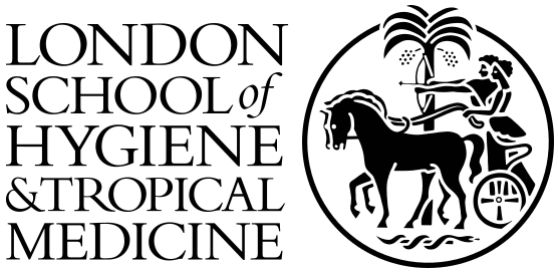

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CLINICAL RESEARCH

Prevalence and Demographics of CKD in Canadian Primary Care Practices: A Cross-sectional Study

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Introduction: Surveillance systems enable optimal care delivery and appropriate resource allocation, yet Canada lacks a dedicated surveillance system for chronic kidney disease (CKD). Using data from the Canadian Primary Care Sentinel Surveillance Network (CPCSSN), a national chronic disease surveillance system, this study describes the geographic, sociodemographic, and clinical variations in CKD prevalence in the Canadian primary care context.

Methods: This cross-sectional study included 559,745 adults in primary care in 5 provinces across Canada from 2010 through 2015. Data were analyzed by geographic (urban or rural residence), sociodemographic (age, sex, deprivation index), and clinical (medications prescribed, comorbid conditions) factors, using data from CPCSSN and the Canadian Deprivation Index. CKD stage 3 or higher was defined as 2 estimated glomerular filtration rate (eGFR) values of $<$60 ml/min per 1.73 m^2 more than 90 days apart as of January 1, 2015.

Results: Prevalence of CKD was 71.9 per 1000 individuals and varied by geography, with the highest prevalence in rural settings compared with urban settings (86.2 vs. 68.4 per 1000). CKD was highly prevalent among individuals with 3 or more other chronic diseases (281.7 per 1000). Period prevalence of CKD indicated a slight decline over the study duration, from 53.4 per 1000 in 2010 to 46.5 per 1000 in 2014.

Conclusion: This is the first study to estimate the prevalence of CKD in primary care in Canada at a national level. Results may facilitate further research, prioritization of care, and quality improvement activities to identify gaps and improvement in CKD care.

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CKD is a major public health burden both nationally and internationally. The global mean prevalence of CKD is 13.4%, and within Canada, most recent estimates suggest at least 4 million people have the disease.[1,2] CKD poses a significant burden on the health care system: recent estimates of health care costs for Canadians with CKD exceed $40 billion annually.[1] This condition is more common among people with cardiovascular disease, hypertension, and diabetes, all of which have adverse health outcomes.[3] Individuals with CKD are at increased risk of premature mortality, hospitalization, and acute kidney injury.[2] Most patients with CKD can be effectively managed in primary care.[4]

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Although no Canada-wide data are available, upward of 95% of patients with CKD in Alberta are managed in primary care, making primary care data very relevant.[5]

Reliable surveillance data is important at multiple levels (i.e., local, provincial/state, national) to ascertain variations in processes of care, as well as treatment and disease burden, which can drive improvements in care delivery. These measures inform optimal care delivery and have implications for increased life span, improved quality of life, and lower individual and societal costs.[4–7] A national surveillance system is particularly suited for CKD, as the diagnosis is based on easily obtainable laboratory measures. Presently in Canada, there is no unified system to capture national CKD surveillance data.[6,7] In the absence of this, an existing pan-Canadian surveillance system, the CPCSSN,[8] can be used for epidemiological studies of chronic diseases. The CPCSSN is a network of primary care practices that provide care to more than 1.5 million individuals across Canada and pool their data from electronic medical records (EMRs) to a central repository enabling disease surveillance from a primary care perspective. This data source is appropriate for our study given that most patients with CKD are managed in primary care.[4,5] The CPCSSN was designed to collect and maintain national epidemiological surveillance data to improve outcomes in primary care and optimize chronic disease management.[8] The data have undergone processing to achieve a standardized format to allow for jurisdictional comparisons of many chronic conditions.

This cross-sectional study leverages data derived from individuals' EMRs available in the CPCSSN to define the burden of moderate-to-advanced CKD (stages 3–5) and identify gaps in care. Specifically, the objectives of this study were to leverage the CPCSSN to (i) estimate the prevalence and range of severity of CKD in the Canadian primary care context; and (ii) describe geographic, sociodemographic, and clinical variations in CKD prevalence. This information will help ascertain the burden of CKD in Canada and identify modifiable care gaps in the optimal management of this important health condition.

METHODS

The details of this project are described elsewhere.[9] We briefly outline the methodological approach for this analysis in the following sections.

