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Prevalence of chronic kidney disease in Western Australia, 2010–2020

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ABSTRACT

Objective To assess the prevalence and trends of chronic kidney disease (CKD) in Western Australia (WA) from 2010 to 2020 using linked pathology data.

Design A retrospective observational cohort study using linked de-identified data from WA pathology providers, hospital morbidity records and mortality records.

Setting A Western Australian population-based study.

Participants All individuals aged 18 years and older with at least one serum creatinine test.

Primary outcome measure CKD status as determined by estimated glomerular filtration rate and urine albumin-creatinine ratio.

Results Analysing data from 2 501 188 individuals, there was a significant increase in age-sex standardised CKD prevalence from 4.7% in 2010 to 6.0% in 2020, with annual average percentage change of 3.0% (95% CI: 2.3% to 3.7%). Prevalence of CKD stages 3 and above was 4.8% in 2020. Higher CKD prevalence was observed in regional and remote areas compared with major cities, and among individuals in the most socioeconomically disadvantaged quintiles. Sensitivity analysis indicated minor impacts from data exclusions and methodological choices.

Conclusions CKD prevalence in WA has been steadily increasing, reflecting broader Australian trends. The study highlights significant disparities in CKD prevalence based on age, socioeconomic status and geographic remoteness.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study used a novel linked pathology dataset to produce chronic kidney disease (CKD) prevalence estimates, containing pathology test results from the four major providers in Western Australia.
⇒ The study analysed over 27 million pathology collections from over 2 million individuals, making it one of the largest studies of its kind.
⇒ Multiple sensitivity analyses were conducted, strengthening the study's findings by assessing the impact of methodological decisions.
⇒ Limited urine albumin-creatinine ratio testing in the community meant potential underestimating of early-stage CKD.

INTRODUCTION

Chronic kidney disease (CKD) is a major public health concern and is projected to be the fifth leading cause of death worldwide by 2040.[1] The CKD burden continues to increase, led by an ageing population and high rates of risk factors (eg, obesity, diabetes, hypertension) in the community.[2]

In its early stages, CKD is often asymptomatic and can go undetected until the condition has progressed and requires specialist care. As CKD progresses, it can lead to complications such as cardiovascular disease, bone and mineral disorders, and neurological and psychiatric diseases,[3 4] ultimately progressing to kidney failure, requiring dialysis or transplantation. These complications produce significant strain on healthcare resources.[5]

System-wide efforts to address CKD typically involve a combination of measures such as lifestyle modification to reduce risk, targeted surveillance, early detection and timely CKD treatment to slow disease progression. Public health initiatives promoting healthy lifestyles, regular screening for high-risk populations, and access to effective treatment modalities are essential components in tackling the growing burden of CKD.

To understand the extent of and trends in the burden of CKD, comprehensive assessment of CKD prevalence is required. This entails not only quantifying the current numbers but also analysing the demographic distribution of the disease over time which is crucial for developing targeted healthcare strategies and allocating resources efficiently. Using population-level data through administrative records provides a relatively inexpensive way to assess prevalence across a jurisdiction, providing enough power to investigate demographic and geographic distributions of the disease. However, to date, this has remained difficult, due to the disaggregation of individual medical records and limited access to health data in the early stages of disease (ie, prior to hospitalisation or outpatient specialist care). As early-stage CKD is managed outside the hospital setting,

administrative primary care or pathology records are required to gain a full understanding of CKD prevalence, which are typically less accessible for secondary use. Pathology records, which provide an actual measure of renal function, are likely to be the most accurate measure of CKD status within recorded clinical data.

Worldwide, CKD prevalence is estimated at 13.4%, with significant variation between countries.[6] A number of Australian studies have measured CKD prevalence; an overview is found in table 1. Among these studies, significant variability is found both in the methods of estimating CKD prevalence and in results, with prevalence estimates for the general population ranging from 0.9% to 11%. The lowest estimates were found through self-report,[7–9] while the highest through biochemical testing (on a single occasion) of a random sample of the population.[10 11] The most recent effort, a study of over 2.5 million general practice records, estimated CKD prevalence of 3.1%.[12]

This study aimed to assess the prevalence and trends in CKD prevalence in Western Australia (WA) from 2010 to 2020. To do this, we used a novel linked pathology dataset, consisting of pathology test results from the public and private pathology providers of WA.

METHODS

Data sources and study cohort

The present study analysed de-identified, longitudinal data of people living in the state of WA. Datasets included the Hospital Morbidity Data Collection, Death Register and data from four pathology providers in WA: PathWest, Australian Clinical Laboratories (ACL), Clinipath Pathology and Western Diagnostic Pathology. These data were linked using probabilistic privacy preserving methods, allowing identification of records within and between datasets belonging to the same person.[13] All individuals with a serum creatinine test from one of the four pathology providers were included within the cohort. The four pathology providers have near total coverage of the Western Australian pathology market (including inpatient and outpatient testing), meaning nearly all renal function testing in WA was captured within the study.

Outcome measures

The primary outcome measure was CKD status. CKD status was determined based on evidence of CKD across pathology records. Individuals were classed as having CKD if (1) they had a period >90 days where their estimated glomerular filtration rate (eGFR) was consistently less than 60 mL/min/1.73 m^2, with two tests at least 90 days apart and less than 365 days apart, or (2) they had a period >90 days where their urine albumin-creatinine ratio (uACR) was consistently ≥2.5 mg/mmol for men or uACR ≥3.5 mg/mmol for women, with two tests at least 90 days apart, and less than 365 days apart. eGFR was calculated from serum creatinine using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formula.[14] Forward filling of CKD status was carried out such that once identified as having CKD, an individual continued to be a prevalent CKD case unless they were lost to follow-up or died.

An individual's CKD stage was based on the Kidney Disease - Improve Global Outcomes (KDIGO) staging system, where uACR was used in combination with creatinine to identify individuals with CKD stages 1 and 2.[15] An individual needed to have a period >90 days with at least two tests, where these tests occurred within 365 days, where all tests met the criteria for a stage, to be classed as that stage. Once classed as a stage, an individual remained at that stage unless they were lost to follow-up or died, or their stages progressed—individuals could not regress. In addition to pathology results, individuals with CKD with a hospital International Classification of Diseases (ICD) code indicating dialysis (Z49) were classified as stage 5. An individual's highest CKD stage for a calendar year was reported.

Individuals were excluded from the study when they lived solely out of state (all postcodes outside of WA); all other individuals were included within the study. An individual was considered lost to follow-up from a particular year if they had no pathology, hospital, emergency or mortality records within that year, or any future years.

Statistical analyses

Individuals were included in the analyses until their last pathology collection date, hospitalisation separation date or death. CKD prevalence percentage in WA during 2010–2020 was calculated by dividing the number of CKD cases by the total population in the state in that year, multiplied by one hundred. The estimated resident WA population aged ≥18 years was obtained from the Australian Bureau of Statistics. Information on sociodemographic characteristics such as birth year, sex and postcode was obtained from the pathology data and used to compute CKD prevalence stratified by (1) age, (2) sex, (3) socioeconomic disadvantage and (4) remoteness of areas. Individuals less than 18 years of age or with postcodes suggesting they resided outside of WA were excluded from all analyses. Overall prevalence rates were age and sex standardised (5-year age bands) using the direct method, standardised to the 2021 Australian estimated residential population.

Socioeconomic disadvantage was measured using the geographic area-based Socio-Economic Index for Areas: Index of Relative Socioeconomic Disadvantage (IRSD), developed by the Australian Bureau of Statistics.[16] IRSD uses census data on income, employment, education, housing and other related indicators, and ranks geographical areas based on relative social and economic disadvantage. For the purpose of the present analysis, IRSD scores from the 2011 census were assigned based on an individual's postcode. The IRSD scores were summarised into quintiles. The proportion of adult individuals living in the postcodes that made up these quintiles was taken from the 2011, 2016 and 2021 censuses, with population estimates derived for the years in-between through linear interpolation.

Table 1 Studies of CKD prevalence in Australia*

Study	Year	Population	Prevalence	Methods	Adjustments	CKD definition
AusDIAB study[10]	1999–00	11 247 randomly selected adults aged ≥25 years	10% (6.7% stages 1–2, 3.1% stages 3–5)	Results from collected blood/urine test	Age-sex standardised	Single creatinine or uACR result
	2011–12 follow-up	6186 individuals from previous AusDIAB study	13.6% 8.8% stages 1–2 4.8% stages 3–5	Results from collected blood/urine test	None	Single creatinine or uACR result
Gopinath[33]	2002–04	1952 adults from Blue Mountains region of New South Wales aged ