Report: Kidney Care in Alberta
Winter 2023

Prevalence and Quality of Care in Chronic Kidney Disease

Alberta Health Services
Medicine Strategic Clinical Network™

ICDC
interdisciplinary chronic disease collaboration

AKDN
Alberta Kidney Disease Network

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Executive Summary

Background

Chronic kidney disease (CKD) is associated with increased morbidity and mortality and represents a substantial burden to the health care system in Alberta. Adverse outcomes of CKD can be reduced through high quality care including early detection and appropriate treatment.

The Kidney Health Section of the Medicine Strategic Clinical Network in collaboration with the Interdisciplinary Chronic Disease Collaboration (ICDC), and the Alberta Kidney Disease Network (AKDN) have completed this updated report outlining the prevalence, measurement, and status of identified quality indicators in CKD. This report informs long-term program planning for Alberta's renal programs, identifies variations in care and outcomes across the province, and highlights areas for quality improvement and future research.

Methods

Routine laboratory and administrative data were examined for adults in Alberta for the fiscal year of 2018/2019, with follow up until March 31, 2020.

Key Findings

- The number of people affected by CKD has increased substantially in recent years, with close to 215,000 Albertans identified with CKD Stage G1-4 based on laboratory measurement. However, there is significant geographical variation in prevalence across the province.
- The number of cases of CKD Stage G3 and G4 has **increased by 20% over five years** –this appears to be largely attributable to the growth in the older population where CKD is much more prevalent.
- Practice guidelines suggest annual screening for the presence of diabetes-related kidney disease yet **only 42% of people with diabetes** had an ACR measurement with some geographical variation across the province.
- The appropriate use of pharmacotherapy has been shown to reduce the progression of CKD associated with proteinuria and reduce the risk of cardiovascular events. We found that:
    - In adults without diabetes and with CKD defined by increased albuminuria alone (>30 mg/mmol, A3), **only 36%** are receiving ACE/ARB prescriptions.
    - Statin use in patients (>50 years) with CKD Stage G3 or G4 and no diabetes was low with **only around 40**% receiving a prescription
    - Prescribing rates of ACE/ARBs and statins have seen small increases over the past five years.
    - The use of SGLT2 inhibitors was low **with only 27%** of people with diabetes and albuminuria receiving a prescription.

Implications

The number of cases of CKD Stage G3 and G4 in Alberta is continuing to grow and demonstrates an increasing care burden for both primary care and nephrology specialty care. Working to improve targeted screening for CKD as well as increasing the proportion of patients appropriately prescribed guideline-recommended pharmacotherapy are important. Maximizing these key strategies will help to prevent the progression to end stage renal disease and reduce the risk of morbidity and mortality for people with CKD. Future work into understanding the associated barriers is warranted.

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Background

The Kidney Health Section of the Medicine Strategic Clinical Network (SCN) within Alberta Health Services is committed to ensuring that Albertans are receiving high quality kidney care. Measuring the quality of care, based on reliable provincially consistent data, is required to improve the quality of decisions made regarding priorities for kidney care improvement, the evaluation of improvement initiatives, and the sustainability of positive outcomes. The purpose of creating a reporting framework and developing quality indicators is to enable ongoing evidence-based decision making, monitoring and evaluating kidney care in Alberta. Appropriate screening and management of kidney disease in the early stages is a key priority of the Kidney Health Section. This report describes the prevalence of chronic kidney disease (excluding kidney failure) in Alberta and reports on several quality of care indicators.

Chronic Kidney Disease

Chronic kidney disease (CKD) is associated with increased morbidity and mortality and represents a substantial burden to the health care system in Alberta. CKD can lead to end-stage renal disease requiring dialysis or transplantation, and increases the risk of heart disease, both of which can greatly impact a patient's quality of life. Nationally, it is estimated that kidney disease affects nearly 1 in 10 Canadians[1,2], with over-representation in marginalized populations such as Indigenous people and the elderly.

CKD is defined by an estimated glomerular filtration rate [eGFR; an estimate of kidney function] <60 mL/min/1.73m^2 that is persistent for at least three months, or persistent moderate or severe albuminuria (Appendix A). In addition, among those with eGFR <60 mL/min/1.73m^2, the measurement of albuminuria can provide important prognostic information and indicate that a patient is at high risk for cardiovascular events and progression to kidney failure. When the eGFR falls below 15mL/min/1.73m^2, patients are considered to have kidney failure (please note that kidney failure is not covered in this report).

A key objective of this report is to describe the prevalence and measurement of CKD in the province of Alberta. This report builds upon previous reports on Kidney Care in Alberta[3,4].

Quality Indicators Relevant to Early Stages of Chronic Kidney Disease

High quality care of patients with or at risk of CKD can delay the onset of kidney disease or delay its progression to kidney failure. This care includes appropriate testing to detect the presence of abnormalities of kidney function and structure in people at high risk of kidney disease, and adherence to treatment goals in CKD. These goals address reducing cardiovascular risk through appropriate lifestyle management, blood pressure and lipid control, as recommended by international guidelines[5,6].

Angiotensin-converting enzyme inhibitors (ACEi) and angiotensin receptor blockers (ARB) have been shown to delay progression to end-stage renal disease in people with proteinuric CKD[7], and

reduce mortality in people with CKD and diabetes[8]. In addition, recent evidence supports the use of sodium-glucose transport protein 2 (SGLT2) inhibitors in reducing the risk of kidney failure, acute kidney injury and all-cause mortality in patients with diabetes[9].

The Kidney Health Section examined the literature and completed extensive stakeholder consultation (e.g. Alberta Kidney Care Programs, Interdisciplinary Chronic Disease Collaboration, and content experts) to identify and prioritize quality indicators and build consensus on data definitions. The identified quality indicators span a range of kidney care. This report examines quality indicators pertinent to CKD and expands and builds upon the previous Kidney Care in Alberta Reports[3,4,10].

For the purpose of this report, and given the laboratory and medication data available, the following quality indicators (each representative of high quality care recommended by guidelines) were most appropriate and feasible to measure:

Indicator	Description
Quality Indicator 1	Albuminuria screening in adults with diabetes
Quality Indicator 2	Guideline concordant use of ACEi/ARBs and statins in adults with CKD Stage G3 and G4 and/or albuminuria
Quality Indicator 3	Guideline concordant use of ACEi/ARBs and statins in adults with CKD defined by albuminuria only (CKD Stage G1 and G2)
Quality Indicator 4	Appropriate use of SGLT2 inhibitors in adults with CKD (eGFR>30) and albuminuria.

Note: see Appendix B for complete data definitions.

Methods: Overview

Data Sources

The main data sources used in this study were the Alberta Kidney Disease Network[11] (AKDN) database, a repository of provincial laboratory and administrative data, and data from the Northern and Southern Alberta Renal Programs. All data sources were linked using the unique provincial health number.

Study Population

The study population consisted of all Alberta residents aged 18 years and older. Because data sources were updated to March 31, 2020, we defined most cohorts for the fiscal year April 1, 2018 to March 31, 2019, in order to have one year of follow-up to evaluate quality indicators. A separate cohort was created for each quality indicator.

Covariates and Other Variable Definitions

Demographic data including age and sex were determined from the Alberta Health registry file. We determined zone of residence using the postal code of residence from the AH registry file, which we linked with the Postal Code Translator File. In order to examine geographical variations, data was stratified by the five zones in Alberta Health Services (North, Edmonton, Central, Calgary, and South).

We used validated algorithms to define diabetes[12,13], hypertension[14], history of congestive heart failure[15] and history of acute myocardial infarction[16] using the Alberta Health physician claims and hospitalization databases. We calculated eGFR from outpatient serum creatinine measurements that had been corrected for inter-lab and temporal measurement differences (see Appendix D), and using the CKD-EPI equation[17], and defined albuminuria based on ACR, PCR and urinary protein dipstick (UDIP) measurements. We defined filling a prescription for an ACEi/ARB, statin, or SGLT2 inhibitor by using the Drug Identification Numbers for drugs dispensed in the Alberta Pharmaceutical Information Network (PIN) database.

Ethics and Privacy

We are secondary users of the data, as defined by the Alberta Health Information Act. Ethics approval was obtained from the Universities of Calgary and Alberta for ongoing AKDN data collection and for the purposes of this report. Data is housed within the Secure Computing Data Storage within the IT department of the University of Calgary, which has been approved for storage of patient level data.

Findings

Measurement and Prevalence of CKD

Cohort

The population cohort consisted of all adults in Alberta who were at least 18 years old on April 1, 2018 and registered with Alberta Health from April 1, 2018 to March 31, 2019, a total of 3,625,099 individuals (see Appendix B for details). Table 1 shows the details of this cohort.

Table 1. Characteristics of the 2013/14 and 2018/19 population cohorts (% unless otherwise indicated)

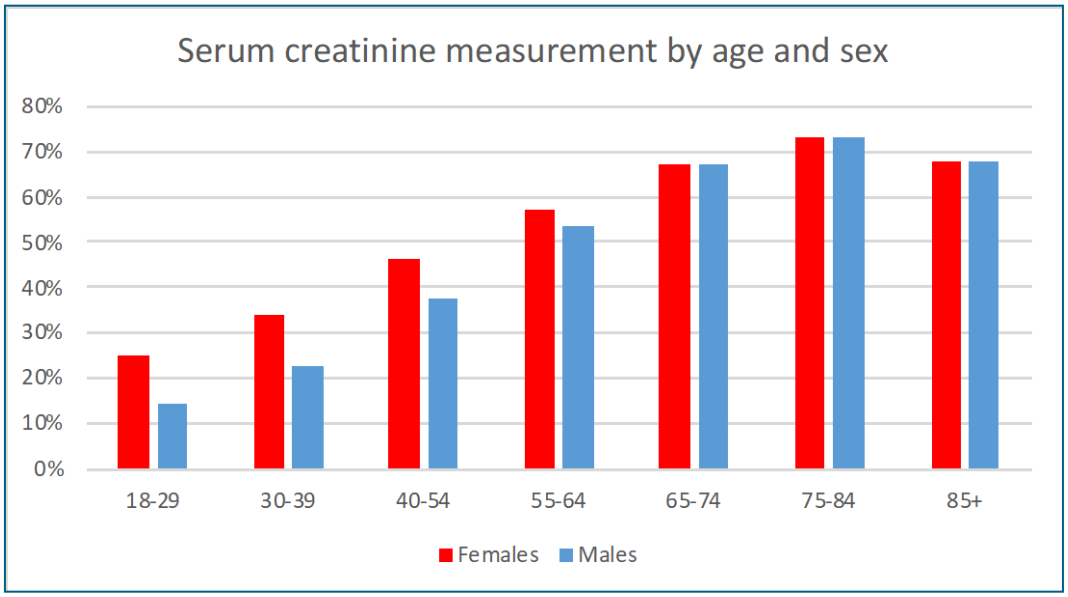
	2013-14 cohort	2018-19 cohort
Characteristic		
N	3,244,197	3,625,099
Male	50.3	50.3
Age, years: mean (SD)	44.9 (17.1)	45.2 (17.2)
Age category		
18-29	23.8	21.3
30-39	20.5	21.6
40-54	27.7	25.8
55-64	14.5	15.8
65-74	7.8	9.4
75-84	4.2	4.4
85+	1.5	1.8
eGFR category, mL/min/1.73m^2		
>90	18.6	19.6
60-90	15.9	16.9
45-60	2.2	2.7
30-45	0.9	1.0
15-30	0.3	0.3
<15	0.1	0.1
Unmeasured	62.1	59.5
Albuminuria category		
Normal/mild (A1)		25.5
Moderate (A2)		2.3
Severe (A3)		0.8
Unmeasured in 2018/19		71.4
Type of albuminuria measurement used		
ACR		7.3
PCR		0.7
UDIP		20.6
Unmeasured in 2018/19		71.4
Diabetes	7.5	9.5
Hypertension	20.3	23.2
Zone of residence		
Calgary	38.0	38.8
Central	11.4	10.9
Edmonton	31.9	32.4
North	11.5	11.0
South	7.1	6.9

Notably, Table 1 shows that while the Alberta population grew by 12% over the 5 years, the population aged 65 and older grew from 13.6% to 15.6% (440,000 to 564,000, an increase of 28%), mainly due to aging baby-boomers. In addition, the number of people with diabetes increased from 7.5% to 9.5%, from 243,000 to 343,000, an increase of 41%.

Serum creatinine measurement

During the fiscal year 2018/2019, 40.5% of adults in Alberta had at least one outpatient serum creatinine measurement (Figure 1). The proportion with a measurement was highest in the 75-84 age bracket, with almost three quarters having at least one measurement. Among those younger than 65, the proportion was higher among women than men, but among those 65 and older it was very similar in men and women.