Data Sources

The CPCSSN is a national disease surveillance system composed of 12 regional practice-based primary care research networks that collect primary care health information in 8 of 13 provinces and territories in Canada (Figure 1).[10–12] Past literature comparing CPCSSN data with Canadian census data has determined that age- and sex-adjusted prevalence rates are reasonably representative of the general primary care population.[10] Primary care providers (PCPs) contributing data to the CPCSSN were found to be younger and work more frequently in academic settings than colleagues in family medicine,[10] although the practices were found to be representative of primary care practices using EMRs.[13] PCPs voluntarily contribute de-identified data; approximately every 6 months data are cleaned, coded, processed, and made available for surveillance, research, quality improvement initiatives, and clinical decision-making. During the study period, validated algorithms were used to monitor the following chronic diseases and neurological conditions: hypertension, osteoarthritis, diabetes, chronic obstructive pulmonary disease, depression, Alzheimer's and related dementias, epilepsy, and Parkinson's disease. The definitions used a combination of *International Classification of Diseases, Ninth Revision* codes and numeric and textual data drawn from diagnosis, billing, laboratory test results, and prescribed medication data, as available in patient charts.[11] Although there are additional relevant comorbidities in relation to CKD, these have not yet been validated for use in the CPCSSN and therefore were not examined in this study.

Participants and Setting

For this study, data were extracted from the CPCSSN for the period January 1, 2010, through December 31, 2015. A baseline cohort of individuals whose PCP was a CPCSSN sentinel was identified based on the following criteria: participants were seen by a provider included in the CPCSSN, had a valid date of birth in the system, were at least 18 years of age, and had 2 or more measures of eGFR in a 1-year period following their index date (date of first eGFR entry in their CPCSSN record) (Figure 2). All these measures are ambulatory-based, and no hospital-based (acute care) data were included during the study period. Serum creatinine measurements were used to calculate eGFR using the CKD Epidemiology Collaboration equation. Serum creatinine measurements were calibrated to the standard isotope dilution mass spectrometry. Before 2012, the Modification of Diet and Renal Disease study equation was the standard equation to calculate eGFR in Canada; however, for consistency, any measurements before 2012 were manually calculated using the CKD Epidemiology Collaboration equation. The CKD Epidemiology Collaboration equation has been found to more accurately estimate eGFR than the Modification of Diet and Renal Disease study equation[14] and has been endorsed by Kidney Disease Improving Global Outcomes and the Canadian Society of Nephrology.

Individuals in the baseline cohort were identified as having CKD if they had 2 eGFR values of <60 ml/min

