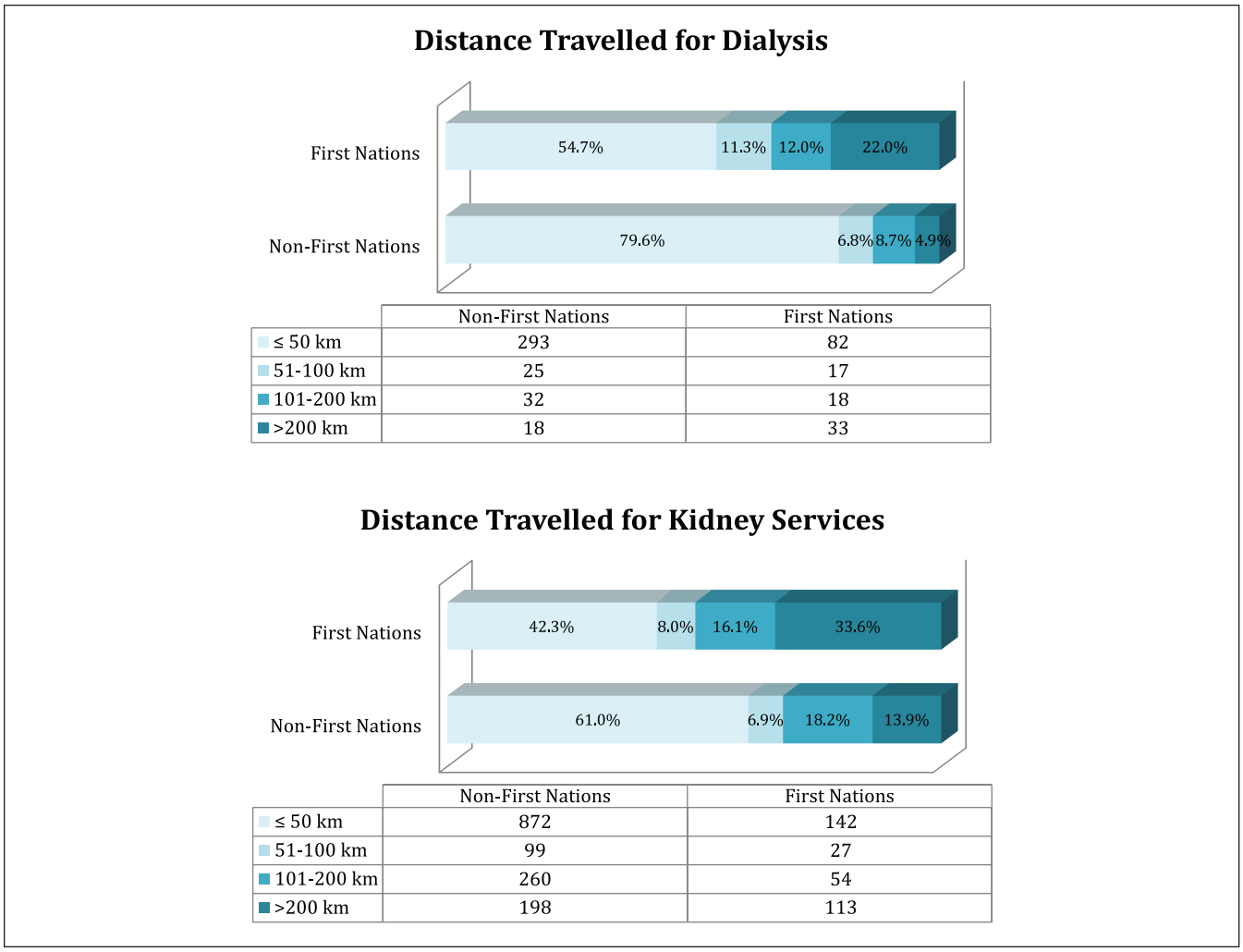
Main Findings

Our analysis shows that First Nations people have CKD at an earlier age and have more severe stages of CKD than non-First Nations people in Saskatchewan. Chronic kidney disease secondary to type 2 diabetes is more prevalent in First Nations people. First Nations people are more likely to require dialysis, and travel further to receive kidney health services and dialysis. First Nations people die with CKD nearly 14 years younger than non-First Nations people.