Figure 1. Percent of adults with an outpatient serum creatinine measurement in 2018/19, by age and sex



Measurement of serum creatinine

Appropriate screening for CKD is important in identifying and preventing progression of CKD. As outlined in the provincial CKD pathway[18] (http://www.ckdpathway.ca/), screening for CKD should not be universal, but should be targeted at individuals at risk of developing CKD such as those with any of the following:

- Hypertension
- Diabetes Mellitus
- Family history of CKD Stage G5 or hereditary kidney disease
- Vascular disease (prior diagnosis of cardiovascular disease, stroke or peripheral vascular disease)

- Multisystem disease with potential kidney involvement (e.g. systemic lupus erythematosus)

Serum creatinine measurement by zone

Figure 2. Percent of adults having at least one outpatient serum creatinine measurement in 2018-19, by zone (adjusted for age and sex)

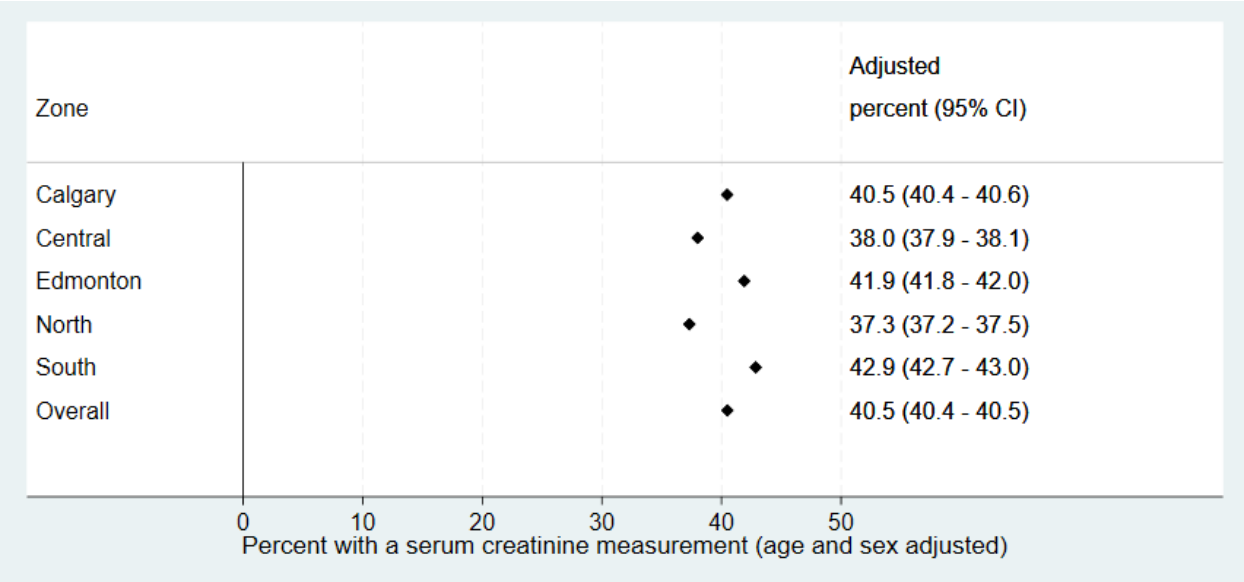


Figure 2 shows some variation in serum creatinine measurement by zone, with the highest adjusted rate being in the South Zone (42.9%), and the lowest adjusted rate in the North Zone (37.3%).

Serum creatinine measurement: change over time

We compared serum creatinine measurement in the fiscal year 2018-2019 to measurement in 2015-2016. Overall, the proportion of adults with a measure in the year stayed similar with a slight increase from 40.0% to 40.5%. However, comparing within age groups, there were actually slight decreases (approx. 0.5%) in measurement between the fiscal years in all age groups 30 and older. The apparent increase in overall measurement was due to the more rapid increase in the older population, among whom serum creatinine measurement was more common. Nevertheless, the changes were very small, so any changes seen in the provincial prevalence of CKD Stage G3 and G4 between 2015-16 and 2018-19 (see next section) were likely actual changes in prevalence, rather than changes due to increase/decrease in measurement.

Prevalence of eGFR CKD Stage G3 and G4

Based on patients with lab measures, we identified 131,152 adults with sustained eGFR between 15 and 60 ml/min/1.73m^2 in the fiscal year 2018-19 (see Quality Indicator 2), for an overall prevalence of 36.2 per 1,000 (3.62%).

Table 2. Prevalence of eGFR 15 to 60 by age and sex in 2018-19: rates per 1,000 adults, and rates per 1,000 adults with a serum creatinine measurement

	# of adults with eGFR 15 to 60		Rate per 1,000 adults		Rate per 1,000 adults with an outpatient serum creatinine measurement	
Age group	Female	Male	Female	Male	Female	Male
18-29	105	120	0.3	0.3	1.1	2.1
30-39	425	425	1.1	1.1	3.3	4.7
40-54	2,927	2,874	6.4	6.0	13.9	16.0
55-64	9,310	7,798	33	27	58	50
65-74	19,915	17,818	116	106	172	159
75-84	23,982	19,660	280	269	383	367
85+	16,353	9,440	398	394	590	581
Overall	**73,017**	**58,135**	**40.5**	**31.9**	**91**	**88**

Table 2 shows that 56% of eGFR CKD Stage G3 and G4 cases were in women, while 95% occurred in people 55 and older. Age-specific rates were highest among those older than 85, although because of the smaller size of this group, the greatest number of cases was in the 75-84 age group. Age-specific rates were only slightly higher among women than men in the older age brackets; the main reason there were more cases among women was the greater number of older women compared to men.

Figure 3. Prevalence of eGFR 15 to 60 among Alberta adults, by zone (adjusted for age and sex)

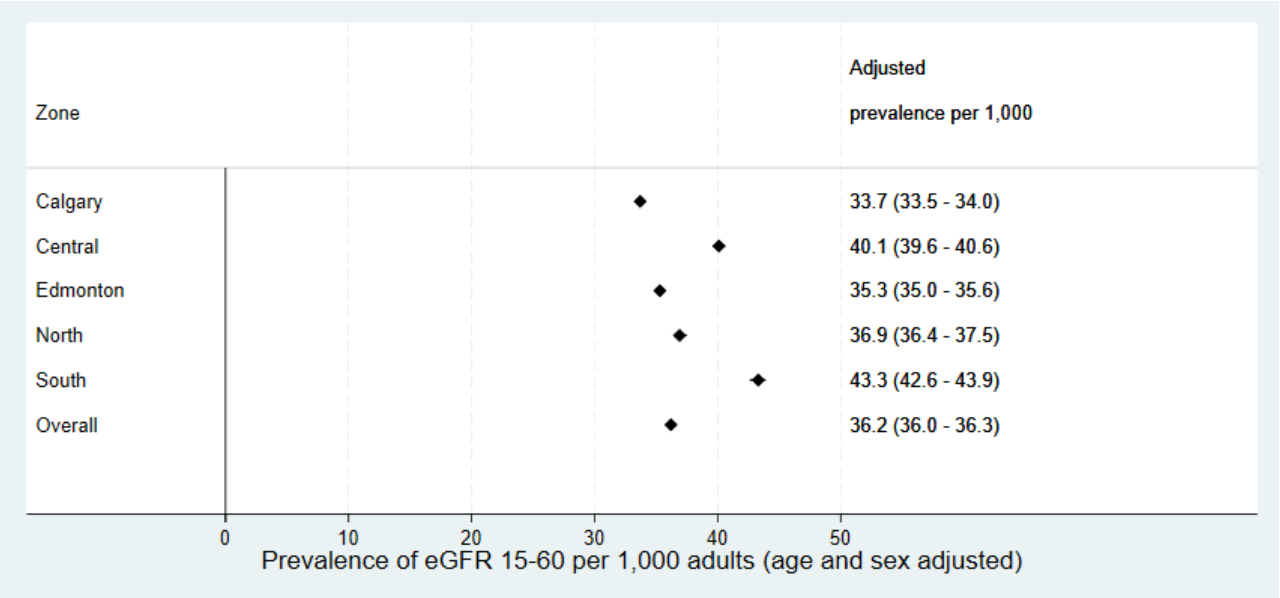


Figure 3 shows some geographical variations in the age and sex adjusted prevalence of eGFR CKD Stage G3 and G4, with the South Zone having the highest adjusted prevalence (4.33%, 95% CI 4.26% – 4.39%), and Calgary Zone the lowest (3.37%, 95% CI 3.35% – 3.40%). Note that these estimates may have been affected by serum creatinine measurement bias in some zones (see Appendix D), as well as by differences in the rates of serum creatinine measurement.

Change over Time in Prevalence of eGFR CKD Stage G3 and G4

We assessed change in provincial prevalence of eGFR CKD Stage G3 and G4 over time by comparing this cohort to similar cohorts for the 2013-2014 and 2015-16 fiscal years (Table 3). Overall, the number of adults with eGFR CKD Stage G3 or G4 increased from 109,339 (33.7 per 1,000) to 131,152 (36.2 per 1,000) from 2013-14 to 2018-19, **an increase of 20%.** The age-specific prevalence of eGFR Stage G3 and G4 was stable or increased slightly in age groups <65, but continued to decline in age groups >65 (which contained 82% of cases of eGFR CKD Stage G3 and G4) – e.g., from 281.4 to 274.8 per 1,000 in the 75-84 age bracket, a decrease of 2.3%. The overall increase in the rate per 1,000 was due to the rapid increase in the size of the older age groups, particularly the 65-74 age group, as the “baby boomers” entered. For example, the population aged 65-74 increased by 19% between 2015-16 and 2018-19, compared to a 6% increase in the overall adult population in the 3 years.

Table 3. Age-stratified prevalence of eGFR 15-60 (CKD Stage G3 and G4) in the 2013-14, 2015-16 and 2018-19 fiscal years

	2013-14			2015-16			2018-19		
Age	Population	Cases of G3 or G4	Rate per 1000	Population	Cases of G3 or G4 eGFR	Rate per 1000	Population	Cases of G3 or G4	Rate per 1000
18-29	772,909	237	0.3	789,019	201	0.3	770,649	225	0.3
30-39	664,083	700	1.1	722,220	763	1.1	781,884	850	1.1
40-54	897,559	5,198	5.8	914,974	5,525	6.0	936,421	5,801	6.2
55-64	469,181	13,947	29.7	512,362	15,200	29.7	572,517	17,108	29.9
65-74	253,588	29,751	117.3	285,410	32,711	114.6	339,767	37,733	111.1
75-84	135,520	38,609	284.9	141,934	39,947	281.4	158,828	43,642	274.8
85+	51,357	20,897	406.9	56,725	22,759	401.2	65,033	25,793	396.6
Total	**3,244,197**	**109,339**	**33.7**	**3,422,644**	**117,106**	**34.2**	**3,625,099**	**131,152**	**36.2**

The 20% increase in the number of cases of G3 or G4 CKD, while substantial, is less than the 41% increase in people with diabetes during the same period, noted in Table 1. Notably, in the 2013-14 G3/G4 cohort, 36,071 (33.0%) had diabetes, whereas in the 2018-19 G3/G4 cohort, 49,841 (38.0%) had diabetes. The number of people with diabetes and G3/G4 increased by 38%; at the same time, the number of people with G3/G4 without diabetes increased by only 11% (from 73,268 to 81,311).

By linking the population cohorts for 2015-16 and 2018-19, we determined how many people identified with CKD Stage G3 or G4 in 2015-16 were still identified with CKD Stage G3 or G4 in 2018-19. Of the 117,106 people with CKD Stage G3 or G4 in 2015-16, 21,201 were no longer in the 2018-19 population cohort, in 96% of cases because they had died. Of the remaining 95,905, 67,347 (70.2%) still had sustained G3/G4 CKD, while 28,558 (29.8%) remained in the cohort but were no longer identified as having G3 or G4 CKD. Of these,15,309 (16.0%) were unmeasured in 2018-19; 11,810 (12.3%) were now classified as G1 or G2; and 1,439 (1.5%) had moved into G5. This finding gives some insight as to how the population of individuals with CKD in Alberta is not static, with some individuals moving in and out of the defined CKD definition.

Prevalence of eGFR CKD Stage G4

Identifying and describing the trends in prevalence of eGFR CKD Stage G4 (15-30 ml/min/1.73m^2) is valuable in understanding demands on nephrology specialty clinics and potential future increases in those requiring renal replacement therapies. Clinical practice guidelines[18] suggest that individuals with eGFR <30 should be referred to a nephrologist.