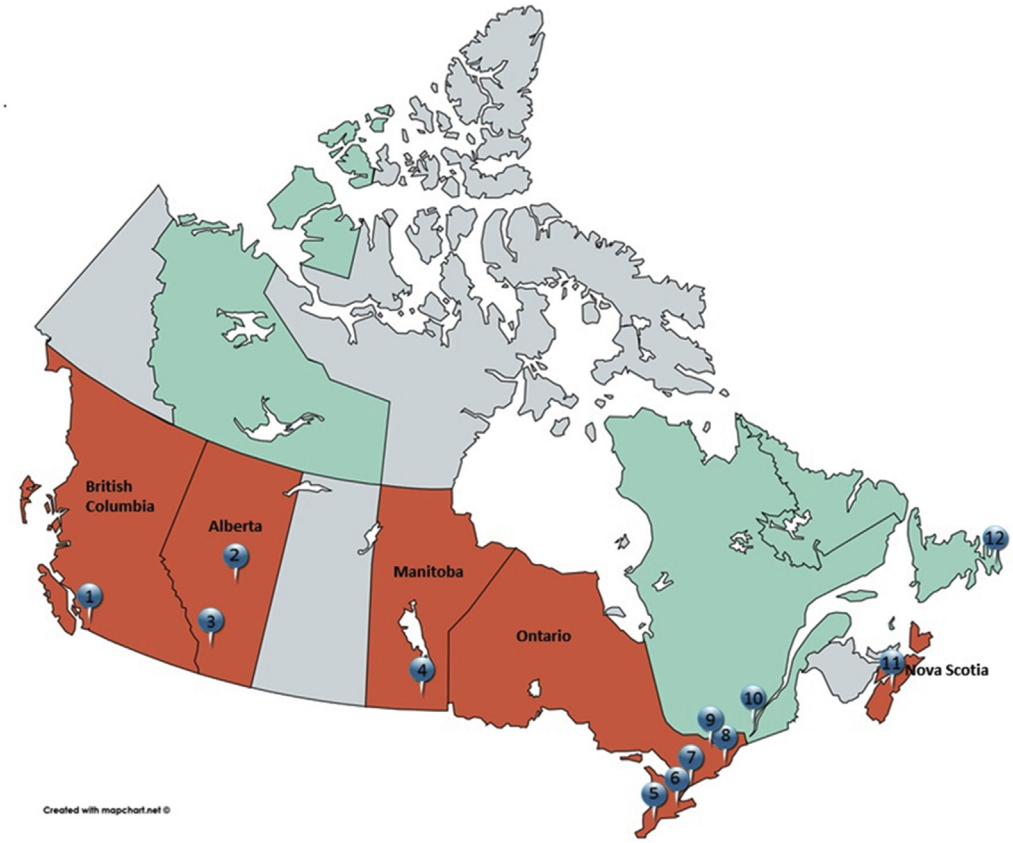

Figure 1. Participation of Canadian Primary Care Sentinel Surveillance Network (CPCSSN) networks by province. **Blue,** nonparticipating CPCSSN networks; **orange**, participating CPCSSN networks. Primary care research networks contributing data to the CPCSSN: *1*, British Columbia Primary Care Research Network (BCPCReN); *2*, Northern Alberta Primary Care Research Network (NAPCReN); *3*, Southern Alberta Primary Care Research Network (SAPCReN); *4*, Manitoba Primary Care Research Network (MaPCReN); *5*, Deliver Primary Healthcare Information Project (DELPHI); *6*, McMaster University Sentinel and Information Collaboration (MUSIC); *7*, University of Toronto Practice-Based Research Network (UTOPIAN); *8*, The Eastern Ontario Network (EON); *9*, Ottawa Practice Enhancement Network (OPEN); *10*, Réseau de recherche en soins primaires de l'Université de Montréal (RRSPUM); *11*, Maritime Family Practice Research Network (MaRNet-FP); *12*, Atlantic Practice-Based Research Network (APBRN).

per 1.73 m^2 more than 90 days apart as of January 1, 2015. We considered only those with advanced stages of CKD (stages 3–5), as eGFR alone is insufficient to indicate the presence of CKD in less advanced stages. Those diagnosed with ESRD and on dialysis or having renal transplantation were excluded. This definition was based on existing national and international CKD frameworks and conventions.[15,16]

This study drew data from 5 provinces (British Columbia, Alberta, Manitoba, Ontario, and Nova Scotia), which together account for approximately 70% of the Canadian population. Although Canada maintains a universal health care system, the delivery, management, and organization of health services are overseen by the province or territory of residence.

Covariates

Data from the study cohort were analyzed according to geographic, sociodemographic, and clinical factors. Geography included province and urban or rural residence, defined using standard methods based on postal code data.[17,18] Sociodemographic factors included age, sex, and material deprivation. Material deprivation was calculated using postal code data extracted from the EMR and linked to the Canadian Deprivation Index, an ecological measure of material deprivation expressed as a quintile (1–5; with 1 being least deprived and 5 most deprived). The Canadian Deprivation Index score for each postal code is derived from census data from 2011 on rates of home ownership, educational level, and food security. Canadian Deprivation Index data are made available by the federal government for research purposes.[19] Clinical factors included medications prescribed and comorbid conditions. All variables were extracted from individual EMRs as available in the CPCSSN database.

Analytic Approach

Descriptive statistics were used to characterize the study cohort. This included means and SDs for normally distributed continuous variables, and numbers (*n*) and percentages (%) for categorical variables. The unadjusted

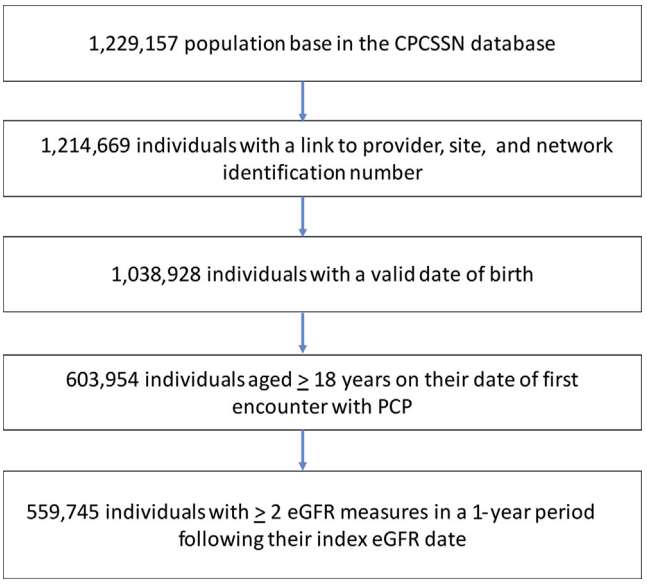

Figure 2. Selection of study population. CPCSSN, Canadian Primary Care Sentinel Surveillance Network; eGFR, estimated glomerular filtration rate; PCP, primary care provider.

prevalence of CKD was calculated per 1000 individuals and stratified by sociodemographic and clinical data. Prevalence estimates for CKD were then stratified by CKD stage, age range, sex, deprivation index, urban/rural residence, and type and number of comorbid conditions. Period prevalence of CKD by year, stratified by the same variables, was also determined.

Ethics and Privacy

The data extraction process was reviewed and approved by institutional research ethics boards in each participating jurisdiction across Canada as well as the Health Canada Research Ethics Board. This study was granted approval by the CPCSSN Surveillance and Research Standing Committee and the University of Alberta Health Research Ethics Committee.

RESULTS

Baseline Demographics

A baseline cohort of 559,745 individuals managed in primary care was identified, residing in Ontario (59.4%), Alberta (16.4%), Manitoba (12.3%), Nova Scotia (9.7%), and British Columbia (2.2%). Most individuals lived in urban areas (79.9%), and 18.5% lived in rural areas. Mean (SD) age of the study cohort was 48.5 (17.8) years and 60.4% were female. Individuals were spread nearly evenly across the deprivation index (range from 8.3% to 13.2% across the 5 quintiles); however, 257,285 individuals (46.0%) had incomplete postal code and/or census data, and were unable to be scored. The missing postal codes might relate to incomplete data collection on this variable across CPCSSN networks.

