Alberta Kidney Care Report
February 2019

Prevalence and Quality of Care in Chronic Kidney Disease

Alberta Health Services
Kidney Health 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 Strategic Clinical Network™ in collaboration with the Interdisciplinary Chronic Disease Collaboration, and the Alberta Kidney Disease Network 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 2015/2016, with follow up until March 31, 2017.

Key Findings

- The number of people affected by CKD is increasing in Alberta, with close to 191,000 Albertans identified with Stage 1-4 CKD based on laboratory measurement. However, geographical variation exists across the province.
- The prevalence of Stage 3 and 4 CKD has increased by 7.1% over two years. This appears to be largely attributable to the growth in the aging population where CKD is much more prevalent.
- Practice guidelines suggest annual screening for the presence of diabetes-related kidney disease yet overall albuminuria measurement in people with diabetes was found to be low at 43% with some geographical variation across the province.
- The appropriate use of Angiotensin-converting enzyme inhibitors (ACEi) and angiotensin receptor blockers (ARBs) therapy has been shown to delay the progression of CKD associated with proteinuria, and reduce the risk of cardiovascular events. The use of ACEi/ARBs is lower than expected in non-diabetic individuals with CKD with only 64% of those with albuminuria and only 32% of those with eGFR ≥60 and severe albuminuria (> 300mg/g) filling a prescription for an ACEi or ARB.
- Despite evidence that statins are effective at reducing cardiovascular and kidney risk, the use of statins is also low in non-diabetic individuals with CKD over the age of 50, with only 33-39% filing a prescription.

Implications

The prevalence of early CKD 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 treatment (e.g. ACEi/ARBs and statins) 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 AHS Kidney Health Strategic Clinical Network™[1] (SCN™) 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 SCN. 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, kidney disease affects nearly four million Canadians, with over-representation in vulnerable 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 portion of the report builds upon and is an update of the first Alberta Kidney Care Report[2].

Quality Indicators Relevant to Earlier 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. Appropriate testing to detect the presence of abnormalities of kidney function and structure in people at high risk of kidney disease, for example those with diabetes, can improve the quality of care. Treatment goals in CKD include reducing cardiovascular risk through appropriate lifestyle management, blood pressure control, and the use of statins, as recommended by international guidelines[3,4]. In addition, 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[5], and reduce mortality in people with CKD and diabetes[6].

From 2016 to 2017 the Kidney Health SCN examined the literature and completed extensive stakeholder consultation (e.g. Northern and Southern Alberta Renal 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 Alberta Kidney Care Supplementary Report: "Quality of Care in Early Stage Chronic Kidney Disease 2012-2013"[7].

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	Appropriate use of ACEi/ARBs and statins in adults with Stage 3 and 4 CKD
Quality Indicator 3	Appropriate use of ACEi/ARBs and statins in adults with CKD defined by albuminuria only (Stage 1 and 2)

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[8] 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, 2017, we defined most cohorts for the year April 1, 2015 to March 31, 2016, 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 and former health region 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 nine former Health Regions of Alberta Health Services. This was done as laboratory services have historically been structured according to these regions, and as it would allow for more granular comparisons than an analysis by zone. Appendix C outlines a map of the former Health Regions.

We used validated algorithms to define diabetes[9,10], hypertension[11], history of congestive heart failure[12] and history of acute myocardial infarction[13] 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[14], and defined albuminuria based on ACR, PCR and urinary protein dipstick (UDIP) measurements. We defined filling a prescription for an ACEi/ARB or a statin 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 ICDC / AKDN data collection (Ethics ID: E-22590), and for the purposes of this report (Ethics ID: REB 16-1575). 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

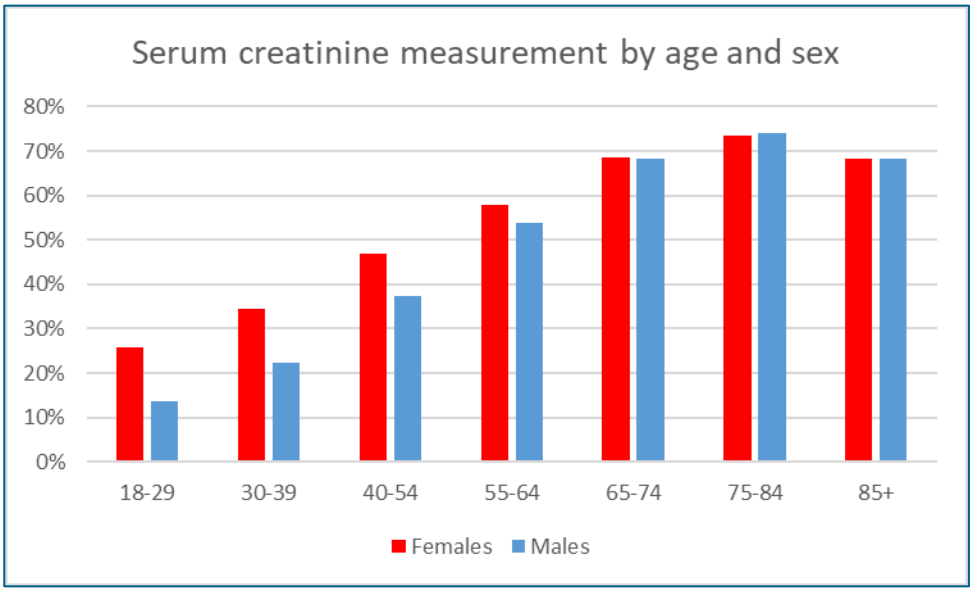
Measurement and Prevalence of CKD

Cohort

The population cohort consisted of 3,422,644 adults in Alberta who were at least 18 years old on April 1, 2015 and were registered with Alberta Health from April 1, 2015 to March 31, 2016 (see Appendix B for details).

Over the fiscal year of 2015/2016, 40% 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. Table 1 shows the characteristics of this cohort.

Figure 1: Percent of adults with an outpatient serum creatinine measurement in 2015/16



Measurement of serum creatinine

Appropriate screening for CKD is important in identifying and preventing progression of CKD. As outlined in the provincial CKD pathway[15] (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:

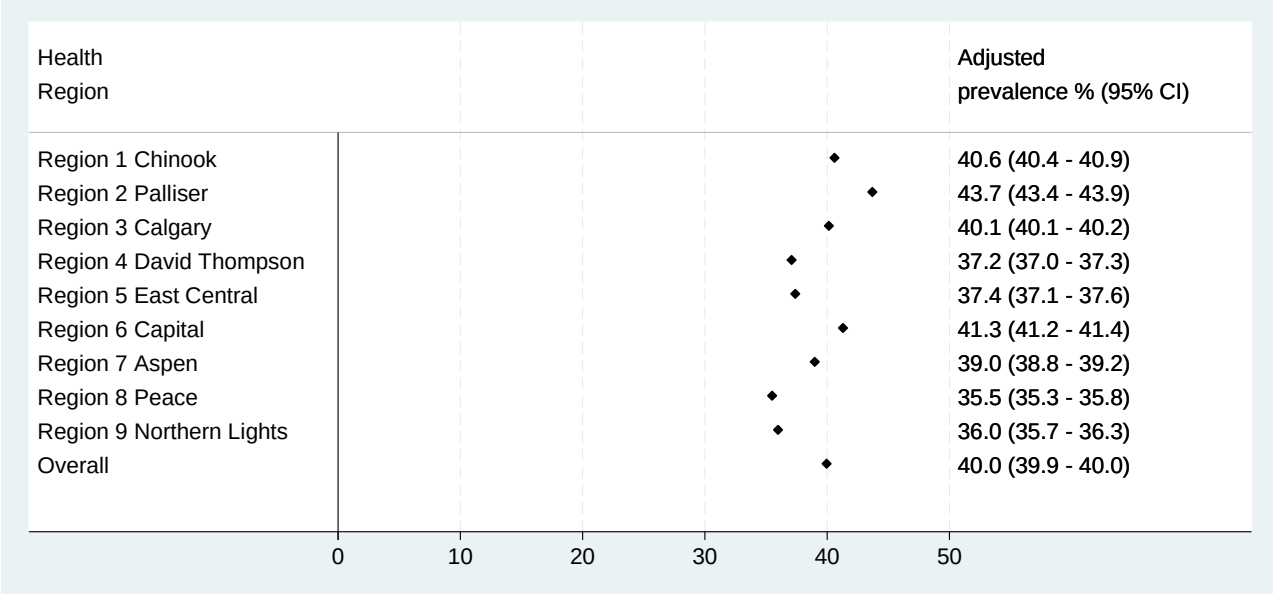
- Hypertension
- Diabetes Mellitus
- Family history of Stage 5 CKD or hereditary kidney disease
- Vascular disease (prior diagnosis of cardiovascular disease, stroke or peripheral vascular disease)
- Multisystem disease with potential kidney involvement (e.g. systemic lupus erythematosus)

Table 1 – Characteristics, 2015/16 population cohort (N = 3,422,644)

Characteristic	% (unless otherwise noted)
Female	49.6
Age, years: mean (SD)	45.2 (17.2)
Age categories	
18-29	23.1
30-39	21.1
40-54	26.7
55-64	15.0
65-74	8.3
75-84	4.2
85+	1.7
eGFR Category, mL/min/1.73m^2	
>90	19.9
60-90	16.6
45-60	2.2
30-45	0.9
15-30	0.3
<15	0.1
Unmeasured	60.0
Albuminuria category	
Normal/mild (A1)	27.5
Moderate (A2)	2.1
Severe (A3)	0.7
Unmeasured in 2015/16	69.7
Type of albuminuria measurement used	
ACR	6.3
PCR	0.6
UDIP	23.4
Unmeasured in 2015/16	69.7
Diabetes	8.6
Hypertension	22.1
(Former) health region of residence	
1 Chinook	4.2
2 Palliser	2.7
3 Calgary	38.4
4 David Thompson	8.2
5 East Central	3.0
6 Capital	32.2
7 Aspen	4.7
8 Peace	4.0
9 Northern Lights	2.6

Measurement by region

Figure 2: Percent of adults having at least one outpatient serum creatinine measurement in 2015-16, by former health region (adjusted for age and sex)



The figure shows some variation in serum creatinine measurement by former health region, with the highest adjusted rate being in the former Palliser Health Region (43.7%), and the lowest adjusted rates in the former Peace Country and Northern Lights health regions (35.6% and 36.1%, respectively).

Serum creatinine measurement: change over time

We compared serum creatinine measurement in the fiscal year 2015-2016 to measurement in 2013-2014. There were slight increases in serum creatinine measurement between 2013-14 and 2015-16 in age groups younger than 65. Among those 65 and older, however, there was almost no change between 2013-14 and 2015-16. Since most cases (~80%) of Stage 3 and 4 CKD occur in people 65 and older, this implies that any changes seen in the provincial prevalence (see next section) of Stage 3 and 4 CKD between 2013-14 and 2015-16 were likely actual changes in prevalence, rather than changes due to increase/decrease in measurement.

Prevalence of Stage 3 and 4 CKD

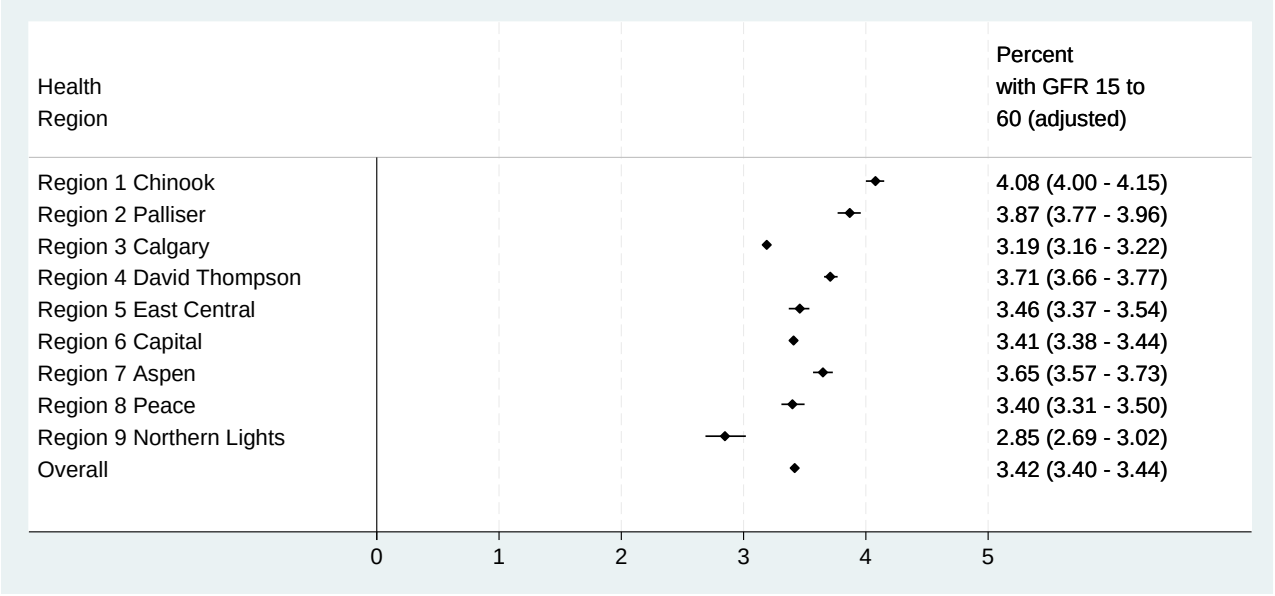
Based on patients with lab measures, we identified 117,106 adults with Stage 3 and 4 CKD in the fiscal year 2015-16 by linking with the cohort of adults with sustained eGFR between 15 and 60 ml/min/1.73m^2 (see Quality Indicator 2).

Table 2: Prevalence of Stage 3 and 4 CKD by age and sex in 2015-16: rates per 1,000 adults, and rates per 1,000 adults with a serum creatinine measurement

	# of adults with Stage 3 and 4 CKD		Rate per 1,000 adults		Rate per 1,000 adults with a serum creatinine measurement	
Age group	Female	Male	Female	Male	Female	Male
18-29	96	105	0.2	0.3	1.0	1.9
30-39	376	387	1.1	1.1	3.1	4.7
40-54	2,926	2,599	6.6	5.5	14.0	14.8
55-64	8,261	6,939	33	27	57	49
65-74	17,270	15,441	119	110	174	161
75-84	22,020	17,927	285	277	387	375
85+	14,859	7,900	405	395	592	579
Overall	**65,808**	**51,298**	39	30	87	84

Overall, 56% of Stage 3 and 4 CKD 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.

Figure 3: Prevalence of Stage 3 and 4 CKD in the Alberta adult population, by former health region (adjusted for age and sex)



There were substantial variations in the age and sex adjusted prevalence of Stage 3 and 4 CKD based on laboratory measurement by former health region, with Chinook Region having the highest adjusted prevalence (4.08%, 95% CI 4.00% – 4.16%), and Northern Lights the lowest (2.87%, 95% CI 2.71% – 3.04%). Note, however, that these estimates may have been affected by residual serum creatinine measurement error in certain former health regions (see Appendix D). Also, the low apparent prevalence in Northern Lights likely reflects the relatively low rate of serum creatinine measurement in Northern Lights (particularly in the older age groups), as noted previously.

Change Over Time in Prevalence of Stage 3 and 4 CKD

We assessed change in prevalence over time by comparing this cohort to a similar cohort from the 2013-2014 fiscal year.

Table 3: Age stratified rates of Stage 3 and 4 CKD in the 2013-14 and 2015-16 fiscal years

	2013-14			2015-16		
Age	Population	Stage 3 or 4 CKD	Rate per 1000	Population	Stage 3 or 4 CKD	Rate per 1000
18-29	772,909	237	0.3	789,019	201	0.3
30-39	664,083	700	1.1	722,220	763	1.1
40-54	897,559	5,198	5.8	914,974	5,525	6.0
55-64	469,181	13,947	29.7	512,362	15,200	29.7
65-74	253,588	29,751	117.3	285,410	32,711	114.6
75-84	135,520	38,609	284.9	141,934	39,947	281.4
85+	51,357	20,897	406.9	56,725	22,759	401.2
Total	**3,244,197**	**109,339**	**33.7**	**3,422,644**	**117,106**	**34.2**

Overall, the number of adults with Stage 3 or 4 CKD increased from 109,339 to 117,106 over the 2 years, an increase of 7.1%. The age stratified rate of Stage 3 and 4 CKD was stable in age groups <55, but declined slightly in age groups >65 (which contained about 80% of cases of Stage 3 and 4 CKD) – e.g., from 284.9 to 281.4 in the 75-84 age bracket, a decrease of 1.2%. The total adult population increased by 5.5% in this two year period. However, the increase in population among some of the older groups was more rapid (e.g., 12.6% in the 65-74 age group and 10.4% in the 85+ age group), explaining why the increase in the total number of Stage 3 and 4 CKD cases was greater than the increase in population.

By linking the population cohorts for 2013-14 and 2015-16, we determined how many people identified with Stage 3 or 4 CKD in 2013-14 were still identified with Stage 3 or 4 CKD in 2015-16. Of the 109,339 people with Stage 3 or 4 CKD in 2013-14, 13,744 were no longer in the 2015-16 population cohort, in most cases because they had died. Of the remaining 95,595, 27,814 (29.1%) remained in the cohort but were no longer identified as having CKD. 15,197 of these (15.9%) were unmeasured in 2015-16; 11,474 (12.0%) were now classified as Stage 1 or 2; and 1,153 (1.2%) had moved into Stage 5. 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 Stage 4 CKD

Identifying and describing the prevalence of Stage 4 CKD (eGFR 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[15] suggest that individuals with eGFR <30 should be referred to a nephrologist.

Overall, among the 117,106 individuals identified with sustained eGFR between 15 and 60, there were 8,899 people (7.6%) whose first eGFR in the fiscal year was between 15 and 30.

Table 4: Age and sex stratified rates of Stage 4 CKD in the 2015-16 fiscal year

	Female			Male			All		
	Population	# of cases	# per 1000	Population	# of cases	# per 1000	Population	# of cases	# per 1000
18-29	388,955	13	0.03	400,064	24	0.06	789,019	37	0.05
30-39	354,217	55	0.2	368,003	59	0.2	722,220	114	0.2
40-54	445,530	193	0.4	469,444	265	0.6	914,974	458	0.5
55-64	251,106	412	1.6	261,256	459	1.8	512,362	871	1.7
65-74	144,905	881	6.1	140,505	885	6.3	285,410	1,766	6.2
75-84	77,277	1,635	21.2	64,657	1,383	21.4	141,934	3,018	21.3
85+	36,732	1,749	47.6	19,993	886	44.3	56,725	2,635	46.5
Total	**1,698,722**	**4938**	**2.9**	**1,723,922**	**3961**	**2.3**	**3,422,644**	**8,899**	**2.6**

Overall, 55% of the Stage 4 population was female, with the majority of cases (83%) being aged 65 or older.

Figure 4: Prevalence of Stage 4 CKD in the Alberta adult population adjusted rate per 1000 by former health region, (adjusted for age and sex)

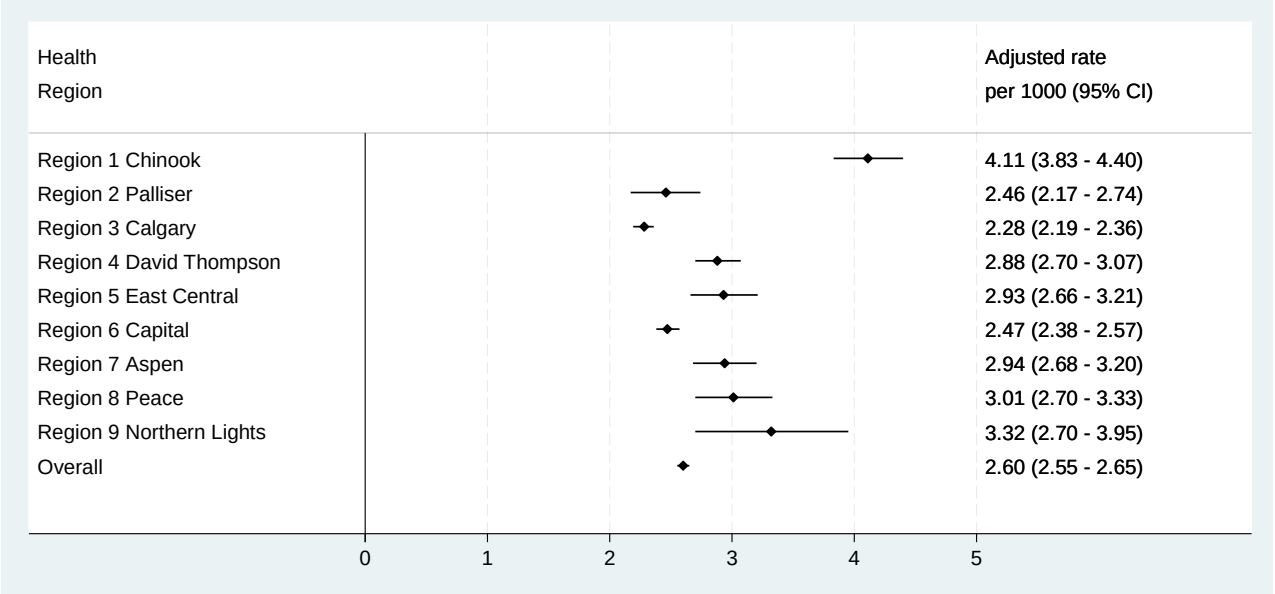


Figure 4 compares the prevalence of Stage 4 CKD by former health region. It is likely that the apparent high prevalence of Stage 4 CKD for Chinook region was affected by residual uncorrected measurement error. While we applied a relatively large negative correction to measurements from Chinook region during this period, this was likely an underestimate of the degree of measurement error at high serum creatinine values (see Appendix D). In support of this, we noted that the age-adjusted rate of dialysis in the Chinook region was similar to other regions outside Calgary and Edmonton.

Change over Time in Prevalence of Stage 4 CKD

We examined change over time by comparing with a similar cohort from the 2013-2014 fiscal year.

Table 5: Age stratified rates of Stage 4 CKD in the 2013-14 and 2015-16 fiscal years

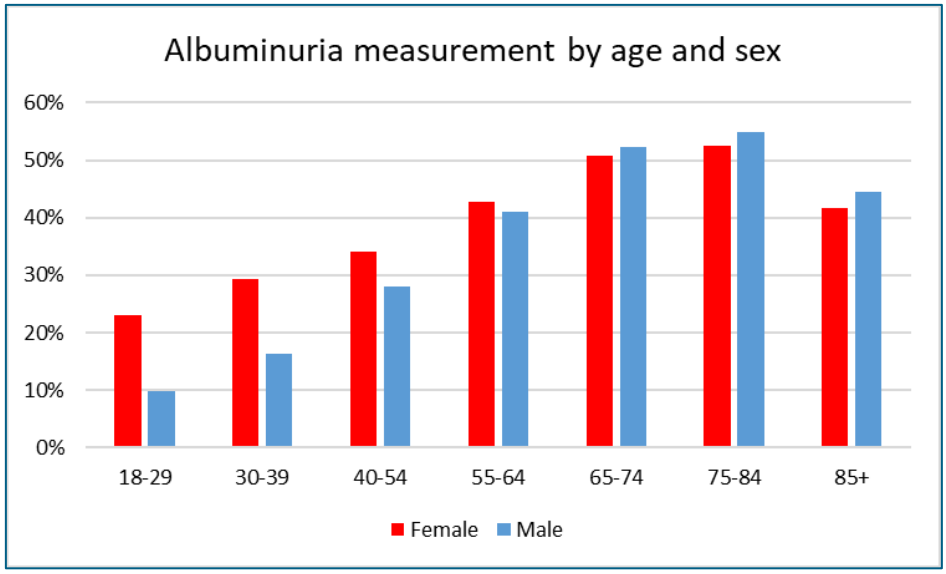
	2013-14			2015-16		
Age	Population	Stage 4 CKD	Rate per 1000	Population	Stage 4 CKD	Rate per 1000
18-29	772,909	48	0.1	789,019	37	0.0
30-39	664,083	112	0.2	722,220	114	0.2
40-54	897,559	447	0.5	914,974	458	0.5
55-64	469,181	796	1.7	512,362	871	1.7
65-74	253,588	1,633	6.4	285,410	1,766	6.2
75-84	135,520	2,952	21.8	141,934	3,018	21.3
85+	51,357	2,470	48.1	56,725	2,635	46.5
Total	**3,244,197**	**8,458**	**2.61**	**3,422,644**	**8,899**	**2.60**

Overall, the number of cases of Stage 4 CKD increased from 8,458 to 8,899 in the 2 years, an increase of 5.2%. The age-specific rates of Stage 4 CKD declined somewhat among those >65 (e.g., from 48.1 to 46.5 among those >85, a decrease of 3.3%). The total adult population increased by 5.5% in this two year period. However, the greater increase in population among some of the older age groups resulted in the increase of Stage 4 CKD cases being similar to the population increase, in spite of the reduction in age-specific rates.

Albuminuria Measurement

Albuminuria measurement is also important for identifying and classifying CKD[3] (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) measurement in the 2015/16 fiscal year.

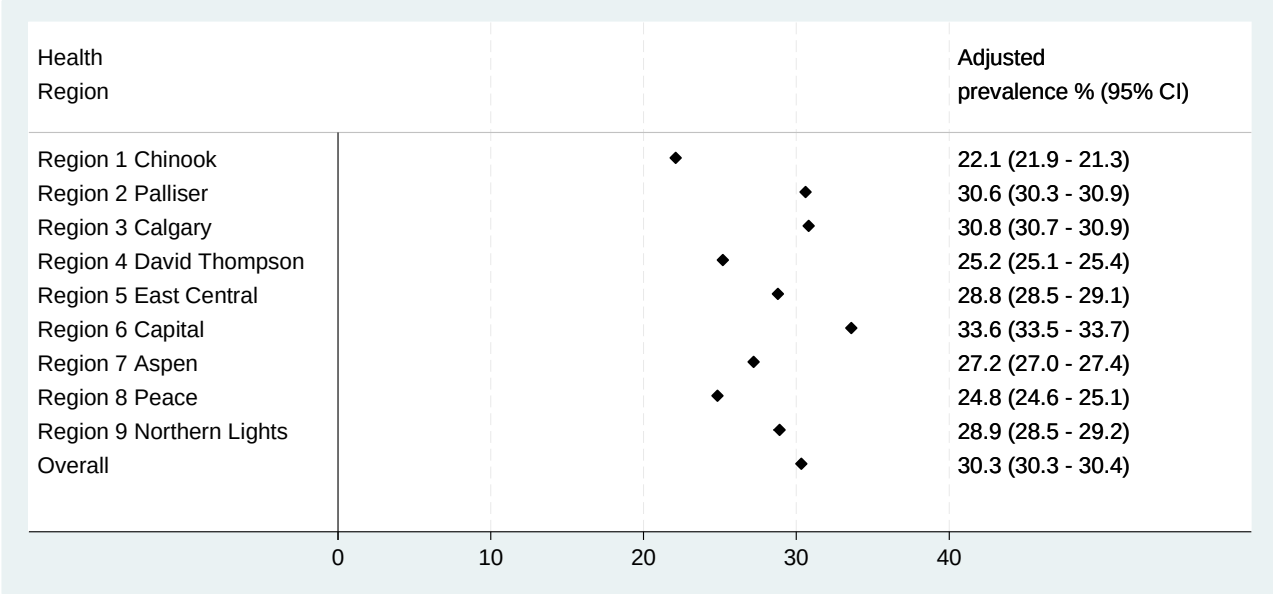
Figure 5: Proportion of people with at least one albuminuria (any type) measurement in 2015/16, by age and sex



We found that 30% of adults in Alberta had albuminuria measured in 2015/2016 using one of the three methods. The proportion of people with an albuminuria measurement was highest in the 75-84 age group. Among those 65 and older, more men than women were measured, while in younger age groups the reverse was true. Details on type of measurement for albuminuria assessment are outlined in Appendix E.

Albuminuria Measurement by Former Health Region

Figure 6: Measurement of albuminuria in 2015/16 by former health region, adjusted for age and sex

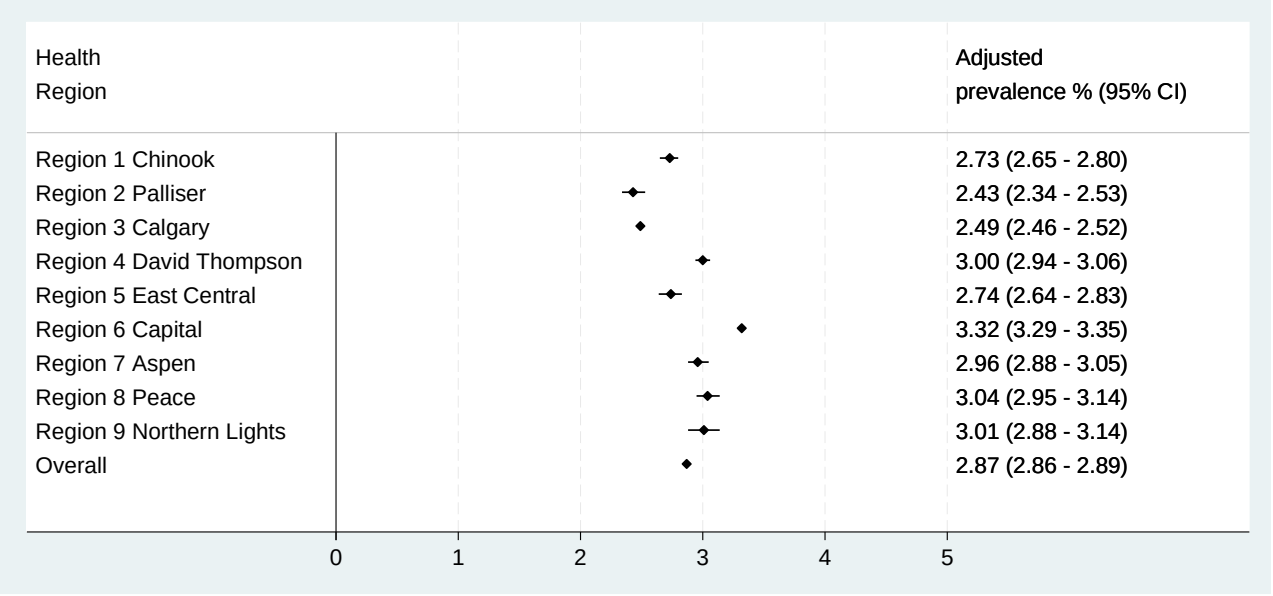


People residing in most regions outside of Calgary and Edmonton were less likely to have been measured for albuminuria – this was particularly true in Chinook, where only 22% were measured. This was mainly the result of fewer protein dipstick tests being done. Capital region had the highest rate of albuminuria measurement, at 34%.

Prevalence of Moderate or Severe Albuminuria

Albuminuria measurements can be categorized as normal/mild (<30 mg/g), moderate (30-300 mg/g), or severe (>300 mg/g)[3]. Figure 7 shows the age and sex-adjusted prevalence of A2 or A3 albuminuria by former health region; however, it is important to bear in mind that only 30% of adults in Alberta had at least one measurement in the year, so prevalence is underestimated.

Figure 7: Prevalence of moderate or severe albuminuria in 2015/16, by former health region (adjusted for age and sex)



There was variation in the prevalence of albuminuria by region, with Capital region being highest (3.3%). However, some of this was related to high levels of measurement in Capital. Conversely, measurement rates were low in Chinook, David Thompson and Peace regions, so the prevalence may have been more underestimated in these regions.

Overall Estimate of Prevalence of CKD in Alberta

Overall, 190,807 adults were identified with Stage 1 to 4 CKD; this translates to 5.6% of the adult population in Alberta. It is important to note that this is likely an underestimate because of incomplete measurement with only 40% of adults having a serum creatinine measurement and ~30% with an albuminuria measurement. Appendix F outlines overall CKD prevalence by eGFR category and albuminuria category.

Among those who had a measurement of both serum creatinine and urine protein in 2015/16, 16% had Stage 1 to 4 CKD; however, 16% of the general population is not expected to have Stage 1-4 CKD as testing is more common among those more at risk (e.g., the elderly). The true prevalence is likely approximately 10-12%, based on Canadian population surveys[16]. In this study, the unidentified cases would likely have been mainly Stage 1 and 2, given the relatively low rates of albuminuria measurement and from comparison with national population prevalence data.

Quality Indicators

The Kidney Health SCN 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 renal failure.

Quality Indicator 1: Screening for Albuminuria in Adults with Diabetes

Diabetes Cohort

Using a validated algorithm, we defined a cohort consisting of adults in Alberta who were diagnosed with diabetes prior to April 1, 2016 and registered with Alberta Health during both the 2015/16 and 2016/17 fiscal years (see Appendix B for details on the definition). We assessed albuminuria measurement in 2016/17, and also compared change over time with comparable cohorts for prior periods. The index date for the cohort was April 1, 2016. Table 6 gives an overview of the patient characteristics in the diabetes cohort.

Using this method, we found that:

- There were 295,484 people in Alberta identified as having a diagnosis of diabetes
- Over 4 years, the size of the cohort grew by 25.4% or an annual increase of 5.8%
- Individuals with an eGFR of <60 mL/min/1.73m^2 comprised 15% of the diabetes cohort

Table 6: Characteristics of the 2016/17 diabetes cohort, N=295,484

Characteristic	Percent (unless otherwise noted)
Female	46.2
Age: mean (SD)	62.0 (15.0)
Age categories	
18-54	30.7
55-64	25.8
65-74	23.7
75-84	14.2
85+	5.7
eGFR category* mL/min/1.73m^2	
> 60 or unmeasured	85.0
45-60	8.3
30-45	4.5
15-30	1.6
<15	0.7
Value of last HbA1c (%) in 2015/16	
<6.5	26.7
6.5 to 8	31.5
>8 to 10	11.6

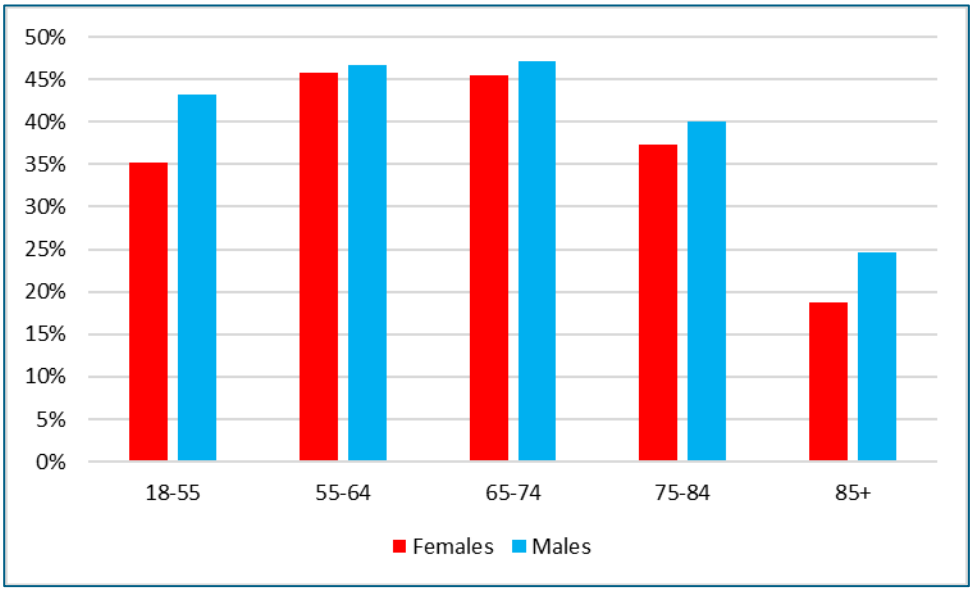
> 10	4.5
Unmeasured	25.7
Former health region of residence	
1 Chinook	4.9
2 Palliser	3.2
3 Calgary	33.7
4 David Thompson	8.2
5 East Central	3.5
6 Capital	35.1
7 Aspen	5.5
8 Peace	3.8
9 Northern Lights	2.1

Abbreviations: HbA1C: hemoglobin A1C; SD: standard deviation

Measurement of ACR

The Diabetes Canada Clinical Practice Guidelines[4] suggest that all people with diabetes be screened annually for albuminuria using a random urine albumin:creatinine (ACR) laboratory test. Figure 8 outlines ACR measurement in adults with diabetes in 2016/2017.

Figure 8. ACR measurement in 2016/17 among adults with diabetes, by age and sex

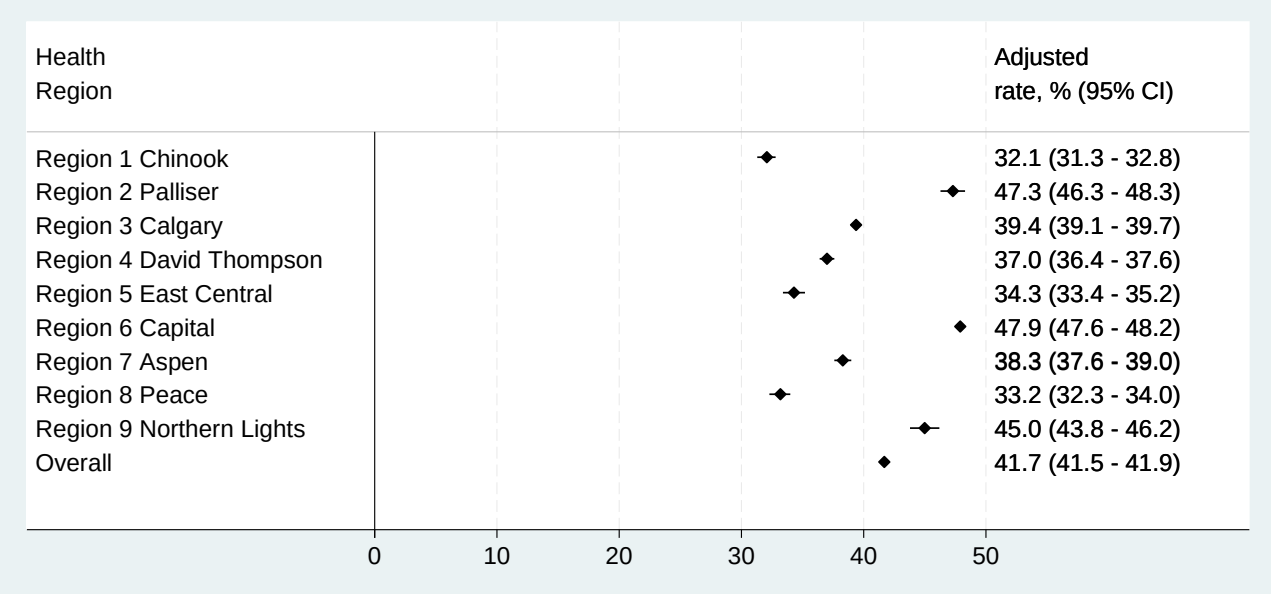


After excluding those who had been censored prior to March 31, 2017 (leaving 286,481), we identified 121,954 people who had at least one outpatient ACR measurement in the 2016/17 fiscal year.

- Overall, only 42.6% of adults with diabetes had at least one ACR test.
- Measurement rates were slightly higher among men than women, particularly in the youngest and oldest age groups.

ACR Measurement by Region

Figure 9: Rate of ACR measurement in adults with diabetes in 2016/17, by former health region, adjusted for age and sex



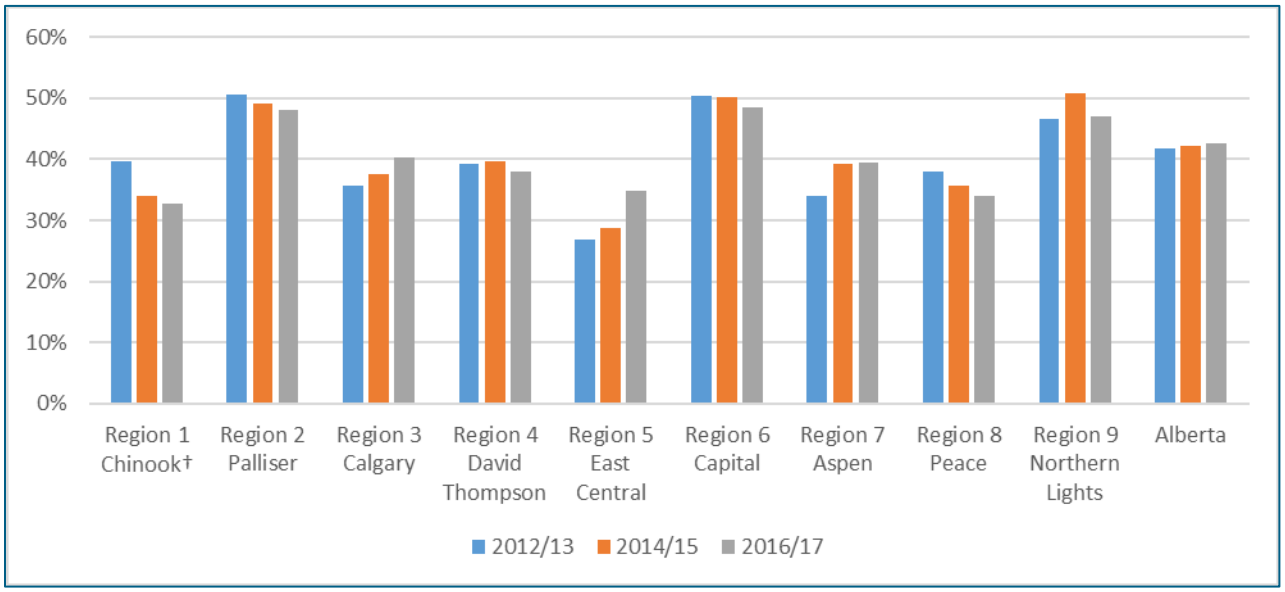
In Figure 9, we see significant variations in ACR testing by geographical region, with the former Capital, Northern Lights and Palliser health regions having relatively high age- and sex-adjusted testing rates (>45%) and the former Chinook, East Central health and Peace regions having a lower testing rate (<35%).[1]

Change over time

Figure 10 shows the change in measurement of ACR by region over time. Overall in Alberta, there was a 0.8% increase in the proportion of people with diabetes who had an ACR measurement in one year between 2012/13 and 2016/17, from 41.8% to 42.6%. Much of the increase can be attributed to an increase in the Calgary Region, from 35.7% to 40.4%.

[1] Note that in Chinook, David Thompson and Peace Country health regions, the number of ACR tests available was reduced by the ACR result not being calculated by the laboratory for approximately 10% to 20% of ACR's that were ordered, because the albumin concentration was below the lower limit of the urine albumin assay (which was 5 mg/L in these regions). Other lab regions either had a lower albumin limit, or reported the ACR result as "<X" when the albumin concentration was below the lower limit. This factor explains the relatively low apparent rates of ACR testing in the former Chinook and Peace Country health regions. Nearly all the unavailable ACR results would presumably have been in the normal range for these tests.

Figure 10: ACR measurement among adults with diabetes, by former health region and year



Quality Indicator 2: Appropriate Medication Use in Adults with Stage 3 and 4 CKD

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 2015/2016 fiscal year (for more details see Appendix B). We defined a comparable cohort for the 2013/2014 fiscal year.

- This resulted in a cohort of 122,855 individuals which reflected a 6.9% increase over the two years.
- We found that 81.7% of the cohort had as assessment of albuminuria (ACR, PCR or UDIP). To assess albuminuria, we used an ACR for 36%, a PCR for 4%, and a UDIP for 42%.
- The index date for the cohort was the date of the first qualifying serum creatinine measurement in 2015/16.

Table 7: Characteristics of the 2015/16 Stage 3 and 4 CKD cohort, N = 122,855

Characteristic	Percent (unless otherwise noted)
Female	56.0
Age: mean (SD)	75.5 (11.6)
Age category	
<65	17.4
65-74	26.9
75-84	34.0
85+	21.7
CKD Stage of index eGFR	
3A (45-60)	64.7
3B (30-45)	27.1
4 (15-30)	8.1
Albuminuria category	
Normal/mild (A1)	56.7
Moderate (A2)	16.4
Severe (A3)	8.6
Unmeasured	18.3
Diabetes at index date	35.0
Hypertension at index date	83.1
Congestive heart failure at index date	23.7
Acute myocardial infarction at index date	8.9
Former health region of residence	
1 Chinook	6.6
2 Palliser	3.8
3 Calgary	33.2
4 David Thompson	10.3
5 East Central	4.2
6 Capital	32.5
7 Aspen	5.3
8 Peace	3.3
9 Northern Lights	0.8
At least one nephrologist outpatient visit in the past year	8.6

Appropriate Medication Use

Reducing the risk of cardiovascular disease is an important treatment goal for people with CKD. Clinical practice guidelines[3,4] 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[5], and reduce mortality in people with CKD and diabetes[6]. Guidelines suggest that all people with diabetes and Stage 3 or 4 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[17-20].

ACEi/ARB use

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

- Only 9% of the cohort had an outpatient nephrologist visit in the past year (38% among those with Stage 4 CKD).
- There was little change (<1.5%) in the ACEi/ARBs prescriptions dispensed when compared to the previous cohort from 2013-2014.
- People younger than 65 or older than 85 were less likely to receive an ACEi/ARB, and males were slightly more likely than females to receive an ACEi/ARB and only 2.9% of the cohort had at least one prescription for an ACEi/ARB that was written by a nephrologist.
- We also identified that people with diabetes and CKD were much more likely to receive ACEi/ARB than those without diabetes and A3 albuminuria (as recommended by the guidelines) with only 64% of those without diabetes receiving an ACEi/ARB overall (Table 8a). Of interest, it appears this problem is driven by lack of recognition of albuminuria since A3 albuminuria was only detected by urine dipstick ~40% of the time, and when it was detected by urine ACR/PCR, use of ACEi/ARB was 71.5%, nearly as high as use of ACEi/ARB in those with diabetes and CKD. This suggests that the low use of ACEi/ARB in those with albuminuria – but without diabetes – may be in part because the significance of heavy albuminuria on urine dipstick is not recognized.

Table 8a: ACEi/ARB prescription by albuminuria level and by diabetes status, among all adults with Stage 3 or 4 CKD, and among only those with an outpatient nephrologist visit in the past year

	All adults with Stage 3 or 4 CKD (N = 122,855)		**Only patients with an outpatient nephrologist visit in the past year** (N = 10,516)	
	N	Percent dispensed an ACEi/ARB	N	Percent dispensed an ACEi/ARB
With diabetes				
A1 or A2 albuminuria	31,516	78.3	3,147	76.6
A3 albuminuria	6,456	82.1	1,683	82.5
Unmeasured albuminuria	5,002	68.4	132	69.7
Overall (regardless of albuminuria)	42,974	**77.7**	5,320	**78.7**
No diabetes				
A1 or A2 albuminuria	58,329	55.6	3,751	62.0
A3 albuminuria	4,111	**64.0**	1,261	**73.5**
Based on ACR or PCR	2,370	**71.5**	1,171	**74.0**
Based on UDIP	1,741	**53.9**	90	**66.7**
Unmeasured albuminuria	17,441	50.6	184	61.4
Overall (regardless of albuminuria)	79,881	54.9	5,196	64.8

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

Further to Table 8a, we stratified by CKD stage to see if there were differences:

Table 8b: ACEi/ARB prescription by albuminuria level and by diabetes status, stratified by CKD stage, and among only those with an outpatient nephrologist visit in the past year

	All adults with eGFR 15 to 60 (N = 122,855)		**Only those with an outpatient nephrologist visit in the past year** (N = 10,516)	
	N	Percent dispensed an ACEi/ARB	N	Percent dispensed an ACEi/ARB
With diabetes				
CKD Stage 3A (45-60)	24,393	78.2	1,115	83.9
CKD Stage 3B (30-45)	13,525	78.7	2,002	80.7
CKD Stage 4 (15-30)	5,056	72.4	2,203	74.2
Overall (regardless of CKD Stage)	42,974	77.7	5,320	78.7
No diabetes, A3 albuminuria				
CKD Stage 3A (45-60)	1,682	62.4	321	80.7
CKD Stage 3B (30-45)	1,470	66.8	424	77.1
CKD Stage 4 (15-30)	959	62.8	516	66.1
Overall (regardless of albuminuria)	4,111	64.0	1,261	73.5

Change over time

We examined the change over time between a comparable cohort from 2013-2014 and the current cohort from 2015-2016. The proportion of Stage 3 and 4 patients recommended by guidelines to receive ACEi/ARBs who filled at least one prescription was similar in the cohorts – both among patients with diabetes, and among patients without diabetes but with A3 albuminuria (78% vs. 77.7% in diabetics, 65.6% vs. 64% in non-diabetics). In the latter group, among those assessed with an ACR or a PCR, the proportion was higher but also changed little, from 73.9% to 71.5%.

Statin Use

The Diabetes Canada Guidelines[21] recommend that anyone with diabetes over age 40, or with microvascular complications, be prescribed statin therapy to reduce cardiovascular risk. Relatedly, the KDIGO guidelines[22] 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 (2015-2016), 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.

Table 9: Proportion of people dispensed a statin among those with Stage 3 or 4 CKD: by diabetes, age group and whether they had seen a nephrologist in the prior year.

Subgroup	All adults with Stage 3 or 4 CKD (N = 122,855)		Only those with an outpatient nephrologist visit in the past year (N = 10,516)	
	N	% dispensed a statin	N	% dispensed a statin
With diabetes	42,974	**66.7**	5,320	**76.7**
No diabetes				
Under 50	2401	15.0	690	26.4
50 or older	77,480	**39.0**	4,506	**54.9**
Overall (regardless of age)	79,881	38.2	5,196	51.1

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

Table 9 demonstrates that ~67% of those with Stage 3 or 4 CKD and diabetes were dispensed a statin, compared to only 39% of those with Stage 3 or 4 CKD 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 between patients with and without diabetes and the prescription of lipid lowering therapy. Not surprisingly, we found a strong association between diabetes diagnosis and statin dispensation. Hypertension and AMI history were also strongly associated with statin prescribing. Males were significantly more likely to be prescribed a statin.

Change over time

There was little change from the 2013/2014 to the 2015/2016 cohort in the proportion filling a prescription for a statin. Among people with diabetes and Stage 3 or 4 CKD, the proportion increased from 65.9% to 66.7%, while in people over the age of 50 with Stage 3 or 4 CKD but no diabetes, the proportion decreased from 39.2% to 39.0%.

Quality Indicator 3: Appropriate Medication Use in Adults with Albuminuria Only

Cohort

This cohort consisted of Alberta adults with moderate or severe albuminuria, based on outpatient ACR, PCR or UDIP measurements between April 1, 2015 and March 31, 2016. 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 (for more details see Appendix B). We had defined a comparable cohort from the 2011/2012 fiscal year.

- This resulted in a cohort of 73,035 individuals which reflected a 12% increase over the four years.
- Only 3.3% of this cohort had an outpatient visit with a nephrologist in the prior year.

Table 10: Patient characteristics, albuminuria only cohort (N = 73,035)

Patient Characteristic	% (unless otherwise noted)
Female	49.1
Age, years: mean (SD)	53.9 (17.5)
Age categories	
18-39	24.3
40-54	25.1
55-64	22.1
65-74	17.1
75-84	8.4
85+	3.1
CKD Stage of first outpatient eGFR in 2015/16	
1 (>90)	45.4
2 (60-90)	44.4
Unmeasured in 2015/16	10.2
Albuminuria category	
Moderate (A2)	78.5
Severe (A3)	21.5
Type of albuminuria measurement	
ACR	47.7
PCR	6.3
UDIP	46.0
No diabetes or hypertension	36.2
Diabetes, no hypertension	8.5
Hypertension, no diabetes	21.6
Hypertension and diabetes	33.6
AHS zone of residence	
Calgary	33.6
Central	11.3
Edmonton	37.7
North	11.1
South	6.2
(Former) RHA of residence	
1 Chinook	3.8
2 Palliser	2.4
3 Calgary	33.6
4 David Thompson	8.4
5 East Central	2.9
6 Capital	37.8
7 Aspen	4.8
8 Peace	3.8
9 Northern Lights	2.3

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 11: 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 = 73,035)		Only those with an outpatient nephrologist visit in the past year (N = 2,392)	
	N	% dispensed an ACEi/ARB	N	% dispensed an ACEi/ARB
With diabetes	30,783	**76.5**	906	**88.2**
No diabetes				
A2 albuminuria	32,863	27.4	741	51.1
A3 albuminuria	9,389	**32.4**	745	**72.3**
Based on ACR or PCR	2,419	**57.2**	681	**74.2**
Based on UDIP	6,970	**23.7**	64	**53.1**
Total	42,252	28.5	1,486	61.7
Overall	73,035	48.8	2,392	71.7

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

Again, there appeared to be a significant difference in the prescribing of ACEi/ARBs between albuminuria patients with diabetes, and those without diabetes but with A3 albuminuria (76.5% vs.32.4%, respectively). As above for those with GFR<60mls/min/m2, it appears, it appears that this problem is partly driven by lack of recognition of albuminuria since A3 albuminuria was detected by urine dipstick ~70% of the time, and when it was detected by urine ACR/PCR, use of ACEi/ARB was higher at 57%. This suggests that the low use of ACEi/ARB in those with albuminuria – but without diabetes – may be in part because the significance of heavy albuminuria on urine dipstick is not recognized.

Change over time

We compared ACEi/ARB dispensing in the 2011/12 and 2015/16 cohorts and found that there was very little difference (≤1%) over the 4 years.

Statin Therapy Use

Guidelines[21,22] suggest that people with diabetes and those without diabetes but 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 age (for those without diabetes), and among all adults and only those who had seen a nephrologist.

Table 12: Statin dispensing by diabetes and age group, among all adults with albuminuria only, and among only those who had seen a nephrologist.

	All adults with A2 or A3 albuminuria (N = 73,035)		Only those with an outpatient nephrologist visit in the past year (N = 2,392)	
	N	% dispensed a statin	N	% dispensed a statin
With diabetes	30,783	**65.2**	906	**72.6**
Without diabetes				
Aged 18 to 49	22,450	5.2	922	13.3
50 or older	19,802	**32.6**	564	**46.3**
Total	42,252	18.0	1,486	25.8
Overall	73,035	37.9	2,392	43.6

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 about double the proportion of those without diabetes who were 50 or older (65.2% vs. 32.6%). While the difference was smaller among those seen by a nephrologist (3.3% of cohort), the proportion among those who had diabetes was still substantially greater than the proportion among those with no diabetes but who were 50 or older. Males were more likely to be prescribed a statin.

Change over time

We examined the change over time between a comparable cohort from 2011/2012 and 2015/2016. We found that there was a slight increase (~2%) over the 4 years in statin dispensing among those with diabetes, and ~1% among those without diabetes but who were 50 or older.

Implications and Considerations

The number of people in Alberta with CKD is continuing to grow with close to 191,000 Albertans affected. This report suggests that the prevalence of non-dialysis CKD among those with laboratory testing has increased by 7.1% over the past two years. However the age specific rates are similar this is largely attributable to growth in the aging 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, awareness and measurement of kidney disease appears to be an area where improvement is needed. 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[16], likely due to the fact that 70% of the population did not have 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 43% of people with diabetes identified in this cohort were found having the appropriate test (ACR) for protein in their urine, when guidelines recommend that all people with diabetes be tested annually.

CKD Stages 1-4 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[23]. 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 and statins).

Formed in 2016 with a mission to optimize the management of CKD across all ages and stages, the Kidney Health 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.

Most (~90%) non-dialysis CKD patients received the majority of 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 and #3) are needed within primary care across the province.

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Further information about this report is available from Neesh Pannu, Co-Scientific Director, Kidney Health – Strategic Clinical Network npannu@ualberta.ca

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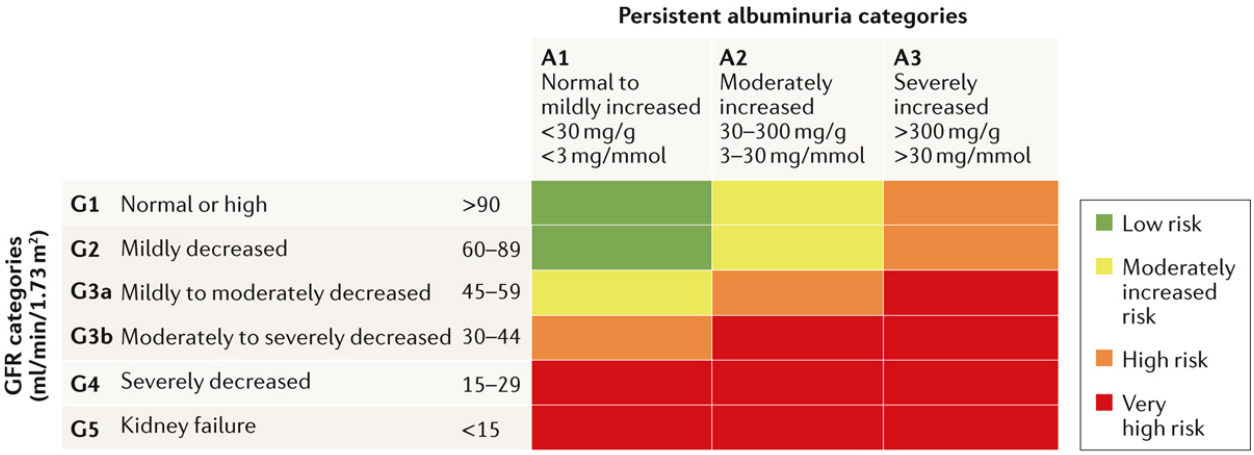
Appendices

A) KDIGO Classification of CKD



Source: Levey AS, et al. The definition, classification, and prognosis of chronic kidney disease: a KDIGO Controversies Conference report. Kidney Int. 2011 Jul;80(1):17-28.

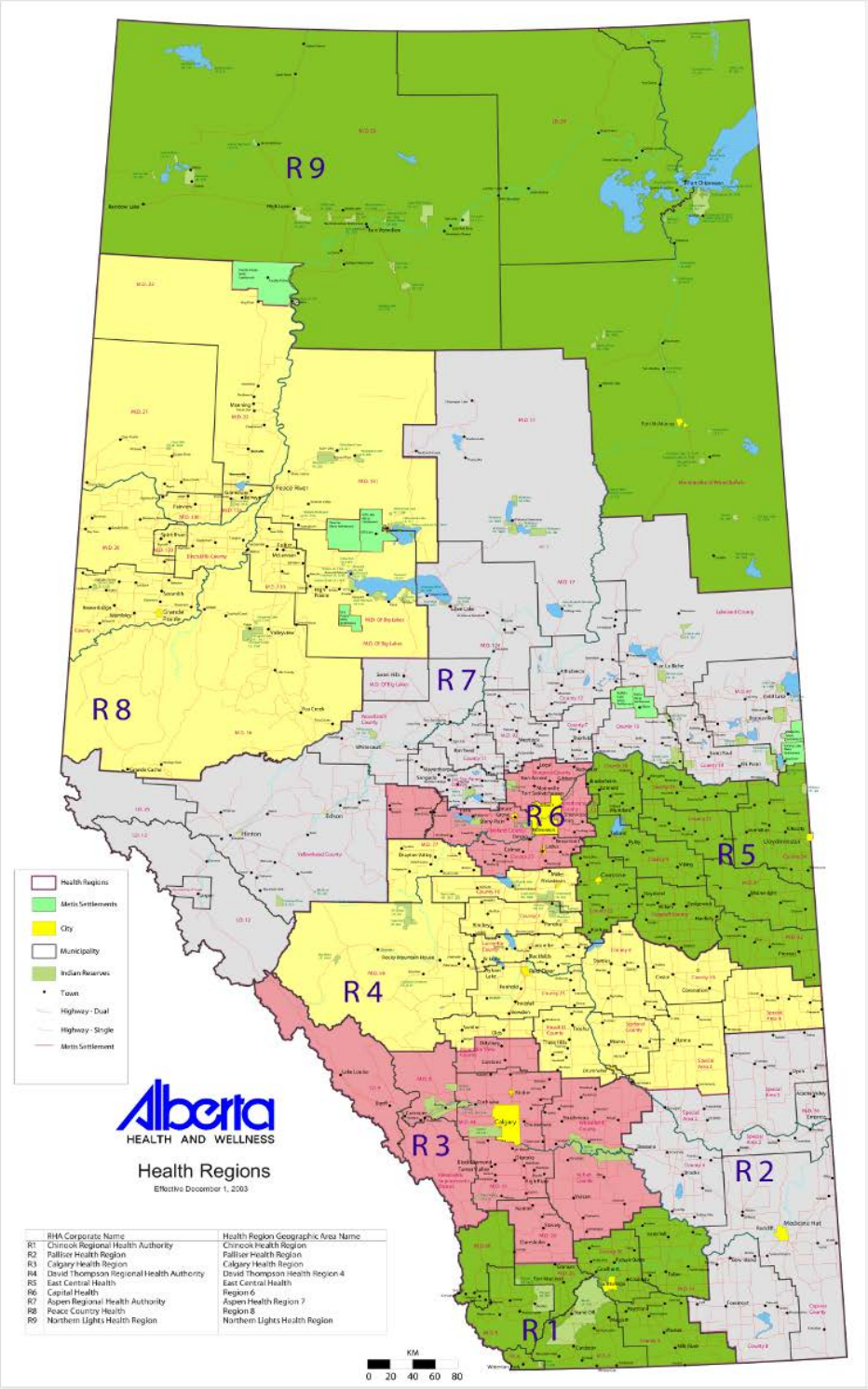
Abbreviation: Kidney Disease Improving Global Outcomes (KDIGO)

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, 2015, who were registered with Alberta Health during the 2015/16 fiscal year, and who were not censored by death, outmigration, or other reason prior to March 31, 2016. This was a total of 3,422,644 individuals. Since not all individuals received serum creatinine measurements, the index date for the analysis was April 1, 2015 for everyone. People were considered to have received a serum creatinine measurement if there was an outpatient measurement between April 1, 2015 and March 31, 2016. We identified people with Stage 3 and 4 CKD through linkage with the Stage 3 and 4 CKD cohort (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 295,484 adults in Alberta who were: diagnosed with diabetes prior to April 1, 2016; at least 18 years old as of April 1, 2016; registered with Alberta Health during both the 2015/16 and 2016/17 fiscal years; and not censored by death, outmigration, or other reason prior to March 31, 2016. The Hux/Blanchard algorithm[10] 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, 2017. 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)	The 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 (based on outpatient serum creatinine measurements that had been corrected for systematic measurement error – see Appendix D), with at least one measurement in the fiscal year April 1, 2015 to March 31, 2016. 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 2015-16 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, 2017), and with at least one measurement falling in the 2015-16 fiscal year. Initially, there were 128,025 people with sustained eGFR less than 60 under both criteria above. After dropping 3,062 people who had commenced dialysis prior to their first qualifying eGFR in 2015/16, 392 people who had received a kidney transplant prior to their first qualifying eGFR, and 1,716 people whose first qualifying eGFR was <15, 122,855 people remained: 113,456 who qualified under method 1 and 9,399 under method 2.

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, 2015 and March 31, 2016. 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 of 108,934 same-day ACR/UDIP pairs, including 2,523 where the UDIP was “Trace” (58% of these were A1, 39% were A2 and 3% were A3 according to the ACR). Note that if a Trace UDIP had been classified as A2, an additional ~13,000 people would have qualified for the cohort. Initially, 99,891 people qualified with A2 or A3 albuminuria. Of these, 24,403 were excluded because they had qualified for the eGFR 15 to 60 cohort, 69 were dropped because they were censored by outmigration or other registration end before their index albuminuria measurement, 1005 were dropped because they had started dialysis prior to the index date, 317 were dropped because they had received a kidney transplant before the index date, and 1,062 were dropped who had initially qualified for the eGFR 15 to 60 cohort but were subsequently excluded because their initial eGFR was <15. This left a final cohort of 73,035 people.
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 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. A UDIP of trace was assigned to A2 if the eGFR was <60, or to A1 if the eGFR was >60 or unknown, based on a review of same-day ACR/UDIP pairs.

C) Former Provincial Health Regions



Former Health Regions:

1. Chinook Health
2. Palliser Health
3. Calgary Health
4. David Thompson Health
5. East Central Health
6. Capital Health
7. Aspen Health
8. Peace Country Health
9. Northern Lights Health

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.

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

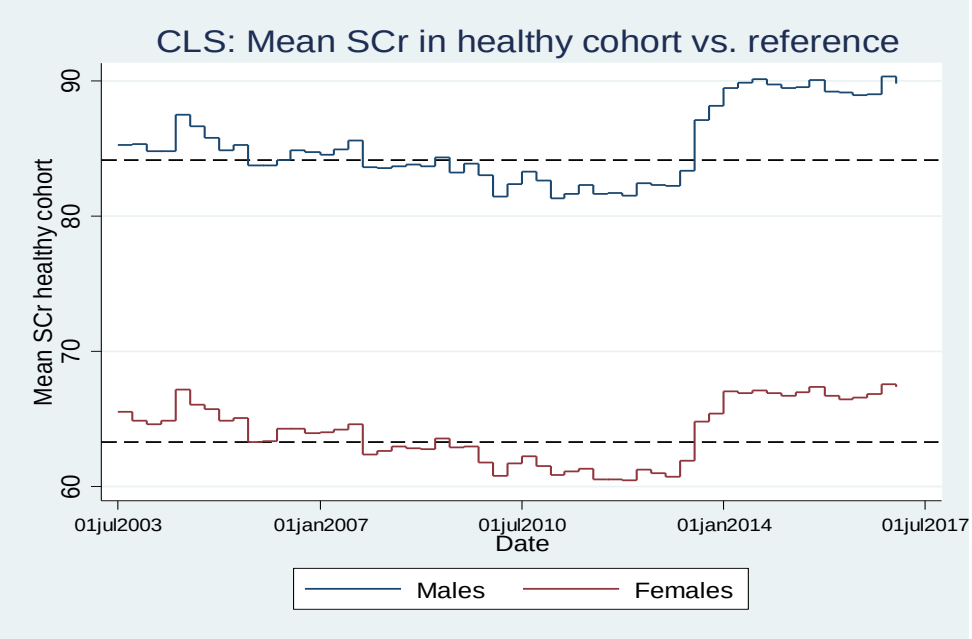


Figure D2. Mean quarterly serum creatinine values in the healthy cohort for Capital Lab Region

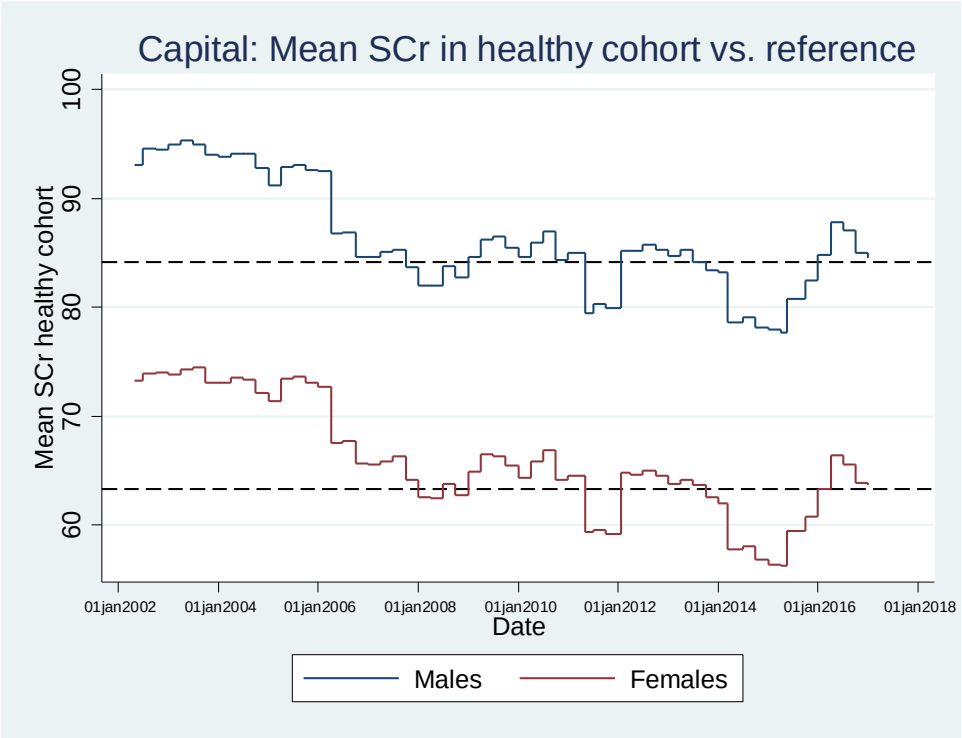
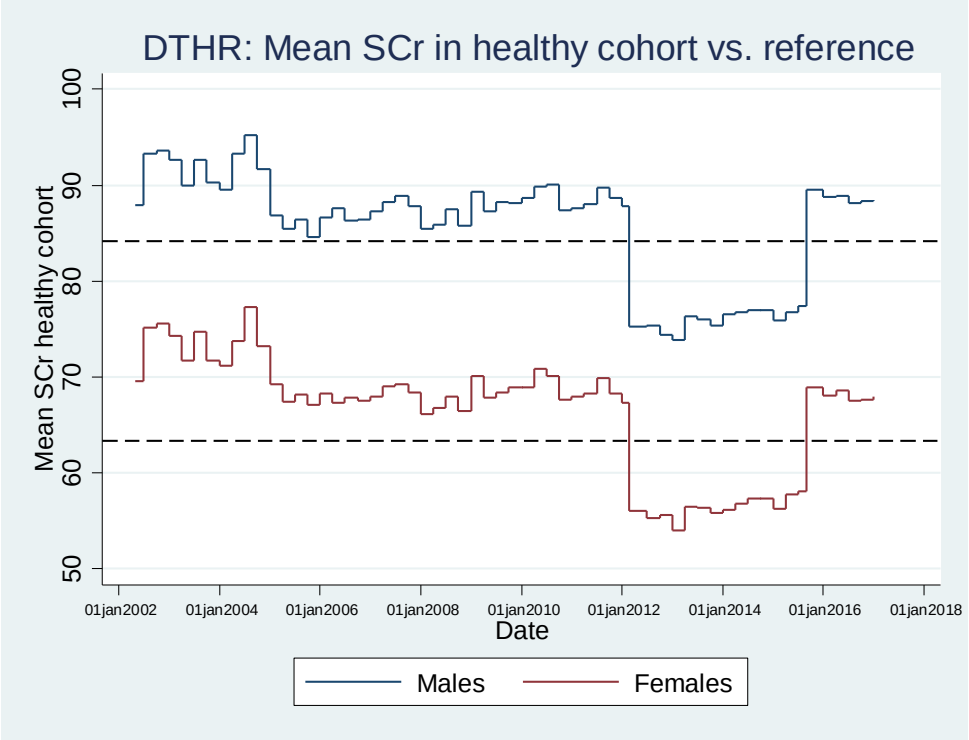


Figure D3. Mean quarterly serum creatinine values in the healthy cohort for David Thompson Lab Region (DTHR)



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 age group. An ACR was used in preference to a PCR, which was used in preference to a protein dipstick.

Table 6: Measurement used for albuminuria assessment, by age group (N = 3,422,644)

	ACR		PCR		Dipstick		Not measured		Total
	N	#	N	%	N	%	N	%	N
18-29	8,353	1.1%	3,055	0.4%	117,126	14.8%	660,485	83.7%	789,019
30-39	17,814	2.5%	3,875	0.5%	142,362	19.7%	558,169	77.3%	722,220
40-54	55,851	6.1%	4,018	0.4%	224,008	24.5%	631,097	69.0%	914,974
55-64	57,976	11.3%	3,485	0.7%	152,895	29.8%	298,006	58.2%	512,362
65-74	47,266	16.6%	3,144	1.1%	96,727	33.9%	138,273	48.4%	285,410
75-84	23,610	16.6%	2,190	1.5%	50,300	35.4%	65,834	46.4%	141,934
85+	5,443	9.6%	700	1.2%	18,054	31.8%	32,528	57.3%	56,725

For all age groups, the majority of albuminuria assessments were based on protein dipstick measurements. The proportion that were based on ACR increased with age up to the 65-84 age range, in which they constituted about a third of all albuminuria assessments.

F) CKD Prevalence by eGFR Category and Albuminuria Category

"Heat map" of CKD prevalence in Alberta, 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	12.55	0.77	0.19	6.37	19.87
60 to 90	10.48	0.74	0.21	5.15	16.58
45 to 60	1.23	0.25	0.10	0.67	2.25
30 to 45	0.41	0.15	0.09	0.27	0.92
15 to 30	0.07	0.06	0.07	0.06	0.26
<15	0.005	0.01	0.03	0.06	0.10
Unmeasured	2.72	0.16	0.05	57.1	60.02
Total	27.46	2.14	0.73	69.67	100

Note: Shaded indicates those defined as CKD