Overall, among the 131,152 individuals identified with sustained eGFR between 15 and 60, there were 9,711 whose first eGFR in the fiscal year was between 15 and 30 ml/min/1.73m^2. This

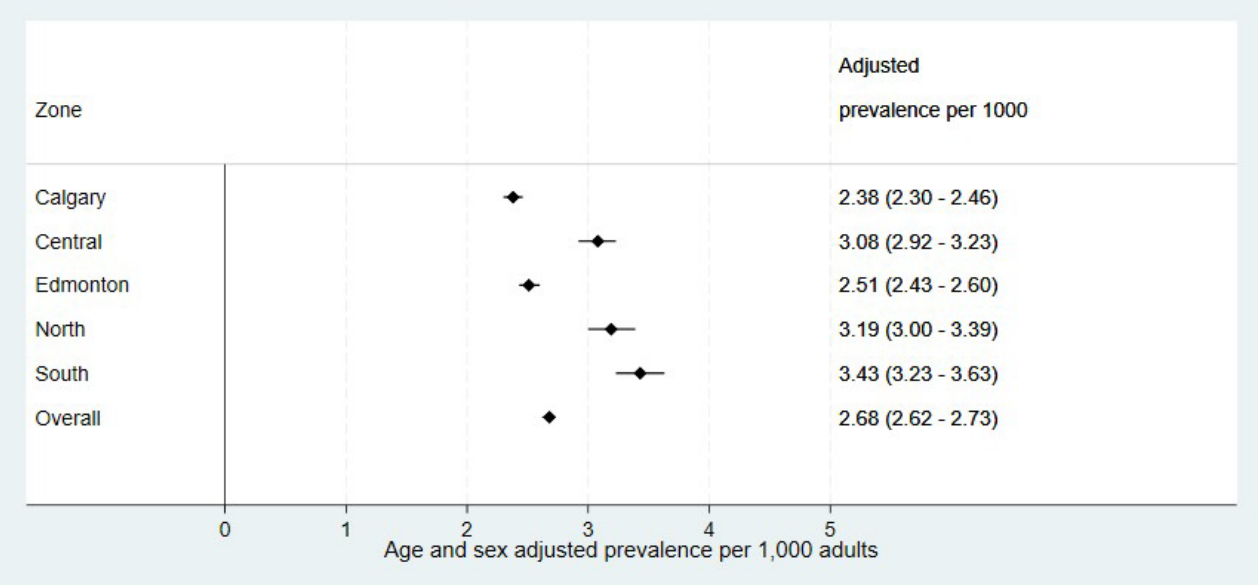
corresponds to an overall prevalence of 2.7 per 1,000. Among these individuals, 55.1% had an outpatient visit with a nephrologist in the year after index date. Rates varied substantially by zone, with higher rates in Edmonton and Calgary (60.9% and 59.7%, respectively), and lower rates in the other three zones (South – 55.1%, North – 45.4%, Central – 43.9%). Referral was also significantly higher among men (63.4% vs. 47.8% among women) and among younger patients.

Table 4. Age and sex stratified prevalence of eGFR CKD Stage G4 in the 2018-19 fiscal year

	Female			Male			All		
	Population	# of cases	# per 1000	Population	# of cases	# per 1000	Population	# of cases	# per 1000
18-29	380,684	20	0.1	389,965	21	0.1	770,649	41	0.1
30-39	385,334	44	0.1	396,550	70	0.2	781,884	114	0.1
40-54	454,629	220	0.5	481,792	276	0.6	936,421	496	0.5
55-64	282,376	466	1.7	290,241	537	1.9	572,517	1003	1.8
65-74	172,330	1049	6.1	167,437	1083	6.5	339,767	2132	6.3
75-84	85,744	1642	19.2	73,084	1474	20.2	159,828	3116	19.6
85+	41,063	1759	42.8	23,970	1050	43.8	65,033	2809	43.2
Total	**1,802,060**	**5,200**	**2.9**	**1,823,039**	**4,511**	**2.5**	**3,625,099**	**9,711**	**2.7**

Just over half (54%) of CKD Stage G4 cases were female, with the majority (83%) being aged 65 or older. Age-specific prevalence of eGFR CKD Stage G4 was slightly higher among men than among women; overall prevalence was higher among women because of the greater number of women in older age groups.

Figure 4. Prevalence of eGFR CKD Stage G4 in the Alberta adult population in 2018-19, by zone (adjusted for age and sex)



Even after adjusting for age, the South Zone appears to have a somewhat higher prevalence of CKD Stage G4 eGFR than other zones. However, the apparent high prevalence was likely related to residual uncorrected serum creatinine measurement error in the former Chinook Health Region (mainly Lethbridge).[1] While we applied a relatively large (negative) correction to measurements from this region during this period, this was likely an underestimate of the magnitude of measurement error at high serum creatinine values (see Appendix D).

[1] The former Chinook Health Region had an adjusted prevalence of 3.95 per 1,000 while Palliser (i.e., Medicine Hat) had a prevalence of only 2.56. The difference persisted even when adjusted for diabetes, hypertension, and First Nations ethnicity. Lethbridge's analyzer has always been problematic, and the calibration study done by APL confirmed that it had a high level of measurement bias at high concentrations of creatinine. It was finally replaced in October 2021; we anticipate that the apparent prevalence will drop substantially at that time.

Change over Time in Prevalence of eGFR CKD Stage G4

We examined change over time by comparing with similar cohorts from the 2013-2014 and 2015-16 fiscal years (Table 5). Overall, the number of cases of eGFR CKD Stage G4 increased from 8,458 to 9,711 between 2013-14 and 2018-19, **an increase of 15%.** The age-specific rates of eGFR CKD Stage G4 declined somewhat among age groups >75, which contained the majority of cases (e.g., from 46.5 to 43.2 per 1,000 in the 75-84 age group). However, in spite of this, the overall increase in the number of cases (14.8%) was greater than the increase in adult population (11.7%) because the population of the older age groups increased substantially.

Table 5. Age stratified prevalence of eGFR CKD Stage G4 in the 2013-14, 2015-16 and 2018-19 fiscal years

	2013-14			**2015-16**			**2018-19**		
Age	Population	Stage G 4 eGFR	Rate per 1000	Population	Stage G4 eGFR	Rate per 1000	Population	Stage G4 eGFR	Rate per 1000
18-29	772,909	48	0.06	789,019	37	0.05	770,649	41	0.05
30-39	664,083	112	0.17	722,220	114	0.16	781,884	114	0.15
40-54	897,559	447	0.5	914,974	458	0.5	936,421	496	0.5
55-64	469,181	796	1.7	512,362	871	1.7	572,517	1003	1.8
65-74	253,588	1,633	6.4	285,410	1,766	6.2	339,767	2132	6.3
75-84	135,520	2,952	21.8	141,934	3,018	21.3	159,828	3116	19.6
85+	51,357	2,470	48.1	56,725	2,635	46.5	65,033	2809	43.2
Total	**3,244,197**	**8,458**	**2.6**	**3,422,644**	**8,899**	**2.6**	**3,625,099**	**9,711**	**2.7**

Table 6. Prevalence of eGFR CKD Stage G4 over time by Zone

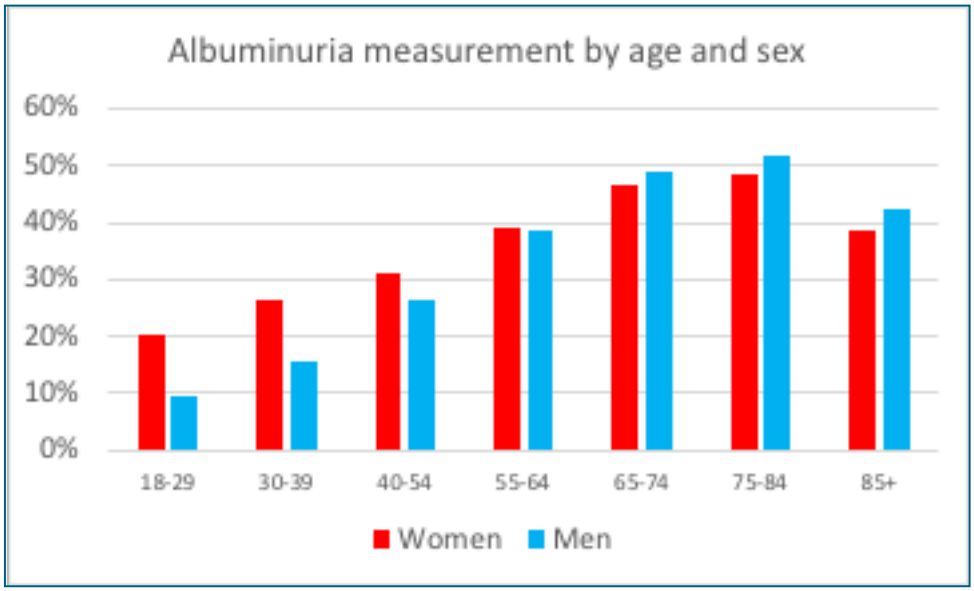
	2013/14 fiscal year			2015/16 fiscal year			2018/19 fiscal year			% change in cases from 2013/14 to 2018/19
	Population	# of cases	# per 1000	Population	# of cases	# per 1000	Population	# of cases	# per 1000	
ry	1,232,711	2,603	2.1	1,310,263	2,770	2.1	1,407,455	3,156	2.2	+21.2%
Calga al	370,932	1,385	3.7	382,477	1,353	3.5	395,430	1,471	3.7	+6.2%
Centr nton	1,034,991	2,582	2.5	1,096,240	2,771	2.5	1,173,601	2,979	2.5	+15.3%
Edmo	374,238	902	2.4	387,520	940	2.4	399,727	1,048	2.6	+16.2%
North n	231,177	986	4.3	237,113	1,065	4.5	248,732	1,057	4.2	+7.2%
Sout	**3,244,197**	**8,458**	**2.6**	**3,413,613**	**8,899**	**2.6**	**3,624,945**	**9,711**	**2.7**	**+14.8%**
Total										

Some of the variation between zones above is due to differences in age, with Central and South Zones having the oldest populations, and the North Zone the youngest.

Albuminuria Measurement

Albuminuria measurement is also important for identifying and classifying CKD[5] (see Appendix A). For this indicator, we included any random urine albumin:creatinine ratio (ACR), urine protein:creatinine ratio (PCR), or urine protein dipstick (UDIP) outpatient measurement in the 2018/19 fiscal year.

Figure 5. Proportion of adults with at least one albuminuria measurement (any type) in 2018/19, by age and sex

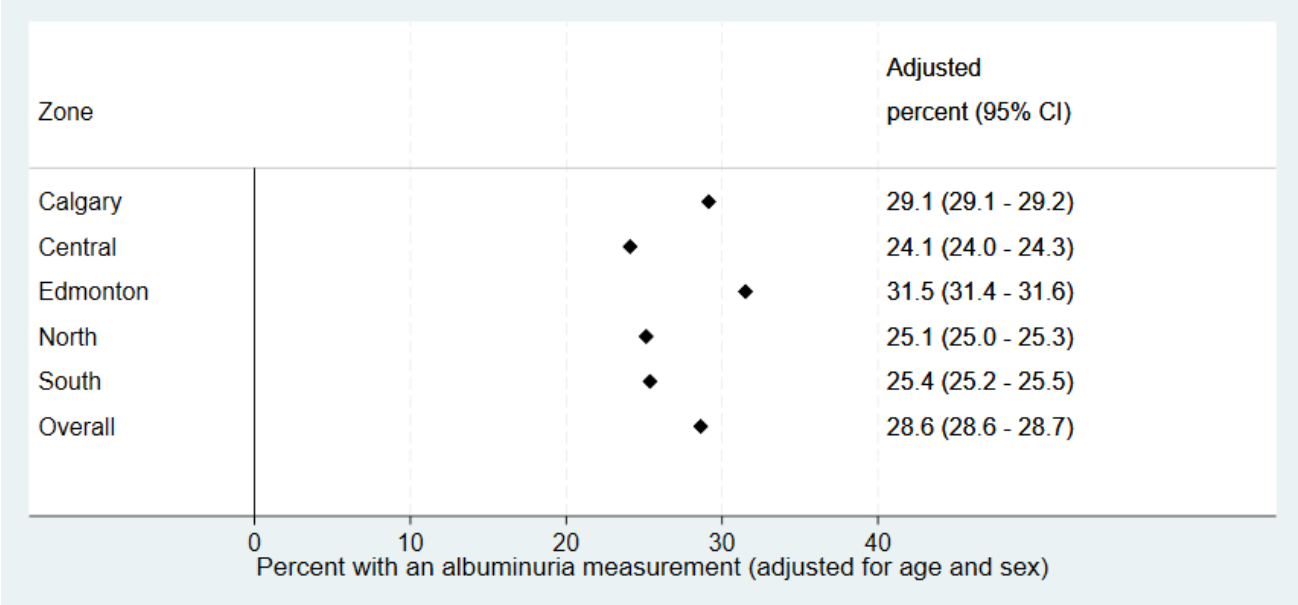


Overall, we found that 28.6% of adults in Alberta had albuminuria measured in 2018/2019 using one of the three methods. The proportion of adults with an albuminuria measurement was highest in the 75-84 age group. Among those 65 and older, men were more likely than women to be measured, while in younger age groups the reverse was true.