Comparison With Other Studies

First Nations people in Saskatchewan face significant geographical challenges, which are reflected in increased distances to participate in their care based on the actual distance traveled. Previous studies[16] have only compared distance "as-the-crow flies," whereas this study used Geographical Information System data to capture actual distance required for travel based on geographical landscape. An additional strength of this analysis was the use of the provincial kidney database. This database is the bedside electronic patient medical record system, maintained by trained medical professionals, and reflects all patients being cared for within the kidney health program in the province. Since an administrative (Ministry of Health billing database) was not used, the *ICD* codes, diagnosis, and patient data would be expected to be more reflective of the actual clinical picture than data found within a billing database. This was the first time a nonadministrative database has been analyzed in Saskatchewan for this purpose. Our results are in keeping with analyses completed by Dyck et al[2,3,15] who utilized the administrative database. Their analyses showed that First Nations patients are younger, are more likely to be diagnosed with type 2 diabetes if they are female, and have more severe kidney disease than non-First Nations.

First Nations people also underutilize home dialysis treatment modalities. This is surprising, as First Nations live in more rural areas in the province and it would be expected that use of home modalities would be maximized in those who have the greatest geographical challenges.[16] Our study agreed with Tonelli et al[8] who found in Alberta that First Nations underutilized home dialysis. The reasons for this, however, are unclear. The underutilization of kidney program resources such as home therapies in the province of Saskatchewan requires a better effort to identify barriers and implement successful service delivery. Recent research has identified that Aboriginal and First Nations patients are at higher risk of



	Non-First Nations	First Nations
≤ 50 km	293	82
51-100 km	25	17
101-200 km	32	18
>200 km	18	33

	Non-First Nations	First Nations
≤ 50 km	872	142
51-100 km	99	27
101-200 km	260	54
>200 km	198	113

Figure 4. Distance traveled for dialysis alone (top panel) or to any kidney service (bottom panel) including to nephrologist's office, dialysis site, etc by the First Nations and non-First Nations chronic kidney disease patients (dialysis only: $\chi^2_3 = 44.058$, $P < .001$; all services: $\chi^2_3 = 78.195$, $P < .001$).

infectious complications of peritoneal dialysis[18,19]; however, these are preventable complications with adequate support and care. In Ontario and Manitoba, financial concerns and anxiety were the main barriers to utilization of peritoneal dialysis.[20] Therefore, more work needs to be done to identify the barriers to providing equitable home services within First Nations communities compared with their non-First Nations counterparts.

It is noteworthy that in this study, the proportion of First Nations people in the severe stages of CKD is higher than in the non-First Nations people. Similarly, in this cohort, a higher proportion of First Nations people were dialysis dependent compared with non-First Nations people, indicating a higher severity of kidney disease. The reasons for this are unknown, but may reflect the need for a better upstream approach and engagement for both the prevention of kidney disease (and type 2 diabetes) and its progression. In the indigenous population of Manitoba,[11,21,22] where higher rates of CKD were also reported, a greater severity of proteinuria was identified, a factor which would predict faster progression to end-stage renal disease. In Alberta, a higher incidence of end-stage renal disease was identified and predicted an increased risk of death.[10] It is notable that our findings are consistent with these neighboring provinces and suggests there may be common challenges and solutions between the Prairie Provinces in Canada where high proportions of First Nations people reside.

Limitations

This was a retrospective study using existing data within a clinical database. One of the limitations of the study is that this database does not capture data from any patients who

are not followed by the chronic kidney health program (ie, patients followed solely through a nephrologist's office or a primary care provider). However, it would be expected that primary care providers and nephrologists would refer patients with more severe kidney failure to be followed in the chronic kidney program. In contrast, all kidney patients on dialysis or who received a kidney transplant are captured in this database.

A strength of this study is that the presence or absence of an INAC number was used to determine First Nations status, eliminating subjectivity and concerns about missing ethnicity data. Previous work in Manitoba[23] suggested that the Indian Registry (which is based on the INAC number, formerly the Department of Indian Affairs and Northern Development [DIAND] number) is the most inclusive identifier for First Nations people in Manitoba, resulting in identification of 20% more First Nations people compared with Manitoba Health identifier. Regardless, patients who self-identify as Indigenous, without an INAC number, were coded in our study as non-First Nations. If those who self-identify as indigenous shared similar health disparities with registered First Nations, one would consider that this would dampen the effect on our results. Previous work by Gao et al in 2007 in Alberta reported on rates of CKD in First Nations communities, identifying First Nations peoples as those registered under the Federal Indian Act; however, it is unclear by which First Nations indicator was used to confirm registration.

An additional limitation is the use of *ICD-9-CM* codes to determine inclusion and exclusion criteria. We recognize that *ICD* codes within a billing database may not accurately reflect or may omit specific information; however, in our case, the clinical database is an electronic medical record used for direct patient care and is maintained by trained clinicians. We would anticipate that since our databases are maintained by trained clinicians for the purposes of patient care and management, the data would be more reflective of the actual disease burden (and therefore, more accurate) than in previously studied administrative databases used for billing purposes.

A significant limitation was the volume of missing data points within the data set. In particular, missing data to capture stage of CKD at the beginning and end of the study period resulted in a large number of cases being excluded in some analyses (at times, more than 50% of the sample). It would be beneficial to review the data capture process for the provincial renal database to ensure that each site is collecting and recording data consistently and regularly.

Differences in referral practices may have resulted in delayed identification of patients to the multidisciplinary CKD clinic. Referral practices vary across the province at the discretion of the primary care practitioners and local internal medicine experts. Indeed, this may introduce bias in the study population, which is potentially impacted by rural versus urban expertise, or ability to access primary care. To our knowledge, there was no standardized instrument for referral in Saskatchewan during the time period when this study was conducted.

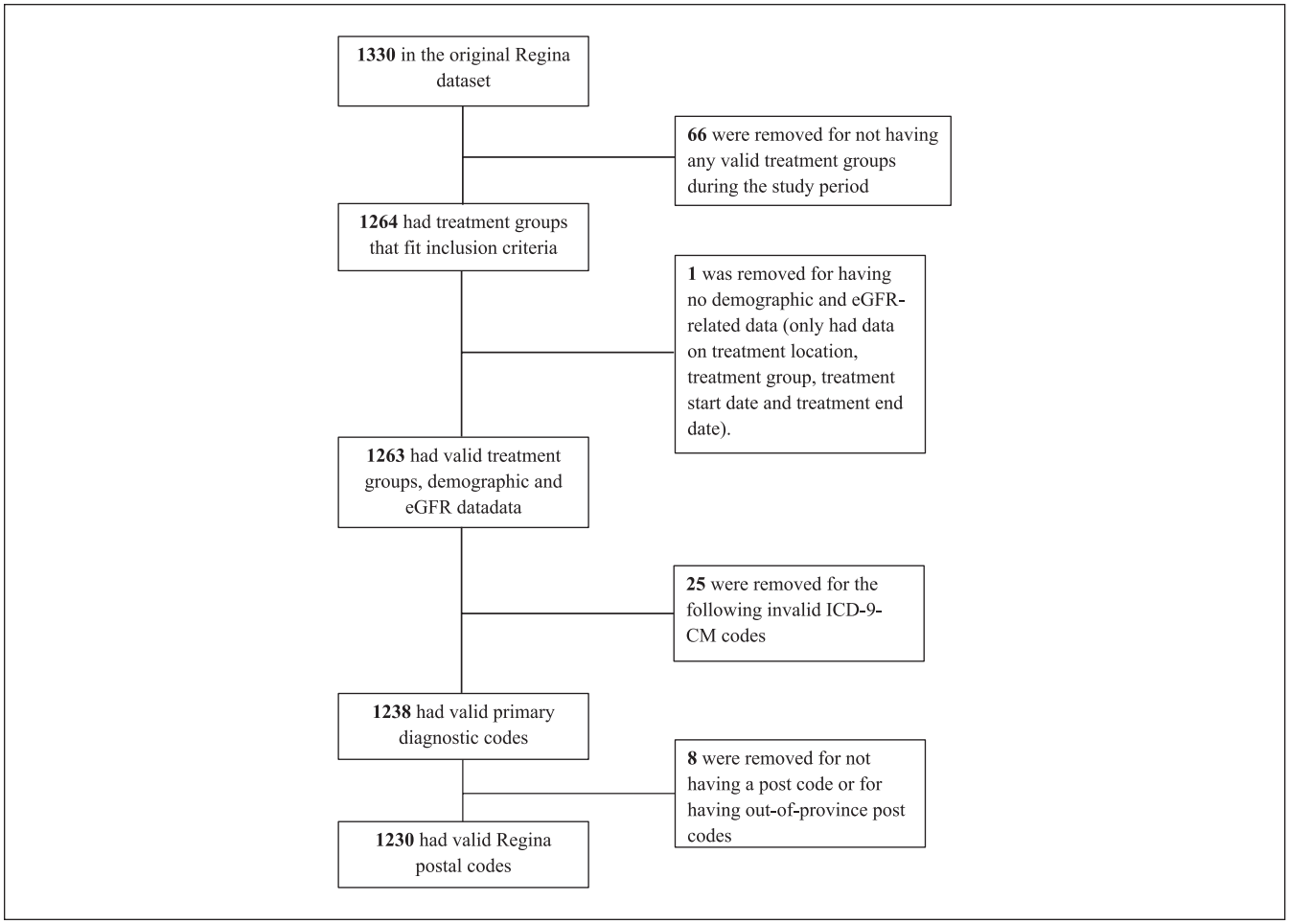
Conclusions and Implications for Practice and Further Research