Table 1. Baseline patient characteristics of the overall study population

Patient characteristics	Overall (N = 559,745)
Age, yr, mean (SD)	48.5 (17.8)
Sex, male, *n* (%)	221,449 (39.6)
Age range, yr, *n* (%)	
18–44	242,235 (43.3)
45–59	164,833 (29.4)
60–64	42,940 (7.7)
65–69	34,058 (6.1)
70–74	25,126 (4.5)
75–80	23,307 (4.2)
>80	27,246 (4.9)
Deprivation index, *n* (%)	
1 (least deprived)	65,206 (11.6)
2	73,808 (13.2)
3	65,861 (11.8)
4	51,203 (9.1)
5 (most deprived)	46,382 (8.3)
Missing	257,285 (46.0)
Province of residence, *n* (%)	
Ontario	332,748 (59.4)
Alberta	91,781 (16.4)
Manitoba	68,987 (12.3)
Nova Scotia	54,191 (9.7)
British Columbia	12,068 (2.2)
Urban/Rural, *n* (%)	
Urban	447,014 (79.9)
Rural	103,627 (18.5)
Missing	9105 (1.6)
Comorbidity, *n* (%)	
COPD	30,192 (5.4)
Dementia	18,701 (3.3)
Depression	111,938 (20.0)
Diabetes	109,395 (19.6)
Epilepsy	7556 (1.3)
Hypertension	188,076 (33.6)
Osteoarthritis	95,597 (17.1)
Parkinson disease	2767 (0.5)
Both diabetes and hypertension[a]	38,966 (7.0)
Comorbidities,[b] *n* (%)	
0	262,425 (46.9)
1–2	251,913 (45.0)
≥3	45,407 (8.1)
Prescribed medications, *n* (%)	
Non-ACEi/ARB antihypertensive[c]	452,532 (27.3)
ACEi or ARB	130,272 (23.3)
Statins	120,763 (21.6)
Metformin	42,136 (7.5)
Other diabetes medication[d]	25,215 (4.5)
Insulin	15,218 (2.7)
Stage of CKD by eGFR, *n* (%)	
Do not meet criteria (eGFR >59)[e]	518,244 (92.6)
3A (eGFR 45–59)	18,851 (3.4)
3B (eGFR 30–44)	14,255 (2.5)
4 (eGFR 15–29)	6559 (1.2)
5 (eGFR <15)	1836 (0.3)

ACEi, angiotensin-converting enzyme inhibitors; ARB, angiotensin-receptor blockers; COPD, chronic obstructive pulmonary disease; eGFR, estimated glomerular filtration rate.
[a]Diabetes and hypertension considered individually and as distinct comorbid group.
[b]Based on the above conditions alone.
[c]Non-ACEi/ARB antihypertensive: antihypertensive medication excluding ACEi and ARB.
[d]Other diabetes medication: excludes insulin and metformin.
[e]Do not meet criteria for CKD stages 3–5 based on eGFR only.

During the study period, more than half of the study population had 1 or more of the 8 listed chronic conditions (53.1%), 45.0% had 1 or 2 comorbidities, and 8.1% had 3 or more comorbidities (multimorbidity). Of these, the most common were hypertension (33.6%), depression (20.0%), and diabetes (19.6%). The medications most commonly prescribed to individuals in the study cohort were antihypertensive medications (50.6%), made up of angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers (23.3%) and non– angiotensin-converting enzyme inhibitors/ angiotensin II receptor blocker antihypertensive medications (27.3%), and statins (21.6%) (Table 1).

Prevalence of CKD Overall, and Stratified by Geography (Residence), Deprivation, Age, Sex, and Comorbidities

At baseline, 41,501 individuals (7.4%) were identified as having CKD stages 3 to 5. Baseline prevalence of CKD was inversely related to severity (stage 3A [31.8 per 1000], stage 3B [25.3], stage 4 [11.7], stage 5 [3.3]). Among individuals with complete deprivation data and able to be assessed using the Canadian Deprivation Index, the highest prevalence of CKD was found in the second most deprived category (score of 4), 67.7 per 1000 individuals, and the lowest prevalence in the least deprived category (score of 1), 52.2 per 1000 individuals (Figure 3a). There were no major differences in sex-specific prevalence. A high prevalence of more severe stages of CKD in elderly individuals (≥65 years of age) was observed, particularly in individuals between the ages of 75 and 80 years (345.1 per 1000) and individuals older than 80 years (397.6 per 1000) (Table 2). With regard to geography, CKD was more prevalent in rural settings (86.2 per 1000) than urban settings (68.4 per 1000) (Figure 3b). There was a high prevalence of CKD among individuals with 3 or more comorbidities, with an overall prevalence of 281.7 per 1000 individuals, most of whom were in stages 3A and 3B (98.9 and 109.6 per 1000). The prevalence of CKD