Albuminuria Measurement by Zone

Adults living in the Calgary and Edmonton Zones were more likely to be tested for albuminuria than in other parts of Alberta (Figure 6). This was mainly a result of more urine dipstick results being done in the Calgary and Edmonton Zones (Appendix E, see Table E1). The higher rate of albuminuria testing in Edmonton compared to Calgary was mainly related to more ACR testing in Edmonton compared to Calgary. See Appendix E for more details on albuminuria testing.

Figure 6. Measurement of albuminuria in 2018/19 by Zone, adjusted for age and sex



Change in albuminuria measurement over time

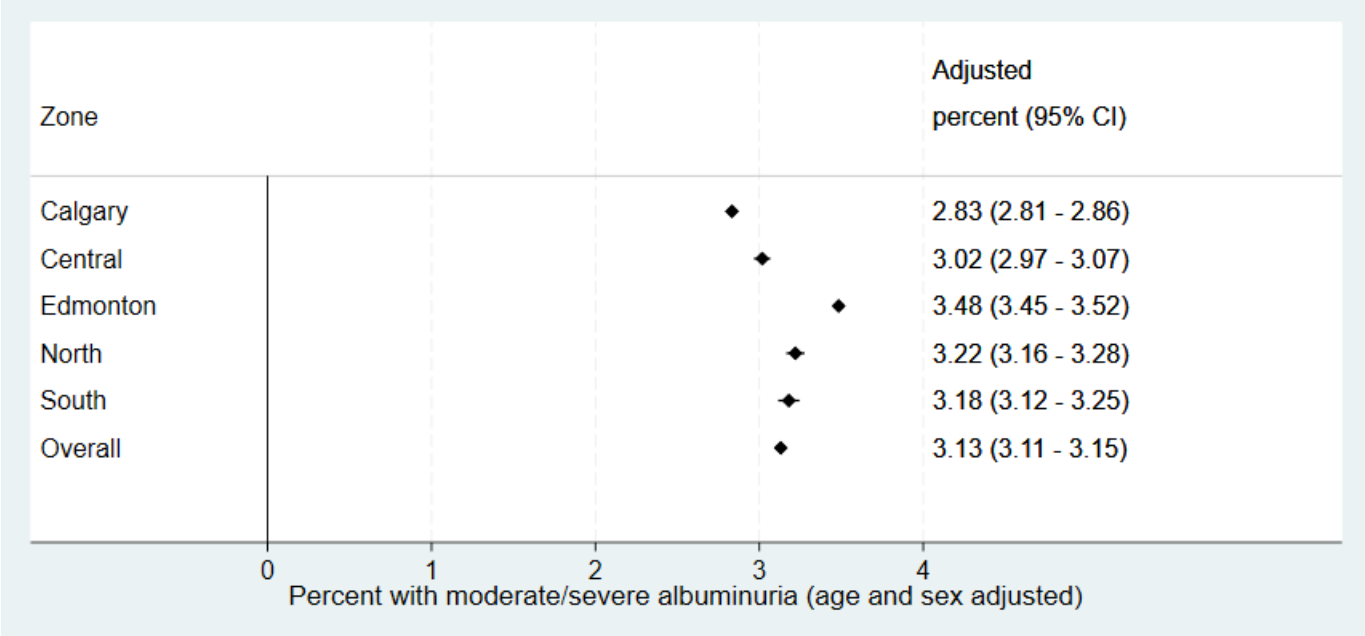
Overall, the proportion of adults with an albuminuria measurement declined from 30.3% in 2015/16 to 28.6% in 2018/19. This appears to be related to a decrease in the proportion of people with a urinary dipstick measurement, which dropped from 28.4% to 26.2%. The proportion with a UDIP measurement declined by about two percentage points in all zones except for South Zone, where it was stable. Meanwhile, the proportion with an ACR measurement increased from 6.3% to 7.3%; the proportion increased substantially in Calgary Zone, from 4.8% to 6.6%, while in Edmonton, which already had the highest rate of ACR measurement, it increased more modestly from 8.3% to 8.8%.

Prevalence of Moderate or Severe Albuminuria

Albuminuria measurements can be categorized as normal/mild (A1, ACR <3 mg/mmol), moderate (A2, 3-30 mg/mmol), or severe (A3, >30 mg/mmol)[5]. For this indicator, an ACR was used in preference to a PCR, which was used in preference to a dipstick measurement. Overall, 113,495 adults (3.13%) tested positive for A2 or A3 albuminuria in 2018/19, an increase from the 98,362 (2.87%) in 2015/16. This increase was in spite of the decrease in the measurement of albuminuria, referred to in the previous section. The increase in prevalence was partly caused by the increase in ACR testing, since ACRs are more effective at identifying moderate albuminuria than urine protein dipstick testing. In addition, it was related to the fact that the number of adults with diabetes, hypertension and eGFR <60 (all of which are risk factors for albuminuria) increased more rapidly than the population between 2015/16 and 2018/19.

Figure 7 shows the age- and sex-adjusted prevalence of A2 or A3 albuminuria by zone. The variations in prevalence between zones are due at least in part to variations in levels of measurement. In particular, Edmonton Zone had the highest apparent prevalence of albuminuria, but also had the highest level of measurement, particularly with an ACR. The variations are also due to variations in prevalence of diabetes, hypertension and low eGFR. For example, Calgary Zone's low prevalence is partly explained by Calgary Zone's relatively low prevalence of these comorbidities.

Figure 7. Prevalence of moderate or severe albuminuria in 2018/19, by zone (adjusted for age and sex)



Overall estimate of CKD prevalence in Alberta

Overlaying the 131,152 adults with sustained eGFR between 15 and 60, and the 113,495 with moderate or severe albuminuria, there were a total of 214,672 adults with CKD in Alberta, or 5.92% of the adult population. Note that this is an underestimate because of incomplete measurement, with only 40.5% of adults having a serum creatinine measurement in 2018/19 and 28.6% having an albuminuria measurement (although these proportions were significantly higher among those at risk of CKD). The true prevalence is likely approximately 10-12%, based on Canadian population surveys[1,2]. Appendix F shows the categorization of the identified cases of CKD by eGFR category and albuminuria category (i.e., a heat map).

Quality Indicators

The Kidney Health Section is committed to promoting high quality evidence-based care for Albertans. Appropriate screening and medical management in the earlier stages of CKD can delay its progression to more advanced stages of CKD and to end-stage kidney failure.

Quality Indicator 1: Screening for albuminuria in adults with diabetes

Diabetes Cohort

Using a validated algorithm, we defined a cohort consisting of all adults in Alberta who were diagnosed with diabetes prior to April 1, 2019 and registered with Alberta Health during both the 2018/19 and 2019/20 fiscal years (see Appendix B for details on the definition). We assessed albuminuria measurement in 2019/20, and also compared change over time with comparable cohorts for prior periods. The index date for the cohort was April 1, 2019. Table 7 provides an overview of patient characteristics in the diabetes cohort.

We found that:

- There were 343,159 adults in Alberta identified with a diagnosis of diabetes
- Over the 3 years since the previous report, the size of the cohort grew by 16.1% or an annual increase of 5.1%
- There were 52,540 adults with sustained eGFR <60 mL/min/1.73m^2, comprising 15.3% of the diabetes cohort.

Table 7. Characteristics of the 2019/20 diabetes cohort, N=343,159

Characteristic	Percent (unless otherwise noted)
Male	53.9
Age: median (IQR)	63.2 (52.6, 72.7)
Age categories	
18-54	29.7
55-64	25.4
65-74	24.8
75-84	14.3
85+	5.9
Category of index eGFR (those with sustained eGFR < 60 mL/min/1.73m^2)	
45-60	8.6
30-45	4.5
15-30	1.6
<15	0.6
Value of last HbA1c (%) in 2018/19	
<6.5	24.0
6.5 to 8	34.0
>8 to 10	12.3
> 10	4.7
Unmeasured in 2018/19	25.0

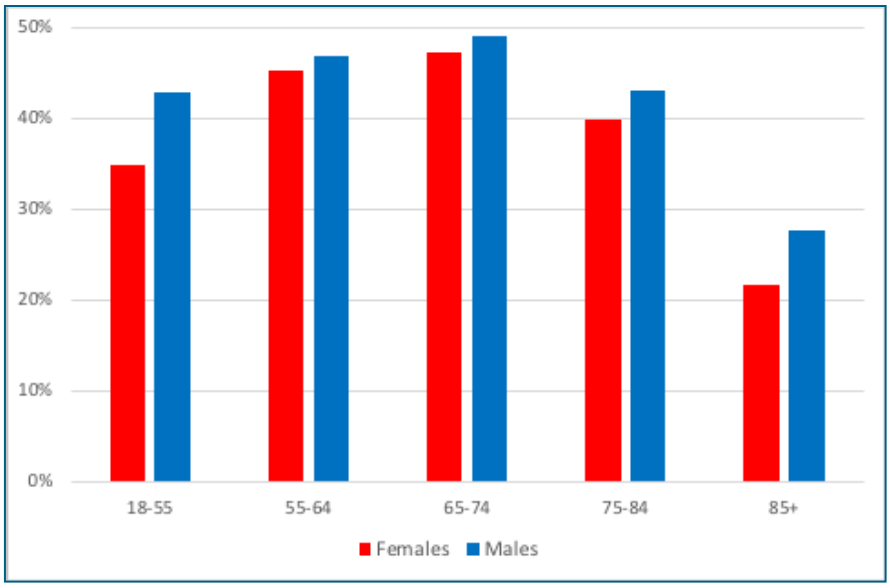
Zone of residence	
Calgary	34.3
Central	11.3
Edmonton	35.5
North	11.3
South	7.6

Abbreviations: IQR: interquartile range; eGFR: estimated glomerular filtration rate; HbA1C: hemoglobin A1C;

Measurement of albuminuria

The Diabetes Canada Clinical Practice Guidelines[6] suggest that all people with diabetes be screened annually for albuminuria using a random urine albumin:creatinine (ACR) laboratory test. Figure 8 below outlines ACR measurement in 2019/20 in Alberta.

Figure 8. ACR measurement in 2019/20 among adults with diabetes, by age and sex



We identified 143,806 people who had at least one outpatient ACR measurement in the 2019/20 fiscal year.

- Overall, **only 41.9%** of people with diabetes were screened for albuminuria (42.7% after excluding 9,892 who were censored before March 31, 2020).
- Measurement rates were slightly higher among men than women, particularly in the youngest and oldest age groups.

ACR Measurement by Zone

Figure 9. Rate of ACR measurement in adults with diabetes in 2019/20, by zone, adjusted for age and sex