First Nations people of Saskatchewan have a high proportion of kidney disease with significant morbidity. However, given the significant limitation of missing data particularly relating to stage of disease at the beginning and end of the study, we acknowledge that more research is needed to determine contributory factors, which in turn can help identify opportunities for improved service delivery among First Nations people. In particular, it would be informative to perform in-depth analysis within the province to identify communities with an excessive burden of disease.

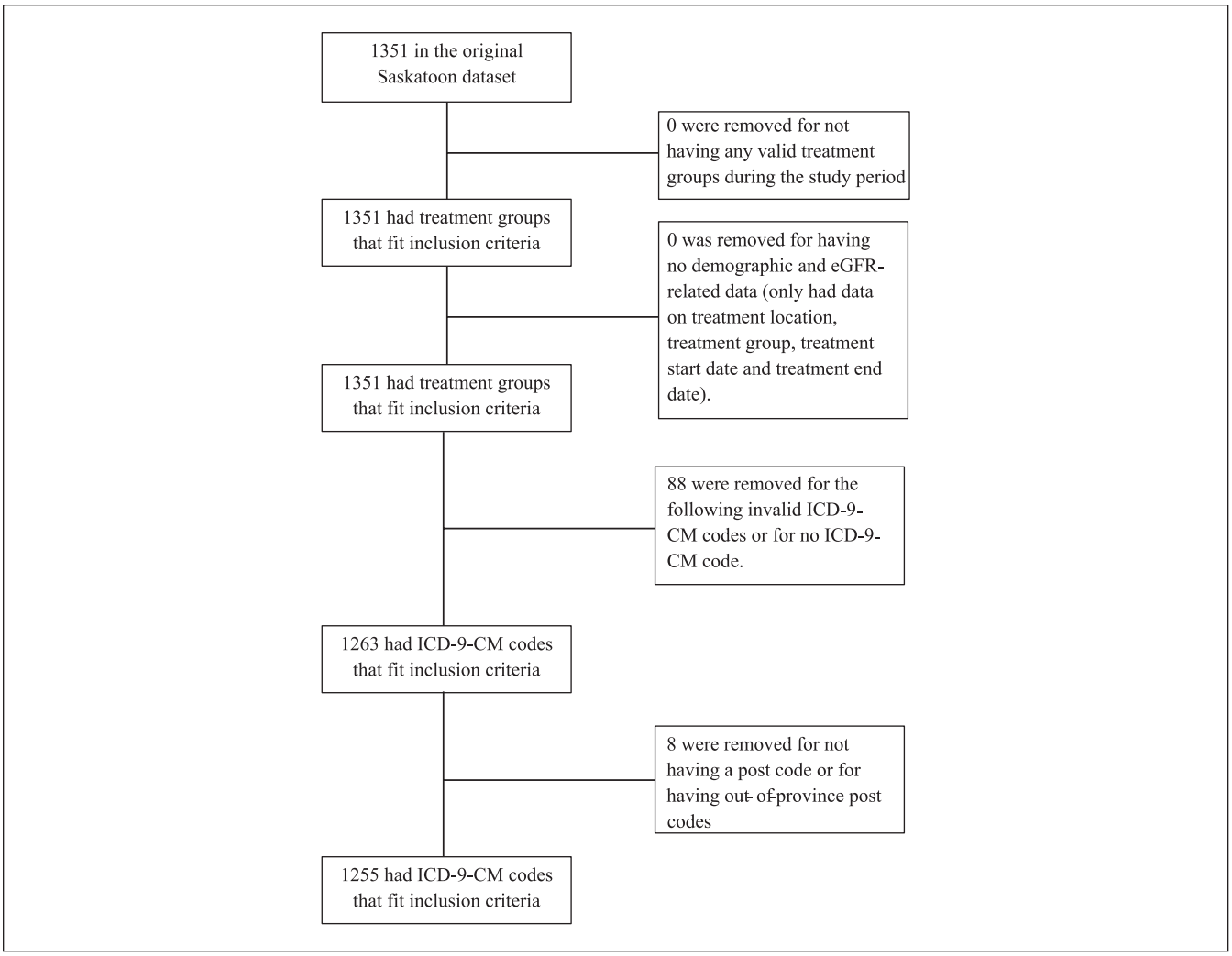
National guidelines recommend screening programs to detect CKD in at-risk populations, including indigenous peoples or those with comorbid conditions such as diabetes and hypertension. Current efforts in Manitoba involve identifying opportunities for triage and screening within First Nations communities.[21,22] Komenda et al identified in the Finished Screening study that remote indigenous populations with less access to primary care demonstrated higher rates of treatable CKD. Replicating this model in Saskatchewan may identify geographic areas of highest need. It follows that additional work to highlight potential impacts of treatment on the progression of CKD would also be helpful. However, a pan-Canadian effort to identify potential variations in epidemiological and demographic contributors to CKD interprovincially and to identify and address barriers to treatment is required to ensure that regional differences are considered and addressed. The barriers to providing kidney health services among First Nations people needs further study and innovative initiatives within First Nations partnering communities such as increased utilization of specialized nurse practitioners, investment in telehealth technologies to reduce travel burden, training of First Nation health practitioners, and development of local programs and expertise. Current research includes development of a screening program for First Nations people within a multidisciplinary environment to identify people at risk of CKD and offering timely referral to specialized nephrology care.[21,22] The challenge is not only to improve delivery of kidney health programs but also the effective implementation of primary prevention initiatives to delay the onset of type 2 diabetes in First Nations people.