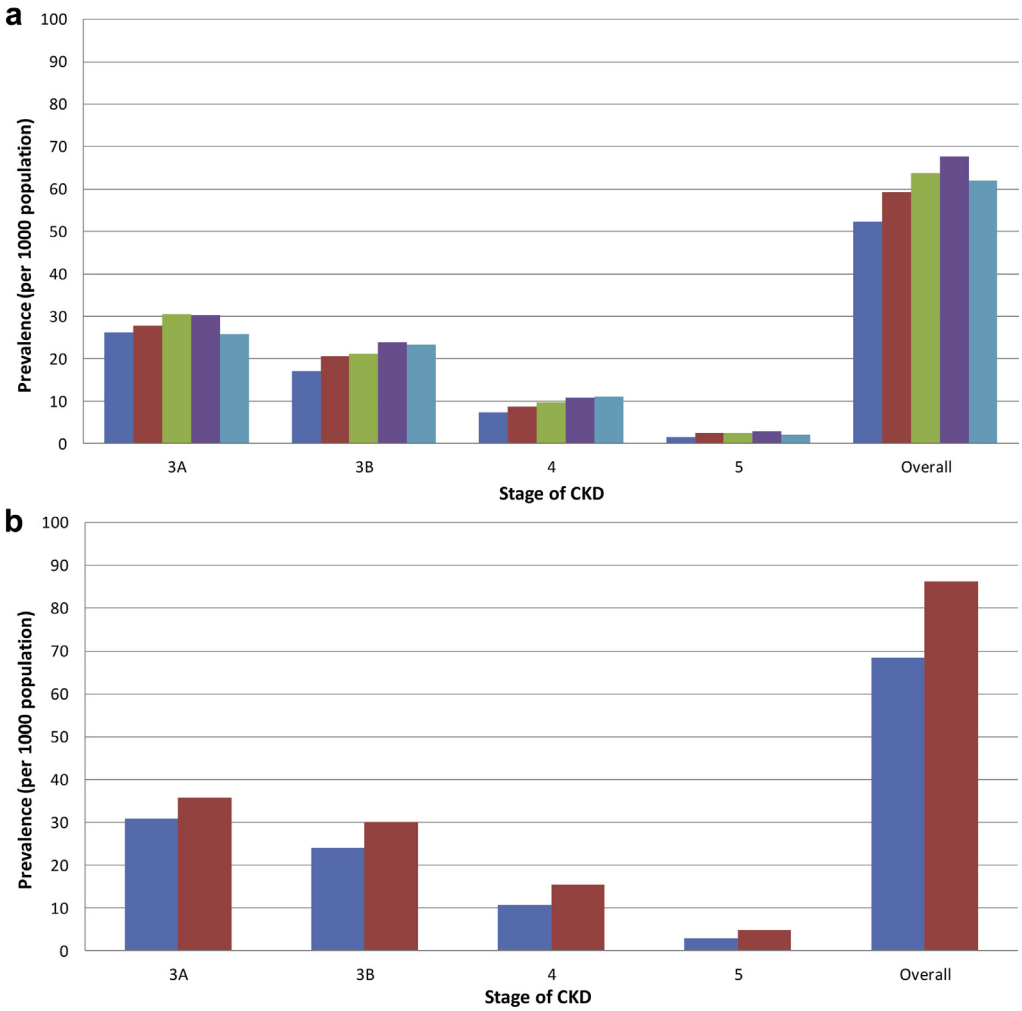

Figure 3. (a) Overall prevalence of chronic kidney disease (CKD) (2010–2015) by deprivation index, by CKD stage. Level of deprivation of Canadian Deprivation Index score: 1 (least deprived), dark blue; 2, red; 3, green; 4, purple; 5 (most deprived), light blue. (b) Overall prevalence of CKD (2010–2015) by urban/rural residence, stratified by CKD stage. Participant residence: urban (blue); rural (red).

Table 2. Prevalence of CKD stages 3–5 (2010–2015), stratified by sociodemographic and clinical characteristics; per 1000 individuals

Characteristic	Stage 3A	Stage 3B	Stage 4	Stage 5	Overall
Overall	31.76	25.26	11.66	3.26	71.94
Sex					
Male	32.53	25.22	11.75	3.84	71.02
Female	31.27	25.28	11.60	2.88	73.34
Age range					
18–45	2.32	1.28	0.71	0.52	4.82
46–59	16.16	7.88	3.54	1.63	29.21
60–64	50.79	26.06	10.43	4.31	91.59
65–69	81.57	49.00	19.58	6.34	156.50
70–74	115.46	84.26	34.43	10.47	244.61
75–80	141.33	132.36	57.41	13.94	345.05
>80	124.83	166.63	90.07	16.11	397.64
Comorbidity					
COPD	76.74	82.11	48.49	13.94	221.28
Osteoarthritis	70.24	60.94	26.65	6.13	163.97
Dementia	110.21	121.81	59.78	11.50	303.30
Epilepsy	32.16	30.44	13.63	3.57	79.80
Parkinson's disease	93.24	86.01	36.86	7.59	223.71
Depression	34.24	28.84	14.15	3.77	81.00
Diabetes	72.24	75.52	42.43	13.63	203.83
Hypertension	76.78	69.75	32.90	8.81	188.23
Both diabetes and HTN	91.95	100.11	57.36	18.02	267.44
Comorbidities[a]					
0	8.31	3.37	1.23	0.50	13.41
1–2	44.10	32.86	14.24	3.91	95.10
≥3	98.86	109.59	57.61	15.59	281.65
Urban/Rural					
Urban	30.89	24.02	10.64	2.81	68.37
Rural	35.80	30.14	15.35	4.93	86.22
Deprivation index					
1 (least deprived)	26.27	17.11	7.27	1.58	52.23
2	27.67	20.47	8.70	2.43	59.26
3	30.49	21.23	9.69	2.38	63.79
4	30.25	23.79	10.78	2.83	67.65
5 (most deprived)	25.74	23.28	10.97	2.07	62.07
Missing	36.05	30.37	14.42	4.44	85.29

Note: CKD: eGFR <60 ml/min per 1.73 m^2 with at least 2 measures 90 days apart (3A [eGFR 45–59], 3B [eGFR 30–44], 4 [eGFR 15–29], 5 [eGFR <15]).
CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; eGFR, estimated glomerular filtration rate; HTN, hypertension.
[a]Based on the above conditions alone.

was high among individuals with comorbid dementia (303.3 per 1000), a combination of both diabetes and hypertension (267.4 per 1000), Parkinson's disease (223.7 per 1000), and chronic obstructive pulmonary disease (221.3 per 1000) (Table 2).

The overall prevalence of CKD declined slightly over the course of this study, from 53.4 per 1000 in 2010 to 46.5 per 1000 in 2014 (Table 3). From 2010 to 2011, prevalence decreased in most subgroups, and from 2011 to 2014, prevalence remained largely stable (Figure 4a and b).

DISCUSSION

This study examined the burden of CKD in adults in primary care in Canada and how prevalence varied by sociodemographic and clinical characteristics. Within a primary care setting, the estimated national prevalence of CKD stages 3 to 5 during the study period was 71.9 per 1000 individuals, with significant variations by geography (urban/rural), sociodemographic factors (age, deprivation), and clinical factors (number and type of comorbidities).

To our knowledge, there have been no comparable national prevalence studies of CKD in Canada. One study, reporting 2007 to 2009 data from a national survey, found a 12.5% prevalence of CKD in Canadian adults,[20] but reported on all stages (1–5), including proteinuria estimates. Our study, which captures prevalence of moderate-to-advanced CKD (stages 3–5) and leverages eGFR criteria recorded in participating primary care clinics, suggests a lower prevalence than the estimated global average.[2] It is possible that previous estimates, based on administrative data, would exaggerate the true prevalence in PCPs' EMRs. A lower prevalence of CKD in the study cohort also could be a result of nondiagnosis (due to lack of testing or reduced health-seeking behavior by individuals because CKD is considered a "silent disease"), selection bias (greater health-consciousness among individuals engaging with primary care), or misclassification (potential errors relating to incorrect laboratory dates or captured stages 3–5). Our results provide preliminary insight into prevalence of CKD in the Canadian context and offer opportunities to test these hypotheses in future research.

Results indicated that individuals with any 3 comorbid conditions or those with the presence of diabetes and hypertension had a CKD prevalence that exceeded 250 per 1000 individuals. In contrast, individuals without diabetes or hypertension, or those with minimal comorbid conditions, had a very low prevalence of CKD, highlighting the appropriate target populations for screening and surveillance. The finding that prevalence of CKD was high among individuals with comorbid dementia and Parkinson's disease may be a result of the established correlation with age and chronic disease.[21]

The higher overall prevalence of CKD in elderly individuals has implications for management of the disease, as this population also has a high rate of comorbidities.[22] This suggests long-term health service planning frameworks should be based on multimorbidity, such as the framework by Bowling and colleagues,[23] rather than on a single disease. Of note, although aging is associated with an increased risk of developing CKD, this is specific to a subset of the population: those with existing chronic conditions, such as hypertension and diabetes.[24] It is also possible that, as a result of increased interaction with the health

Table 3. Period prevalence of CKD stratified by sociodemographic and clinical characteristics and year; per 1000 individuals

Characteristic	2010 $n = 267,658$	2011 $n = 364,421$	2012 $n = 419,782$	2013 $n = 465,372$	2014 $n = 495,550$
Overall	53.36	47.38	46.66	46.82	46.53
Sex					
Male	58.38	53.04	52.58	52.70	51.55
Female	50.29	43.86	42.89	43.04	43.26
Age range					
18–44	5.03	4.40	4.60	4.43	4.36
45–59	23.28	19.2	19.69	21.18	22.37
60–64	67.78	55.62	55.91	60.42	62.41
65–74	145.51	119.47	117.43	123.51	129.91
75–80	249.40	208.51	207.86	214.81	221.64
>80	298.72	264.20	263.05	264.19	257.97
Comorbidity					
COPD	162.79	143.84	142.47	142.83	141.75
Osteoarthritis	106.8	97.30	97.30	98.38	99.43
Dementia	217.94	193.67	187.01	184.85	177.63
Epilepsy	55.72	49.04	48.30	49.64	49.40
Parkinson's disease	161.64	134.00	137.18	136.77	136.25
Depression	58.52	51.30	50.39	50.80	50.74
Diabetes	170.95	158.55	159.22	164.31	160.98
Hypertension	129.34	117.19	117.40	120.07	120.83
Comorbidities[a]					
0	8.02	6.00	5.84	6.09	6.81
1–2	64.4	57.75	56.89	58.39	59.51
≥3	206.00	185.96	186.11	189.20	188.69
Urban/Rural					
Urban	49.40	43.75	44.28	45.09	45.05
Rural	68.46	60.13	55.24	52.95	51.67
Deprivation Index					
1 (least deprived)	33.09	31.28	31.94	33.91	34.57
2	39.64	35.73	36.87	39.43	39.91
3	46.10	40.01	39.96	41.92	42.39
4	51.04	45.02	44.92	46.40	46.76
5 (most deprived)	49.46	43.08	45.23	47.24	46.26
Missing	67.73	59.92	56.24	53.57	52.41

Definition for CKD: eGFR <60 ml/min per 1.73m^2 with at least 2 measures 90 days apart (3A [eGFR 45–59], 3B [eGFR 30–44], 4 [eGFR 15–29], 5 [eGFR <15]).
CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; eGFR, estimated glomerular filtration rate.
[a]Based on the above conditions alone.

care system, this age group is more readily identified and diagnosed with CKD than other age groups.

Prevalence of CKD was higher in rural settings than in urban settings. There is evidence of rural-urban disparities in many chronic diseases, including CKD in certain populations.[25] For example, one study cites that rural and remote indigenous populations had a 3-fold increase in CKD prevalence compared with urban indigenous populations.[25] The results from our study suggest that rural-urban disparities in CKD prevalence are more widespread. Access to health services is a barrier to optimal care in many rural and remote regions of Canada due in large part to the country's expansive land mass and low population density.[26,27] Most common determinants of remote-urban health disparities reported in the literature include travel distance to health care services, geographical isolation, limited providers, and socioeconomic factors.[28,29] Prior Canadian studies have found that rural residents with CKD have less access to specialty care and lower quality of care than their urban counterparts.[28,29] Higher prevalence of advanced stages of CKD in rural populations could reflect this issue. Although there were significant missing data, our findings appear to confirm, as other studies have found, a positive relationship between socioeconomic deprivation, and prevalence of CKD.[30,31] Although Canada has universal coverage (medicare) for medically necessary physician, hospital, and diagnostic services, many gaps exists, including coverage for the cost of prescription drugs and mental health care.[32] This, alongside the aforementioned barriers in accessing health care services, poor health literacy, racial factors, and geography (rural vs. urban), may particularly affect low-income individuals,[32] potentially explaining differentials in the prevalence rate of CKD across socioeconomic strata.

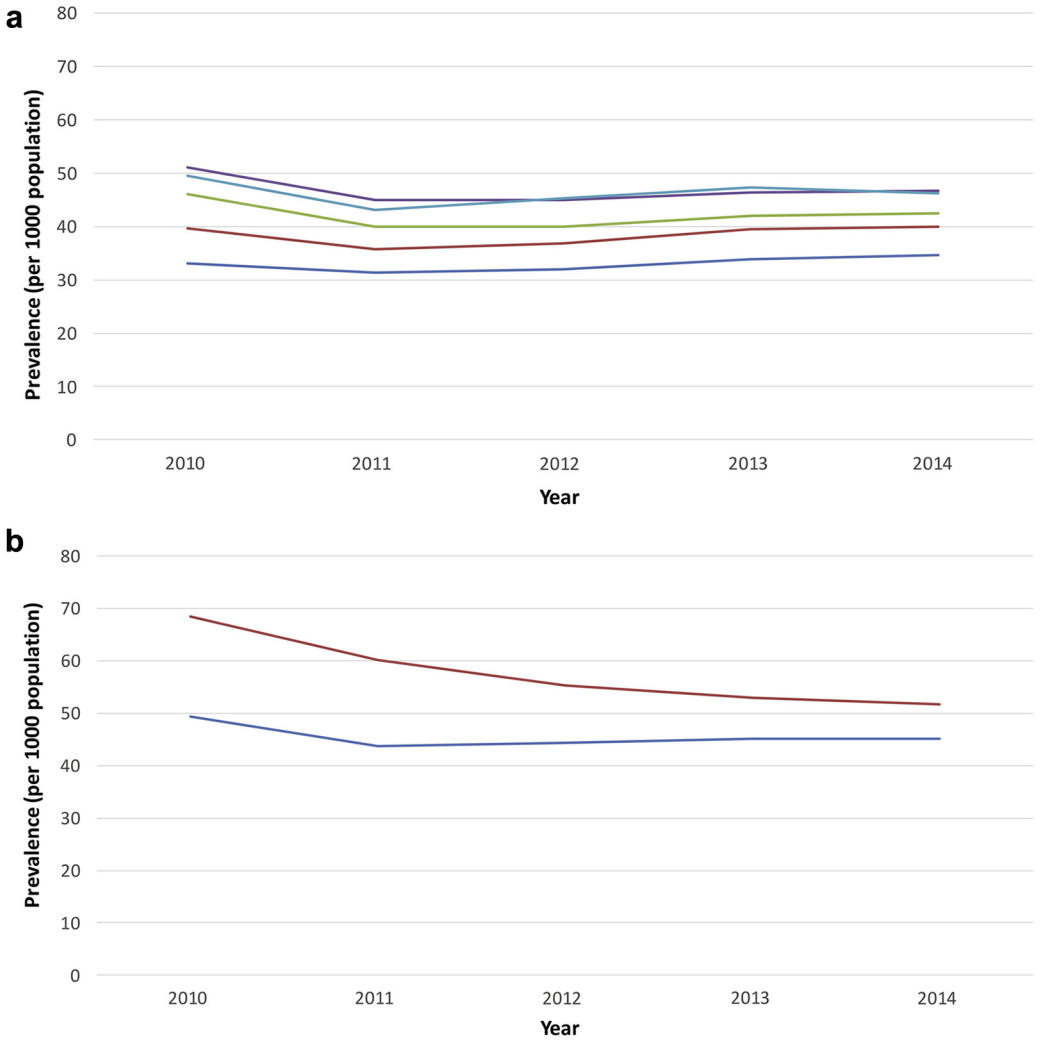

Figure 4. (a) Period prevalence of chronic kidney disease (CKD) by year and deprivation index. Level of deprivation of Canadian Deprivation Index score: 1 (least deprived), dark blue; 2, red; 3, green; 4, purple; 5 (most deprived), light blue. (b) Period prevalence of CKD by year and urban/rural residence. Participant residence: urban (blue); rural (red).

This knowledge of barriers to care can guide health care planning and health-promoting initiatives and further justifies managing CKD through primary care.

Our finding that the overall prevalence of CKD, regardless of subgroup stratified, remained generally stable over time, is consistent with other studies.[33] There was, however, a slight decrease in prevalence among most subgroups from 2010 to 2011, followed by relatively stable prevalence from 2011 to 2014. There were no known changes in CKD definition, physician reporting, or laboratory measurements to explain the slight decrease in prevalence from 2010 to 2011; however, there was a large influx of individuals (n = 96,763) into the CPCSSN system in 2011 increasing the denominator, which could help to explain this finding.

Strengths and Limitations

We used a previously untapped source to estimate the prevalence and patterns of CKD in primary care across Canada. This study included a large population, whose health data were collected from primary care records, and could serve as proof of concept that the barriers to conducting a national CKD study in Canada, such as health service silos or the lack of a dedicated CKD surveillance system, can be overcome. Overall, the surveillance data captured in this study can inform quality improvement and disease surveillance activities across participating PCPs and provinces. Ongoing surveillance of CKD using the methodology detailed in this study can help target care to reduce inequity and maximize effective resource use as well as guide policy and research agendas. For example, this information could be used to guide in-depth studies on disparities in CKD burden across geographic and sociodemographic factors. It could also help inform the debate about the balance between labeling asymptomatic risk factors and preventing progression to symptomatic disease.[22,34] Moving forward, to address the worldwide

growing public health issue of CKD, it will be increasingly important to learn from one another and collaborate at the international level.

This study has some noteworthy limitations that relate to the use of EMR (point of care) data to define the prevalence of CKD. Information in the EMR is based on clinical encounters and might be biased by CKD detection in high-risk populations. Furthermore, the quality and comprehensiveness of data might have varied by region or PCP. Another limitation in this study was incomplete postal code data; however, we considered postal codes only with regard to deprivation data. In addition, the subgroup with missing postal code data was not significantly different from the subgroup with postal code data. Furthermore, the ecological measure of deprivation is less precise than a personal measure would be. Another limitation pertained to the examination of comorbidities; although we examined CKD in relation to certain comorbidities, we were not able to examine all relevant medical conditions, such as congestive heart failure, coronary artery disease, and peripheral vascular disease, as these have not been validated for use in the CPCSSN. Proteinuria is an important marker of kidney damage and quality measure for CKD and inclusion of this would make our analysis more comprehensive; however, because it is not collected and/or reported consistently across primary care practices and therefore could introduce bias, it was not considered in our definition of CKD. Finally, the data did not represent every Canadian province and territory; however, as noted previously, the participating jurisdictions contain approximately 70% of the total Canadian population and so are fairly representative.

CONCLUSION

To our knowledge, this is the first national study to estimate the prevalence and patterns of CKD in primary care in Canada and to report on patterns in the distribution of the disease across geographic, sociodemographic, and clinical factors. We have demonstrated the utility of using existing surveillance networks to study the epidemiology of CKD, even when a national system is lacking. These findings have implications for the design of in-depth Canadian studies to understand how the burden of all severity levels of CKD varies by sociodemographic and clinical factors. The findings will provide the basis for a subsequent study to better understand these patterns and identify variation in CKD care delivery and devise strategies to optimize care.

DISCLOSURE

All the authors declared no competing interests.

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AUTHOR CONTRIBUTIONS

AKB and ND had the original idea for this study. All authors contributed to the development of the idea and the study design, and reviewed the manuscript for intellectual content. All authors approved the final submitted version of the manuscript.

SUPPLEMENTARY MATERIAL

STROBE Statement.

Supplementary material is linked to the online version of the paper at http://www.kireports.org.

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