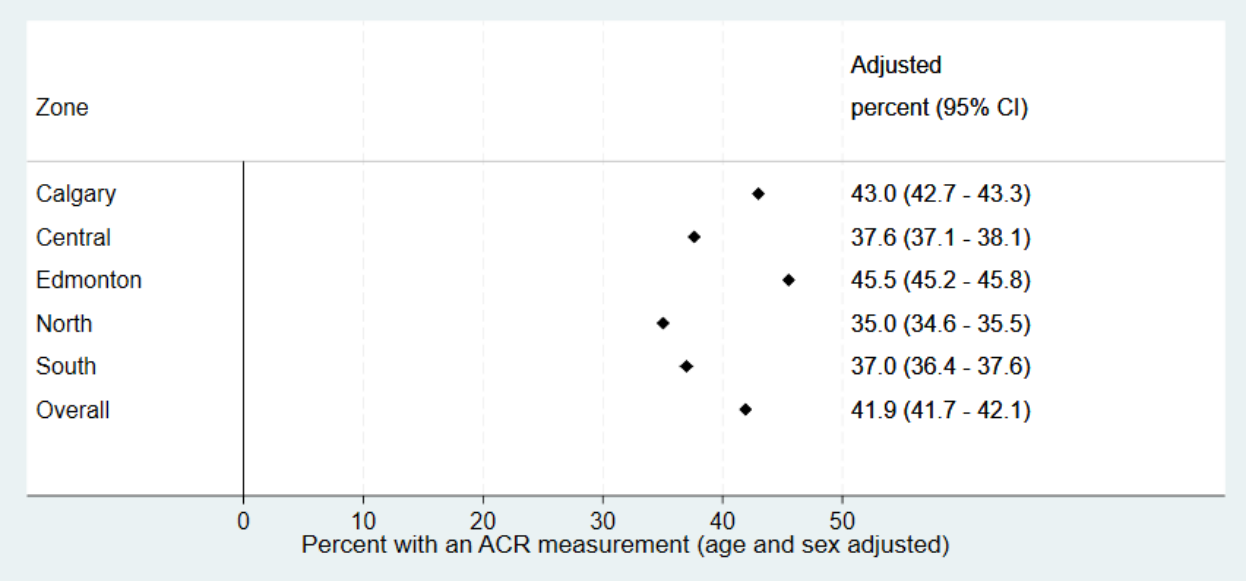


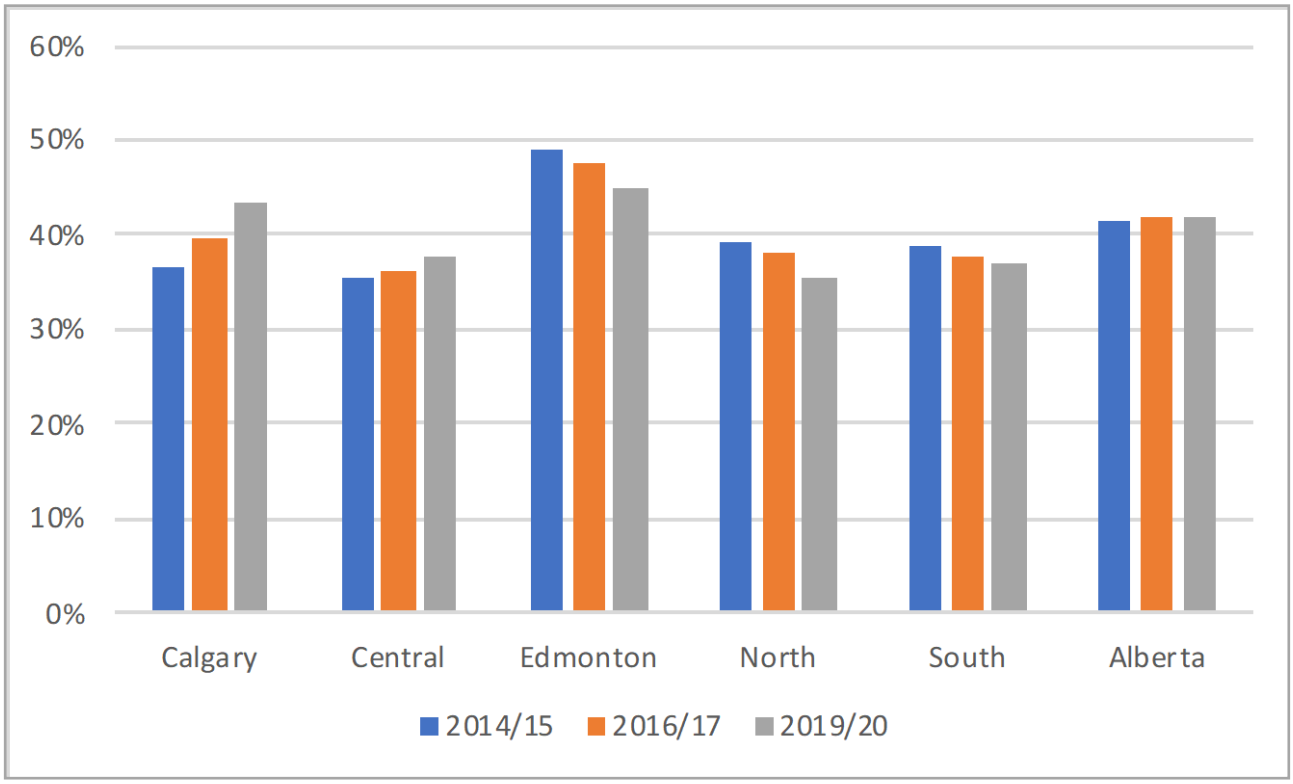
Figure 9 shows significant variations in ACR testing by health zone, with Edmonton and Calgary zones having relatively high age- and sex-adjusted testing rates. The apparent low rates of testing in the Central, North and South Zones are partly explained by the ACR not being calculated by the laboratory in certain former health regions for about 10% to 20% of ordered tests.[2]

Change over time

Figure 10 shows the change in measurement of ACR by zone over time. Overall in Alberta, ACR measurement increased slightly (0.5%) over the period, from 41.4% in 2014/15 to 41.9% in 2019/20. ACR testing increased over the period in the Calgary Zone while it decreased in the Edmonton Zone. In 2014/15, the testing rate was much higher in Edmonton than in Calgary (49.1% in Edmonton vs. 36.7% in Calgary), but by 2019/20 the difference had diminished substantially (45.1% in Edmonton vs. 43.3% in Calgary).

[2] This happened in the former Chinook, David Thompson and Peace Country health regions, which are contained in the South, Central and North Zones, respectively. It occurred when the albumin concentration was below the lower limit of the albumin assay. Other lab regions either had a lower albumin limit, or reported the ACR value was less than the lowest possible calculated value in those instances. As a result, ACR testing rates appear to be significantly lower in these former health regions, compared with the rest of that zone.

Figure 10. ACR measurement among adults with diabetes, by zone and year



Note: Guidelines[6] suggest all people with diabetes are screened with ACR annually.

Appropriate Medication Use

Quality Indicator 2: Guideline concordant use of ACEi/ARBs and statins in adults with CKD Stage G3 and G4 and/or albuminuria

Cohort

The cohort included all adults in Alberta who had a sustained eGFR between 15 and 60 ml/min/1.73m^2 with at least one serum creatinine measurement in the 2018/2019 fiscal year (Appendix B). We defined a comparable cohort for the 2015/2016 fiscal year. This cohort was based on creatinine measurements that were not corrected for measurement bias.

- This resulted in a cohort of 153,499 individuals which reflected a 14% increase over the cohort of 134,411 created for the 2015/16 report.
- We found that 79% of the cohort had as assessment of albuminuria (ACR, PCR or UDIP). To assess albuminuria, we used an ACR for 39%, a PCR for 4%, and a UDIP for 36%. There were fewer people with an albuminuria measurement than in the previous report, due to a decline in the number of UDIP measurements available (43% to 36%).
- The index date for the cohort was the date of the first qualifying serum creatinine measurement in 2018/19.

Table 8. Characteristics of the 2018/19 CKD Stage G3 and G4 cohort (N = 153,499)

Characteristic	%
Female	55.3
Age: mean (SD)	75.0 (11.7)
Age category	
<65	18.4
65-74	28.5
75-84	32.4
85+	20.7
Category of index eGFR	
G3A (45-60)	66.8
G3B (30-45)	25.7
G4 (15-30)	7.5
Albuminuria category	
Normal/mild (A1)	53.6
Moderate (A2)	17.0
Severe (A3)	8.5
Unmeasured	20.9
Diabetes	35.8
Hypertension	81.4
Congestive heart failure	22.6
Acute myocardial infarction	8.6

Characteristic	%
Zone of residence	
Calgary	35.0
Central	15.5
Edmonton	30.6
North	8.2
South	10.8
At least one nephrologist outpatient visit in the past year	8.3

Appropriate Medication Use

Reducing the risk of cardiovascular disease is an important treatment goal for people with CKD. Clinical practice guidelines[5,6] recommend pharmacotherapy to improve blood pressure control and the use of statins to reduce the risk of dyslipidemia, along with appropriate lifestyle management and counselling. Additionally, the use of angiotensin-converting enzyme inhibitors (ACEi) and angiotensin receptor blockers (ARB) have been shown to delay progression to end-stage renal disease in people with proteinuric CKD[7], and reduce mortality in people with CKD and diabetes[8]. Guidelines suggest that all people with diabetes and Category G3 or G4 CKD should receive an ACEi or an ARB, regardless of albuminuria. Guidelines also suggest that those without diabetes but with A3 albuminuria should also receive an ACEi or an ARB. Given the evidence and recommendations for the use of these medications in the CKD population, their use has been identified as important indicators for quality of care[19-22].

ACEi/ARB use

We identified people who were dispensed at least one prescription for an ACEi/ARB in the year after their index date and conducted analysis by albuminuria level and diabetes status.

Key Findings:

- Overall, there was little change (<1.5%) in the ACEi/ARBs prescriptions dispensed when compared to the previous cohort from 2015-2016.
- Overall, most prescriptions for an ACEi/ARB were written by a GP (89%), with only 1.8% written by a nephrologist.
- In people with eGFR between 15 and 60, those with diabetes continued to be more likely to receive an ACEi/ARB than those without diabetes but with A3 albuminuria (77% vs. 66% - see Table 9a). However, among those without diabetes in whom the A3 albuminuria was measured with an ACR or a PCR, the proportion was similar (75%). This suggests the problem may be driven by lack of recognition of the significance of heavy albuminuria from urine dipstick; among these, only 52% received an ACEi/ARB.

Table 9a. ACEi/ARB prescription by albuminuria level and by diabetes status, among all adults with CKD Stage G3 or G4

	All adults with CKD Stage G3 or G4 (N = 153.499)		**Only patients with an outpatient nephrologist visit in the past year** (N = 12,727)	
	N	Percent dispensed an ACEi/ARB	N	Percent dispensed an ACEi/ARB
With diabetes				
A1 or A2 albuminuria	39,661	77.8	3,955	76.0
A3 albuminuria	8,167	82.6	2,622	81.7
Unmeasured albuminuria	7,116	66.1	133	63.9
Overall (regardless of albuminuria)	54,944	77.0	6,710	78.0
No diabetes				
A1 or A2 albuminuria	68,667	54.6	4,345	60.7
A3 albuminuria	4,931	66.0	1,482	78.3
Classified using ACR or PCR	2,927	75.3	1,423	78.6
Classified using UDIP	2,004	52.4	59	71.2
Unmeasured albuminuria	24,957	49.4	190	55.8
Overall (regardless of albuminuria)	98,555	53.9	6,017	64.9

Note: Shading represents those recommended to have prescription by clinical practice guidelines

Further to Table 9a, we stratified by eGFR category to see if there were differences.

Table 9b. ACEi/ARB prescription by albuminuria level and by diabetes status, stratified by CKD Stage

	All adults with CKD Stage G3 or G4 (N = 153,499)		**Only those with an outpatient nephrologist visit in the past year** (N = 12,727)	
	N	Percent dispensed an ACEi/ARB	N	Percent dispensed an ACEi/ARB
With diabetes				
CKD Stage G3A (45-60)	31,951	77.1	1,384	82.8
CKD Stage G3B (30-45)	16,826	78.5	2,435	80.5
CKD Stage G4 (15-30)	6,167	72.1	2,891	73.5
Overall (regardless of eGFR)	54,944	77.0	6,710	78.0
No diabetes, A3 albuminuria				
CKD Stage G3A (45-60)	2,169	63.2	388	82.7
CKD Stage G3B (30-45)	1,637	69.1	461	81.6
CKD Stage G4 (15-30)	1,125	66.8	633	73.3
Overall (regardless of eGFR)	4,931	66.0	1,482	78.3

Change over time

We examined the change over time between a comparable cohort from 2015/2016 and the current cohort from 2018/2019. The proportion of CKD Stage G3 and G4 patients recommended by guidelines to receive ACEi/ARBs who filled at least one prescription stayed similar among patients with diabetes (77.6% to 77.0%) but increased slightly in patients without diabetes but with A3 albuminuria (63.8% to 66.0%). In the latter group, among those assessed with an ACR or a PCR, it increased from 71.6% to 75.3%.

Statin Use

The Diabetes Canada Guidelines[23] recommend that anyone with diabetes over age 40, or with microvascular complications, be prescribed statin therapy to reduce cardiovascular risk. Relatedly, the KDIGO guidelines[24] suggest that those with CKD and over age 50 also be prescribed a statin. Accordingly, we identified people with diabetes who were dispensed at least one prescription for a statin in the year after index date and we also identified the proportion of people with CKD and no diabetes but who were over the age of 50 who were dispensed a statin. This analysis was conducted in the entire cohort, as well as only among those with an outpatient nephrologist visit in the past year.

Key Findings

- There has been a slight increase (+3.5%) in the dispensation of statins in the appropriate identified individuals compared to the 2015-2016 cohort.
- The largest gap remains in people *without* diabetes (>50 years) where only 41% with CKD have been dispensed a statin.

Table 10. Proportion of people with CKD Stage G3 or G4 who were dispensed a statin, by diabetes, age group and whether they had seen a nephrologist in the prior year.

Subgroup	**All adults with CKD Stage G3 or G4** (N = 153,499)		**Only those with an outpatient nephrologist visit in the past year** (N = 12,506)	
	N	% dispensed a statin	N	% dispensed a statin
With diabetes	54,944	**69.3**	6,710	**78.8**
No diabetes				
Under 50	3,260	14.2	783	24.4
50 or older	95,295	**40.7**	5,234	**55.6**
Overall (regardless of age)	98,555	39.8	6,017	51.5

Note: Shading represents those recommended to have prescription by clinical practice guidelines

Table 10 shows that ~70% of those with CKD Stage G3 or G4 and diabetes were dispensed a statin, compared to only 41% of those with CKD Stage G3 or G4 and no diabetes but who were 50 years of age or older. The proportion dispensed a statin was higher among those seen by a nephrologist, but the difference by diabetes status was maintained. There appears to be a significant gap in the prescription of lipid lowering therapy between patients with and without diabetes. Not surprisingly, we found a strong association between diabetes diagnosis and statin dispensation. Hypertension and AMI history were also strongly associated with statin prescribing.

Change over time

There were slight increases between the 2015/2016 and the 2018/19 cohort in the proportion filling a prescription for a statin. Among people with diabetes and CKD Stage G3 or G4, the proportion increased from 65.6% to 69.3%, while in people over the age of 50 with CKD Stage G3 or G4 but no diabetes, the proportion increased from 37.4% to 40.7%.

Quality Indicator 3: Guideline concordant use of ACEi/ARBs and statins in adults with CKD defined by albuminuria only (CKD Stage G1 and G2)

Cohort

This cohort consisted of Alberta adults with moderate or severe albuminuria (CKD Stage G1 and G2), based on outpatient ACR, PCR or UDIP measurements between April 1, 2018 and March 31, 2019. An ACR was used in preference to a PCR, and a PCR in preference to a UDIP. Patients were included whose first measurement in the fiscal year indicated A2 (moderate) or A3 (severe) albuminuria, and who did not have sustained eGFR <60 (Appendix B). The index date was the date of the albuminuria measurement. We had defined a comparable cohort from the 2015/2016 fiscal year.

- This resulted in a cohort of 82,570 individuals which reflected a 13% increase over the 2015/16 cohort.
- Only 3.2% of this cohort had an outpatient visit with a nephrologist in the prior year.

Table 11. Patient characteristics, albuminuria only cohort (N = 82,570)

Patient Characteristic	% (unless otherwise noted)
Male	51.0
Age, years: mean (SD)	54.8 (17.6)
Age categories	
18-39	23.5
40-54	23.6
55-64	22.1
65-74	18.4
75-84	9.1
85+	3.3
eGFR category	
1 (>90)	44.8
2 (60-90)	46.4
Unmeasured in 2018/19	8.8
Albuminuria category	
Moderate (A2)	79.4
Severe (A3)	20.6
Type of albuminuria measurement	
ACR	49.8
PCR	7.2
UDIP	43.0

Patient Characteristic	% (unless otherwise noted)
Diabetes	43.0
Hypertension	57.0
AHS zone of residence	
Calgary	35.8
Central	10.3
Edmonton	36.8
North	10.5
South	6.7
At least one nephrologist outpatient visit in the past year	3.2

ACEi/ARB use

We identified all individuals who were dispensed a prescription for an ACEi or an ARB in the year after the index date, and stratified by diabetes, and by albuminuria category (for those without diabetes), both in the whole cohort and among only those with an outpatient nephrologist visit in the past year.

Table 12. Proportion of people with albuminuria only who were dispensed an ACEi/ARB, by diabetes, albuminuria category, and whether they had had an outpatient nephrologist visit in the past year.

	All adults with A2 or A3 albuminuria (N = 82,570)		**Only those with an outpatient nephrologist visit in the past year (N = 2,679)**	
	N	% dispensed an ACEi/ARB	N	% dispensed an ACEi/ARB
With diabetes	35,541	**76.5**	993	**84.8**
No diabetes				
A2 albuminuria	36,951	29.2	888	52.8
A3 albuminuria	10,078	**35.9**	798	**74.8**
Based on ACR or PCR	2,847	**59.4**	727	**76.9**
Based on UDIP	7,231	**26.6**	71	**53.5**
Total	47,029	30.6	1,686	63.2
Overall	82,570	50.4	2,679	71.2

Note: Shaded number represents those recommended to have prescription by clinical practice guidelines

Again, there was a substantial difference in the prescribing of ACEi/ARBs between albuminuria patients with diabetes, and those without diabetes but with A3 albuminuria (76.5% vs. 35.9%, respectively). As above for those with eGFR<60mls/min/m^2, it appears that this problem was partly driven by lack of recognition of albuminuria on urine dipstick, since A3 albuminuria was detected by this means ~70% of the time, and when it was detected by urine ACR/PCR, use of ACEi/ARB was higher at 59%. This suggests that the low use of ACEi/ARB in those with albuminuria – but without diabetes – may be in part because of the lack of recognition of the significance of heavy albuminuria on urine dipstick.

Change over time

We compared ACEi/ARB dispensing in the 2015/16 and 2018/19 cohorts and found that while ACEi/ARB dispenses were stable among those with diabetes, they increased among those without diabetes but with A3 albuminuria (from 32.4% to 35.9%) over the 3 years

Statin Therapy Use

Guidelines[23,24] suggest that people with diabetes and those without diabetes but with albuminuria and over the age of 50 be prescribed statin therapy to reduce the risk of cardiovascular disease. People with diabetes and moderate or severe albuminuria are at the highest risk of kidney failure. We examined the proportion of people who were dispensed a statin in the year after the index date, by diabetes and, for those without diabetes, by age. We performed this analysis among all adults and only those who had seen a nephrologist.

Table 13. Statin dispensing by diabetes and age group, among adults with albuminuria only, and among only those who had seen a nephrologist.

	All adults with A2 or A3 albuminuria (N = 82,570)		Only those with an outpatient nephrologist visit in the past year (N = 2,679)	
	N	% dispensed a statin	N	% dispensed a statin
With diabetes	35,541	**68.3**	993	**71.8**
Without diabetes				
Aged 18 to 49	24,404	5.6	1025	13.1
50 or older	22,625	**36.3**	661	**44.9**
Total	47,029	20.3	1,686	25.6
Overall	82,570	41.0	2,679	42.7

Note: Shaded number represents those recommended to have prescription by clinical practice guidelines

We found that the proportion of adults in the cohort with diabetes who received a statin was slightly less than double the proportion of those without diabetes who were 50 or older (68.3% vs. 36.3%). The difference was only slightly smaller among those seen by a nephrologist (3.2% of the cohort). Males were more likely to be prescribed a statin.

Change over time

We examined the change over time between a comparable cohort from 2015/16 and the current cohort. We found that there was an increase in statin dispensing of about 3%, both among those with diabetes (65.2% to 68.3%), and among those without diabetes who were 50 or older (32.6% to 36.3%).

Quality Indicator 4: Appropriate use of SGLT2 inhibitors in adults with CKD (eGFR > 30) and albuminuria

Recent and evolving evidence from large high-quality RCTs has emerged for SGLT2 inhibitors that supports indications beyond glucose control in diabetes. Guidelines from KDIGO[25] and Diabetes Canada[26] recommend the use of a SGLT2i for all adults with diabetes and CKD (defined as an eGFR $\geq$30 mL/min/1.73m^3 and albuminuria), to reduce the risk of kidney disease progression, hospitalization for heart failure and major adverse CV events. The evidence base for the use of SGLT2 inhibitors for non-diabetic kidney disease is growing but was not addressed in this analysis given the timeline of the cohort and the existing coverage by Alberta Blue Cross. We have decided to use a conservative definition for the population at this time and recognize that indications for these medications may change as evidence (and coverage) evolves.

Cohort

For this analysis, we initially used the diabetes cohort that was defined to assess ACR testing. This was a cohort of 343,159 adults who were diagnosed with diabetes prior to April 1, 2019 and who were registered with Alberta Health in both 2018-19 and 2019-20.

We defined SGLT2i use as any dispense of a SGLT2i prescription in the 2019/20 fiscal year. In the overall diabetes cohort, there were 54,912 people (16.0%) who received at least one SGLT2i dispense in 2019/20. (For comparison, among the 317,925 in this cohort who were diagnosed before April 1, 2018, the SGLT2i use in 2018/19 was 12.6%).

A total of 42.9% of the diabetes cohort had an ACR measurement in the prior year, while 55.8% had an ACR measurement in the two years prior. SGLT2i use was much higher in both these groups (24.1% and 22.6%, respectively) than among those who hadn't had an ACR measurement in the prior 2 years (7.7%). However, the result of that measurement had little association with SGLT2i use (i.e., there were similar rates of SGLT2i use across A1, A2 and A3 albuminuria).

The group of interest for assessing SGLT2i use consisted of 52,000 adults from the diabetes cohort who had eGFR $\geq$30 and A2 or A3 albuminuria (i.e., ACR $\geq$ 3 mg/mmol). To define eGFR and albuminuria, we used the most recent outpatient serum creatinine measurement and the most recent outpatient ACR in the prior two years. Among these individuals, 26.7% received a SGLT2i dispense in 2019-20. The table below provides some characteristics of the cohort, and also shows the relative likelihood of receiving a SGLT2i dispense, based on these characteristics.

Table 14. Characteristics of the cohort used to assess prevalence of SGLT2i use by patient characteristic (N = 52,000 adults with eGFR >30 and ACR ≥ 3 mg/mmol)

Characteristic	% with characteristic	% with SGLT2i use	Prevalence ratio for SGLT2i use[1]
Overall	--	26.7	--
Age group			
<55	23.2	31.7	0.92 (0.88 – 0.95)
55-64	24.7	33.5	Reference
65-74	28.2	28.4	0.93 (0.90 – 0.96)
75-84	18.0	15.2	0.56 (0.53 – 0.59)
>85	5.8	5.8	0.23 (0.20 - 0.27)
Sex			
Female	37.8	22.7	Reference
Male	62.2	29.2	1.18 (1.15 – 1.22)
Category of most recent eGFR (ml/min/1.73m^2)			
30-45	12.5	15.1	Reference
45-60	17.6	22.7	1.39 (1.30 – 1.48)
60-90	40.8	27.5	1.46 (1.38 – 1.55))
>90	29.2	33.1	1.54 (1.44 – 1.64)
Category of most recent ACR in the past 2 years:			
A2 (3 – 30 mg/mmol)	79.6	26.6	Reference
A3 (> 30 mg/mmol)	20.4	27.3	1.02 (0.99 – 1.06)
Category of most recent A1C in the past year:			
<7%	32.5	13.6	0.43 (0.41 – 0.45)
7 to 8%	27.2	32.6	Reference
>8 to 10%	21.4	39.7	1.17 (1.13 – 1.20)
>10%	10.1	36.3	1.01 (0.96 – 1.05)
Unmeasured in past year	8.9	14.8	0.45 (0.42 – 0.49)
Neighbourhood income quintile			
Lowest quintile	26.3	26.1	Reference
2	22.8	26.5	1.03 (0.99 – 1.07)
3	19.3	26.9	1.04 (1.00 – 1.09)
4	16.8	27.1	1.06 (1.02 – 1.10)
Highest quintile	13.9	27.5	1.07 (1.03 – 1.12)
Undefined	0.9	29.5	1.13 (0.99 – 1.29)
At least 1 outpatient visit with a nephrologist in the past year	7.4	22.5	1.01 (0.95 – 1.07)

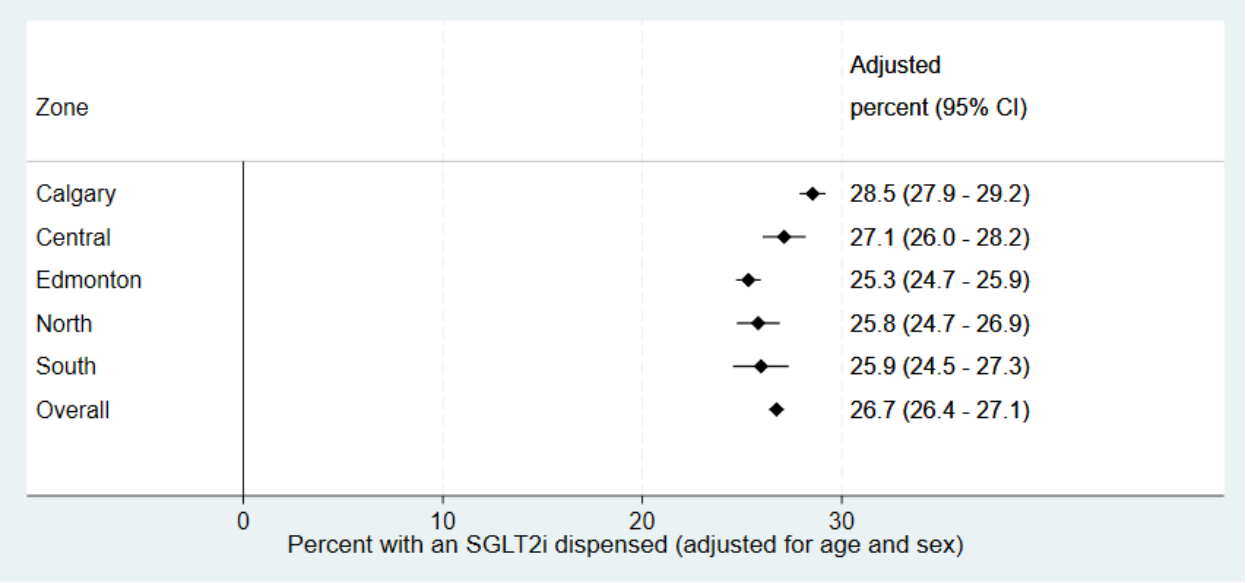
1. From a multivariable log binomial model, including all covariates in the table.

The proportion with SGLT2i use was higher among men and those with higher eGFR, and lower among those older than 75 and those with A1C <7. Note that the likelihood of SGLT2i use did not substantially decline with age until the 75-84 bracket; use in the 65-74 bracket was only slightly lower than the 55-64 bracket. The category of the most recent A1C in the past year was a strong determinant of SGLT2i use, with almost 40% of those with an A1C between 8 and 10% having at least one SGLT2i dispensed in 2019/20. There was a slight increase in use with higher neighbourhood income quintile.

In the diabetes cohort, 86% of all SGLT2i dispenses were prescribed by a GP, with the remainder prescribed by internal medicine specialists (most of whom were probably endocrinologists, who often bill under internal medicine).

The following figure shows the rate of SGLT2i use by Zone, adjusted for age and sex. Rates were fairly similar between zones, although the age and sex adjusted rate was higher in Calgary and Central zones and lower in the Edmonton, North and South zones.

Figure 11. Percent with a SGLT2i dispense in 2019/20, among those with eGFR > 30 and ACR ≥ 3 mg/mmol, by AHS zone (adjusted for age and sex)



Key Findings

- The use of SGLT2i in people with CKD (eGFR>30) and diabetes was found to be low at 26.7% in the 2018-19 cohort.
- The majority of SGLT2i prescriptions (86%) were by primary care physicians.

Implications and Considerations

The number of people in Alberta with CKD in 2018/2019 continues to grow with close to 215,000 Albertans affected. This report suggests that the number of cases of non-dialysis CKD among those with laboratory testing has increased by 20% over the past five years. However, the age specific rates are similar, so this is largely attributable to growth in the older population. This has significant implications for kidney care in the province and demonstrates an increasing care burden for both primary care and nephrology specialty care.

Despite CKD being a relatively common chronic disease, improvement is needed in the awareness and measurement of kidney disease. Although the available data does not allow us to comprehensively evaluate the appropriateness of CKD screening, there appears to be substantial variation in CKD screening practices according to geographic location. The observed CKD prevalence in this cohort is lower than that reported in other population cohorts[1], likely mainly due to 71% of the adult population not having albuminuria measured during the assessment period. This suggests that many people with CKD have not undergone appropriate screening. Further evidence of this is the finding that only 42% of people with diabetes identified in this cohort received the appropriate test (ACR) for protein in their urine, whereas guidelines recommend that all people with diabetes be tested annually.

CKD Stages G1-4 can progress to end-stage renal disease requiring dialysis or transplantation, and increases the risk of heart disease and death, irrespective of whether an individual has diabetes. While diabetes is a major risk factor for heart disease, CKD is often not recognized by many health care providers as an important risk factor for coronary heart disease, even though it is associated with a higher risk for coronary heart disease than diabetes[27]. In Alberta, there is a significant gap where people with CKD but without diabetes are much less likely to receive a prescription for the appropriate cardio-protective medications (i.e. ACEi/ARBs, statins and SGLT2 inhibitors).

With a mission to optimize the management of CKD across all ages and stages, the Kidney Health Section of the Medicine SCN is dedicated to examining solutions and innovative strategies to address these identified gaps. Additionally, the Chronic Kidney Disease (CKD) Clinical Pathway (http://www.ckdpathway.ca/), is a resource for primary care providers to aid in the diagnosis, management, and referral of adults with CKD. The CKD pathway was launched in 2014 and a link to the pathway was incorporated into several Alberta-based primary care electronic medical records starting in January 2017. Updated guidelines on SGLT2 inhibitors have been recently integrated into the pathway.

Most (~90%) non-dialysis CKD patients received their renal treatment through primary care physicians rather than nephrology specialists. It is clear that better strategies to address the gaps within screening practices (Quality Indicator #1) and medication prescribing practices (Quality Indicator #2, 3 and 4) are needed within primary care across the province.

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This report is based in part on data provided by Alberta Health and Alberta Health Services. The interpretation and conclusions contained herein are those of the researchers and do not necessarily represent the views of the Government of Alberta or Alberta Health Services. Neither the Government of Alberta nor, Alberta Health or Alberta Health Services express any opinion in relation to this report.

Further information about this report is available from Marni Armstrong, Assistant Scientific Director, Kidney Health Section of the Medicine Strategic Clinical Network
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Appendices

A) KDIGO Classification of CKD

Prognosis of CKD by GFR and albuminuria category

Prognosis of CKD by GFR and Albuminuria Categories: KDIGO 2012

GFR categories (ml/min/ 1.73 m²) Description and range				Persistent albuminuria categories Description and range		
				A1	A2	A3
				Normal to mildly increased	Moderately increased	Severely increased
				<30 mg/g <3 mg/mmol	30-300 mg/g 3-30 mg/mmol	>300 mg/g >30 mg/mmol
	G1	Normal or high	≥90			
	G2	Mildly decreased	60-89			
	G3a	Mildly to moderately decreased	45-59			
	G3b	Moderately to severely decreased	30-44			
	G4	Severely decreased	15-29			
	G5	Kidney failure	<15			

Green: low risk (if no other markers of kidney disease, no CKD); Yellow: moderately increased risk; Orange: high risk; Red, very high risk.

Source: Kidney Disease Improving Global Outcomes CKD Work Group, KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease: http://kdigo.org/home/guidelines/ckd-evaluation-management/. *Kidney International.* 2013; 3(1)

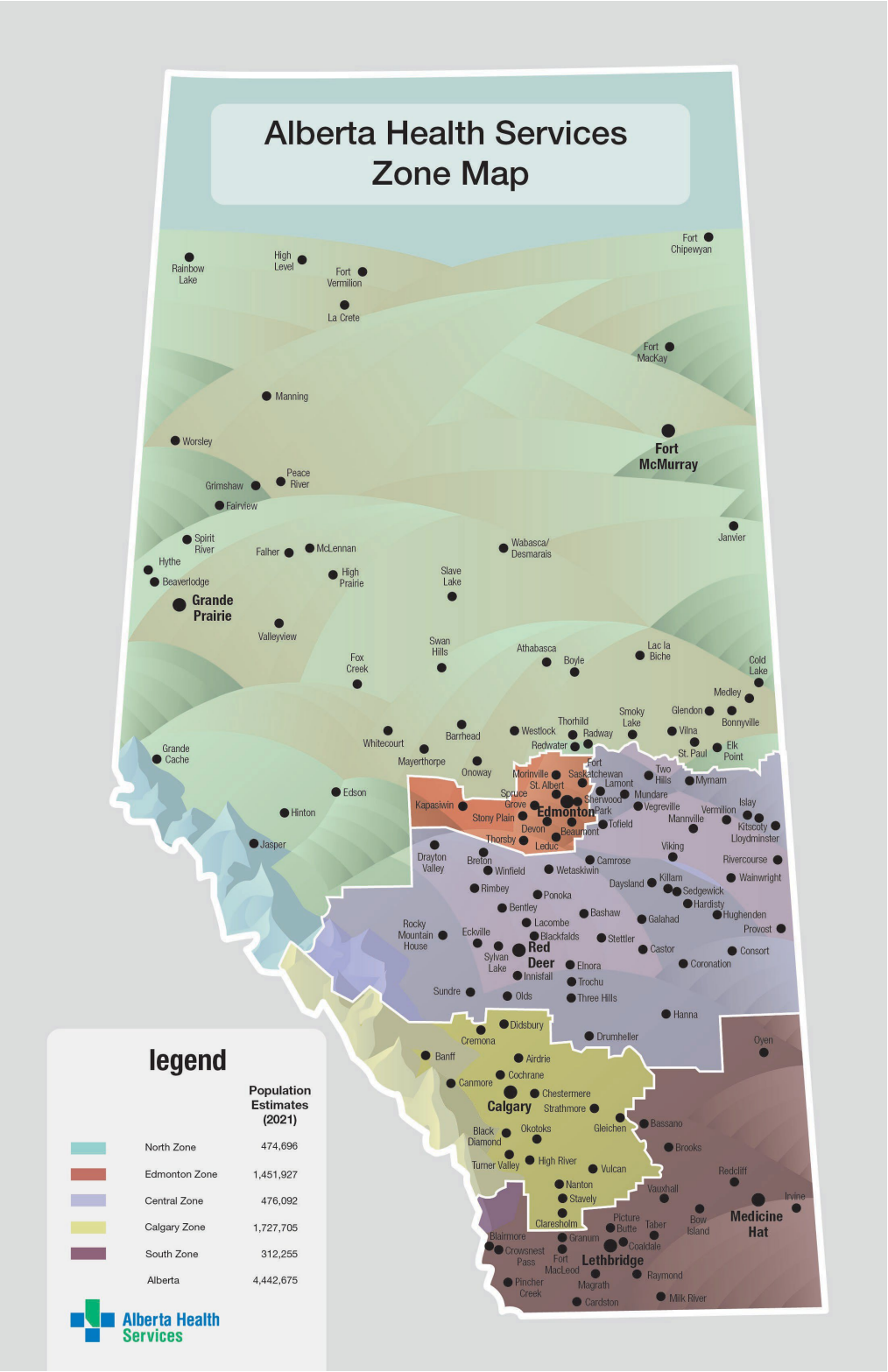
Abbreviation: Kidney Disease Improving Global Outcomes (KDIGO)

B) Detailed Cohort and Variable Definitions

Cohort/variable	Definition
Population cohort (for measurement and prevalence of CKD)	All adults in Alberta who were at least 18 years old as of April 1, 2018, who were registered with Alberta Health during the 2018/19 fiscal year, and who were not censored by death, outmigration, or other reason prior to March 31, 2019. This was a total of 3,625,099 individuals. Since not all individuals received serum creatinine measurements, the index date for the analysis was April 1, 2018 for everyone. People were considered to have received a serum creatinine measurement if there was an outpatient measurement between April 1, 2018 and March 31, 2019. We identified people with Stage 3 and 4 CKD through linkage with a Stage 3 and 4 CKD cohort that was based on serum creatinine measurements that were corrected for laboratory bias (see below). Those who did not qualify with sustained eGFR 15 to 60 were assigned to CKD categories based on the eGFR of their first outpatient serum creatinine measurement in the year, but if their initial eGFR was between 15 and 60 and they did not qualify (i.e., they did not have sustained eGFR <60), they were assigned to eGFR 60 to 90.
Diabetes cohort	We defined a cohort consisting of 343,159 adults in Alberta who were: diagnosed with diabetes prior to April 1, 2019; at least 18 years old as of April 1, 2019; registered with Alberta Health during both the 2018/19 and 2016/17 fiscal years; and not censored by death, outmigration, or other reason prior to March 31, 2019. The Hux/Blanchard algorithm[13] was used to define diabetes; this requires 2 physician claims for diabetes within a 2 year period, or 1 hospital discharge with a diagnosis of diabetes (gestational diabetes is excluded). In implementing this algorithm, we used claims and hospitalizations up to March 31, 2020. We determined eGFR category by linking the diabetes cohort to the CKD Stage 3 and 4 cohort (see below). People who did not link to the eGFR <60 cohort were assigned to the “eGFR >60 or unmeasured category”.
CKD Stage 3 and 4 cohort (sustained eGFR 15-60 ml/min/1.73m^2)	We created two similar cohorts: one based on bias-corrected serum creatinine measurements (see Appendix D), which was used in the estimates of CKD prevalence, and one based on uncorrected serum creatinine measurements, which was used for Quality Indicator 2. Each cohort consisted of all adults in Alberta aged 18 years and older who had sustained eGFR between 15 and 60 ml/min/1.73m^2, with at least one measurement in the fiscal year April 1, 2018 to March 31, 2019. There were 2 ways of qualifying for the cohort: • A sustained period of eGFR between 15 and 60 of at least 90 days, with at least one eGFR falling in the 2018-19 fiscal year. • A sustained period of eGFR between 15 and 60 that was less than 90 days, but with no additional measurements prior to censoring (by death, out-migration, or the end of lab data on March 31, 2020), and with at least one measurement falling in the 2018-19 fiscal year. The cohort based on bias-corrected serum creatinine measurements identified 137,446 individuals with sustained eGFR between 15 and 60, of whom 131,152 were included in the population cohort. The cohort based on uncorrected serum creatinine measurements, which was used for Quality Indicator 2, included 153,499 individuals with sustained eGFR between 15 and 60.

Albuminuria only cohort	This cohort consisted of Alberta adults determined to have moderate or severe albuminuria, based on outpatient ACR, PCR or protein dipstick (UDIP) measurements between April 1, 2018 and March 31, 2019. An ACR was used in preference to a PCR, and a PCR in preference to a UDIP. Patients were included whose first qualifying measurement in the fiscal year indicated A2 (moderate) or A3 (severe) albuminuria, and who did not qualify as having sustained eGFR <60. This corresponded to an ACR ≥ 3 mg/mmol or a PCR ≥ 15 mg/mmol, based on KDIGO guidelines. Patients with a UDIP of 1+ or greater were also considered A2 and were included in the cohort, while patients with a UDIP of Trace were excluded based on a review indicating that the majority were A1 (see below). After excluding those who were already in the eGFR 15 to 60 cohort, who had started dialysis, who had received a kidney transplant or who had eGFR <15, the cohort included 82,570 people with A2 or A3 albuminuria.
Details on ACR, PCR, UDIP categorization	Based on KDIGO guidelines, normal/mild albuminuria (A1) was defined by an ACR < 3 mg/mmol, a PCR <15 mg/mmol, or a negative or trace UDIP. Moderate albuminuria (A2) was defined by an ACR of 3 to 30 mg/mmol, a PCR of 15 to 50 mg/mmol, or a UDIP of 1+. Severe albuminuria was defined by an ACR >30 mg/mmol, a PCR >50 mg/mmol, or a UDIP of 2+ or higher
Medications	Identified by ATC codes

C) Alberta Health Services Zones



D) Serum Creatinine Measurement Variations and ICDC's Steps to Address Them

Measurement of serum creatinine is subject to bias, which can cause different instruments and assays to measure the same creatinine concentration differently, and can result in the same instrument and assay giving different results for the same sample at different times. These differences and fluctuations can be substantial, and can significantly affect estimates of the prevalence of CKD, particularly when regional or temporal comparisons are being done. When IDMS (isotope dilution mass spectrometry) calibration was introduced, it was thought that the measurement of serum creatinine would become more standardized. While it has improved, it is still an issue which needs to be addressed.

In an attempt to address this issue, ICDC has used outpatient serum creatinine measurements for a large cohort of healthy individuals (adults in Alberta between 18 and 39 years of age who are free of diabetes, hypertension and proteinuria at the time of the measurement), and excluding all measurements >130 in men and >110 in women. We calculated mean serum creatinine values in this cohort by lab region, sex and calendar quarter, then derived correction factors by comparing these means to a reference value, in order to adjust the measurements to make them more comparable with each other and over time.

The problem and the steps taken to address it are best illustrated graphically. The following figures show the mean quarterly serum creatinine values by sex in the healthy cohort for the three largest lab regions in Alberta (Edmonton, Calgary, and David Thompson) from 2002/03 to March 2017. The dashed lines are values that we have determined to be reference means for men and women in this cohort. Additional correction factors have been calculated to March 31, 2020 and were used in this report in the analysis of the prevalence of G3 and G4 CKD. The uncorrected values were used in identifying the cohort for Quality Indicator 2, since we wanted to use the same eGFR values the physician would see.

Figure D1. Mean quarterly serum creatinine values in the healthy cohort for Calgary Lab Region (CLS)

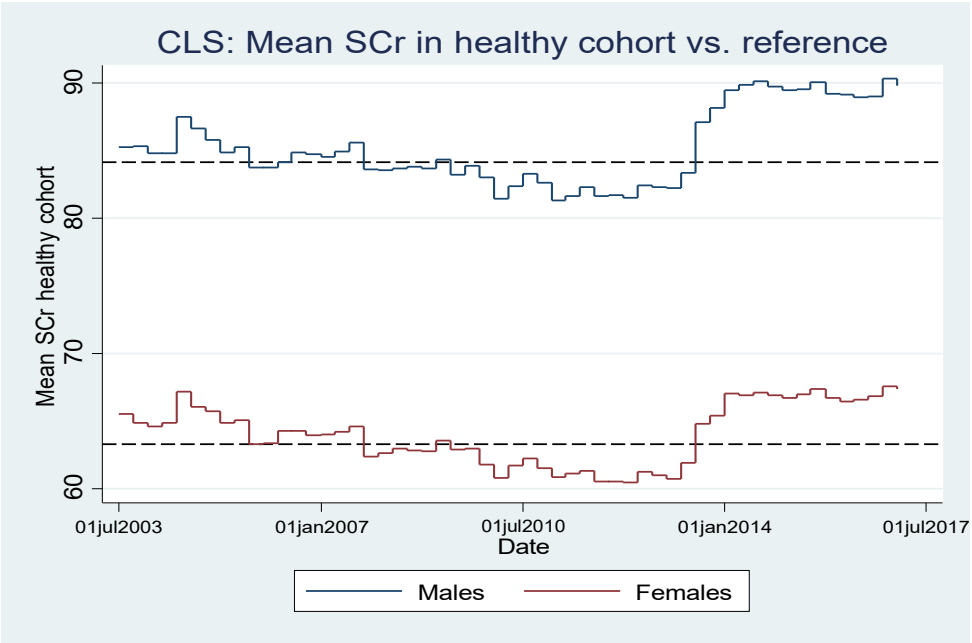


Figure D2. Mean quarterly serum creatinine values in the healthy cohort for Capital Lab Region

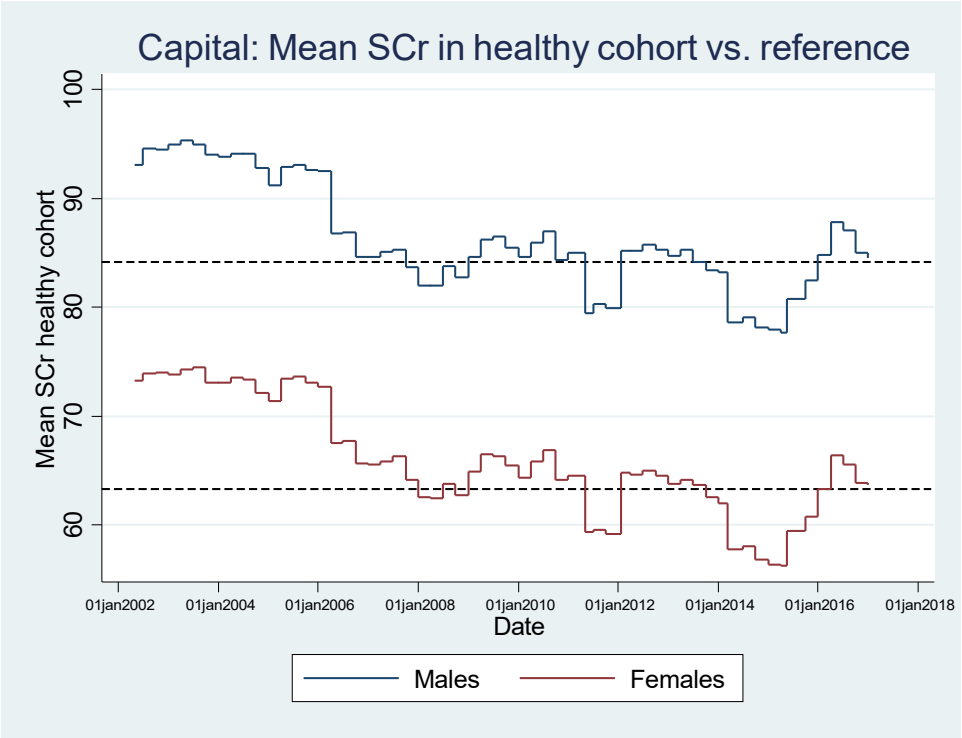
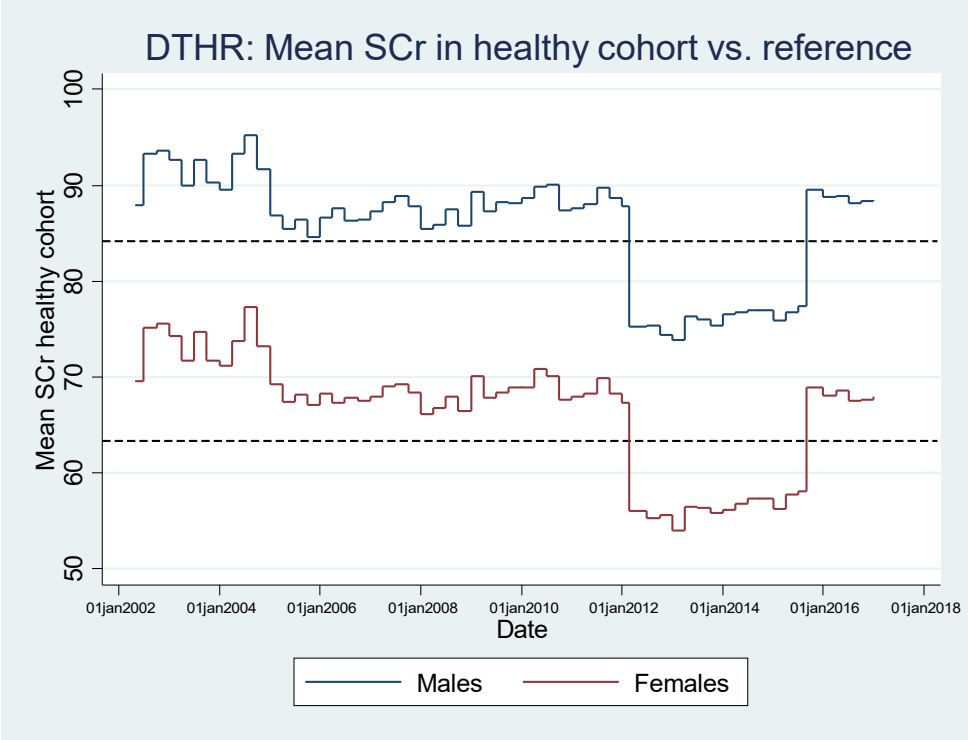


Figure D3. Mean quarterly serum creatinine values in the healthy cohort for David Thompson Lab Region (DTHR)



In the above figures, the close tracking of the lines for males and females in each lab region indicates that the fluctuations are mainly due to systematic measurement variations rather than random error. The charts show some substantial and sudden changes in the mean values in some regions at specific times – e.g., in David Thompson in January 2012 and October 2015. They also show some significant differences between lab regions at certain times – for example, in 2014 the difference between measurements for healthy men in Calgary and David Thompson was as much as 13 µmol/L (90 vs. 77). ICDC's correction factors are the differences between mean quarterly values and the reference values for men and women.

A limitation to these correction factors is that they are based on measurements in the normal range, but they are applied to measurements in all ranges. While the limited literature on the subject provides some support for this approach, it is possible that with some instruments/assays the measurement error may increase at higher values of serum creatinine, implying that the correction factors are under-estimated in these ranges. We have attempted to explore this through the use of cohorts that include people with specific comorbidities, etc., that have higher mean values of serum creatinine. However, the combination of the greater dispersion of the measurements and the smaller size of the cohorts has not allowed the determination of reliable correction factors in higher ranges. We have therefore used only the constant correction factors, knowing that in some situations these may be under-estimated.

E) Details on Albuminuria Assessment

Type of measurement for albuminuria assessment

The following table shows which measurement was used to determine the level of albuminuria, by Zone. An ACR was used in preference to a PCR, which was used in preference to a urine protein dipstick.

Table E1: Measurement used for albuminuria assessment in 2018/19, by health zone (N = 3,625,099)

Zone	ACR		PCR		Dipstick		Not measured		Total
	N	%	N	%	N	%	N	%	N
Calgary	93,387	6.6	5,293	0.4	310,316	22.0	998,459	70.9	1,407,455
Central	26,806	6.8	2,956	0.8	68,389	17.3	297,279	75.2	395,430
Edmonton	103,735	8.8	11,487	1.0	253,822	21.6	804,557	68.6	1,173,601
North	25,944	6.5	4,734	1.2	66,523	16.6	302,526	75.7	399,727
South	15,959	6.4	956	0.4	48,009	19.3	183,808	73.9	248,732
Alberta	265,831	7.3	25,426	0.7	747,059	20.6	2,586,629	71.4	3,624,945

Overall, the highest level of albuminuria measurement was in Edmonton Zone (31.4%), compared to the provincial average of 28.6%. In addition, Edmonton Zone had the highest use of ACR's in measuring albuminuria (8.8%), compared to the provincial average of 7.3%. Calgary Zone had the highest level of dipstick measurement, but a much lower level of ACR measurement than Edmonton, though the difference decreased substantially.

F) CKD Prevalence by eGFR Category and Albuminuria Category

Table F1: "Heat map" of CKD prevalence in Alberta in 2018/19, by eGFR category and albuminuria category (numbers are percentages of the overall adult population)

	Albuminuria category				
eGFR category	A1 (normal/mild)	A2 (moderate)	A3 (severe)	Unmeasured	**Total**
>90	11.58	0.84	0.19	7.02	**19.63**
60 to 90	10.01	0.86	0.23	6.06	**17.15**
45 to 60	1.24	0.26	0.12	0.79	**2.41**
30 to 45	0.39	0.17	0.10	0.29	**0.94**
15 to 30	0.07	0.07	0.08	0.06	**0.27**
<15	0.004	0.01	0.03	0.06	**0.10**
Unmeasured	2.22	0.15	0.04	57.09	**59.50**
Total	**25.51**	**2.35**	**0.78**	**71.36**	**100**

Note: Shaded cells indicate those defined as CKD. Cells with eGFR <15 were considered kidney failure rather than CKD.