Appendix A

Inclusion and Exclusion Criteria for the Analysis of Saskatoon and Regina Chronic Kidney Disease (CKD) Patients



Flow chart for the Regina participants included in the study.
Note. eGFR = estimated glomerular filtration rate; *ICD-9-CM* = *International Classification of Diseases, Ninth Revision, Clinical Modification*.



Flow chart for the Saskatoon participants included in the study.
Note. eGFR = estimated glomerular filtration rate; *ICD-9-CM* = *International Classification of Diseases, Ninth Revision, Clinical Modification*.

Appendix B

International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) Codes Included in the Analysis of Saskatoon CKD Patients

189 Malignant neoplasm of kidney, except pelvis
203 Multiple myeloma, without mention of having achieved remission
250 Diabetes mellitus without mention of complication, type II or unspecified type, not stated as uncontrolled
250.01 Diabetes mellitus without mention of complication, type I (juvenile type), not stated as uncontrolled
250.02 Diabetes mellitus without mention of complication, type II or unspecified type, uncontrolled
250.4 Diabetes with renal manifestations, type II or unspecified type, not stated as uncontrolled
250.41 Diabetes with renal manifestations, type I (juvenile type), not stated as uncontrolled
250.42 Diabetes with renal manifestations, type II or unspecified type, uncontrolled
250.92 Diabetes with unspecified complication, type II or unspecified type, uncontrolled
250.93 Diabetes with unspecified complication, type I (juvenile type), uncontrolled
270 Disturbances of amino-acid transport
277.3 Amyloidosis, unspecified
287 Allergic purpura
289.8 Other disease of blood & blood forming organs
401.9 Unspecified essential hypertension
403.01 Hypertensive chronic kidney disease, malignant, with chronic kidney disease stage V or end stage renal disease
403.1 Hypertensive chronic kidney disease, benign, with chronic kidney disease stage I through stage IV, or unspecified

403.11	Hypertensive chronic kidney disease, benign, with chronic kidney disease stage V or end stage renal disease
403.91	Hypertensive chronic kidney disease, unspecified, with chronic kidney disease stage V or end stage renal disease
405.11	Benign renovascular hypertension
405.91	Unspecified renovascular hypertension
440.1	Atherosclerosis of renal artery
446	Polyarteritis nodosa
446.21	Goodpasture's Syndrome
446.4	Wegener's granulomatosis
580	Acute glomerulonephritis with lesion of proliferative glomerulonephritis
580.4	Acute glomerulonephritis with lesion of rapidly progressive glomerulonephritis
580.81	Acute glomerulonephritis in diseases classified elsewhere
581.1	Nephrotic syndrome with lesion of membranous glomerulonephritis
581.2	Nephrotic syndrome with lesion of membranoproliferative glomerulonephritis
581.81	Nephrotic syndrome in diseases classified elsewhere
581.89	Nephrotic syndrome with other specified pathological lesion in kidney
582	Chronic glomerulonephritis with lesion of proliferative glomerulonephritis
582.1	Chronic glomerulonephritis with lesion of membranous glomerulonephritis
582.2	Chronic glomerulonephritis with lesion of membranoproliferative glomerulonephritis
582.89	Chronic glomerulonephritis with other specified pathological lesion in kidney
582.9	Chronic glomerulonephritis with unspecified pathological lesion in kidney
583.89	Nephritis and nephropathy, not specified as acute or chronic, with other specified
583.9	Nephritis and nephropathy, not specified as acute or chronic, with unspecified pathological lesion in kidney
586	Renal failure, unspecified
590	Chronic pyelonephritis without lesion of renal medullary necrosis
590.8	Pyelonephritis, unspecified
590.81	Pyelitis or pyelonephritis in diseases classified elsewhere
593.73	Other vesicoureteral reflux with reflux nephropathy NOS
593.81	Vascular disorders of kidney
593.89	Other specified disorders of kidney and ureter
593.9	Unspecified disorder of kidney and ureter
596.54	Neurogenic bladder NOS
599.6	Urinary obstruction, unspecified
599.69	Urinary obstruction, not elsewhere classified
710	Systemic lupus erythematosus
710.1	Systemic sclerosis
753.1	Cystic kidney disease, unspecified
753.12	Polycystic kidney, unspecified type
753.13	Polycystic kidney, autosomal dominant
753.15	Renal dysplasia
753.19	Other specified cystic kidney disease
753.6	Atresia and stenosis of urethra and bladder neck, congenital
759.89	Other specified anomalies
790.29	Other abnormal glucose
997.72	Vascular complications of renal artery
E933.1	Antineoplastic and immunosuppressive drugs causing adverse effects in therapeutic use

Appendix C

ICD-9-CM Codes Included in the Analysis of Regina CKD Patients

189	Malignant neoplasm of kidney, except pelvis
195.8	Malignant neoplasm of other specified sites
203	Multiple myeloma, without mention of having achieved remission
233.9	Carcinoma in situ of other and unspecified urinary organs
250	Diabetes mellitus without mention of complication, type II or unspecified type, not stated as uncontrolled
250.4	Diabetes with renal manifestations, type II or unspecified type, not stated as uncontrolled
250.41	Diabetes with renal manifestations, type I (juvenile type), not stated as uncontrolled
250.42	Diabetes with renal manifestations, type II or unspecified type, uncontrolled
250.9	Diabetes with unspecified complication, type II or unspecified type, not stated as uncontrolled
271.8	Other specified disorders of carbohydrate transport and metabolism
273.3	Macroglobulinemia
275.49	Other disorder of calcium metabolism
277.3	Amyloidosis, unspecified
401.9	Unspecified essential hypertension
403.01	Hypertensive chronic kidney disease, malignant, with chronic kidney disease stage V or end stage renal disease
403.11	Hypertensive chronic kidney disease, benign, with chronic kidney disease stage V or end stage renal disease
403.9	Hypertensive chronic kidney disease, unspecified, with chronic kidney disease stage I through stage IV, or unspecified
403.91	Hypertensive chronic kidney disease, unspecified, with chronic kidney disease stage V or end stage renal disease

404.93 Hypertensive heart and chronic kidney disease, unspecified, with heart failure and chronic kidney disease stage V or end stage renal disease
425.4 Other primary cardiomyopathies
428 Congestive heart failure, unspecified
440.1 Atherosclerosis of renal artery
446 Polyarteritis NODOSA
446.21 Goodpasture's Syndrome
446.4 Wegener's granulomatosis
447.6 Arteritis, unspecified
447.8 Other specified disorders of arteries and arterioles
572.4 Hepatorenal syndrome
580 Acute glomerulonephritis with lesion of proliferative glomerulonephritis
580.4 Acute glomerulonephritis with lesion of rapidly progressive glomerulonephritis
581.1 Nephrotic syndrome with lesion of membranous glomerulonephritis
581.2 Nephrotic syndrome with lesion of membranoproliferative glomerulonephritis
581.3 Nephrotic syndrome with lesion of minimal change glomerulonephritis
581.81 Nephrotic syndrome in diseases classified elsewhere
581.89 Nephrotic syndrome with other specified pathological lesion in kidney
582 Chronic glomerulonephritis with lesion of proliferative glomerulonephritis
582.1 Chronic glomerulonephritis with lesion of membranous glomerulonephritis
582.2 Chronic glomerulonephritis with lesion of membranoproliferative glomerulonephritis
582.81 Chronic glomerulonephritis in diseases classified elsewhere
582.89 Chronic glomerulonephritis with other specified pathological lesion in kidney
582.9 Chronic glomerulonephritis with unspecified pathological lesion in kidney
583 Nephritis and nephropathy, not specified as acute or chronic, with lesion of proliferative glomerulonephritis
583.2 Nephritis and nephropathy, not specified as acute or chronic, with lesion of membranoproliferative glomerulonephritis
583.81 Nephritis and nephropathy, not specified as acute or chronic, in diseases classified elsewhere
583.89 Nephritis and nephropathy, not specified as acute or chronic, with other specified pathological lesion in kidney
583.9 Nephritis and nephropathy, not specified as acute or chronic, with unspecified pathological lesion in kidney
585.9 Chronic kidney disease, unspecified
586 Renal failure, unspecified
587 Renal sclerosis, unspecified
590.01 Chronic pyelonephritis with lesion of renal medullary necrosis
590.8 Pyelonephritis, unspecified
591 Hydronephrosis
592 Calculus of kidney
593.71 Vesicoureteral reflux with reflux nephropathy, unilateral
593.72 Vesicoureteral reflux with reflux nephropathy, bilateral
593.73 Other vesicoureteral reflux with reflux nephropathy NOS
593.81 Vascular disorders of kidney
593.89 Other specified disorders of kidney and ureter
593.9 Unspecified disorder of kidney and ureter
599.6 Urinary obstruction, unspecified
600 Hypertrophy (benign) of prostate
710 Systemic lupus erythematosus
710.1 Systemic sclerosis
753.12 Polycystic kidney, unspecified type
753.13 Polycystic kidney, autosomal dominant
753.17 Medullary sponge kidney
753.3 Other specified congenital anomalies of kidney
753.4 Other specified congenital anomalies of ureter
759.89 Other specified anomalies

Appendix D

ICD-9-CM Codes Excluded From the Analysis for the Saskatoon CKD Patients

283.11 Hemolytic-uremic syndrome
584.5 Acute kidney failure with lesion of tubular necrosis
584.6 Acute kidney failure with lesion of renal cortical necrosis
584.9 Acute kidney failure, unspecified
785.51 Cardiogenic shock

Appendix E

ICD-9-CM Codes Excluded From the Analysis for the Regina CKD Patients

38.42 Septicemia due to *Escherichia Coli* (*E coli*)
38.9 Unspecified Septicemia
584.5 Acute kidney failure with lesion of tubular necrosis
584.9 Acute kidney failure, unspecified
593.6 Postural proteinuria
728.88 Rhabdomyolysis
791.3 Myoglobinuria

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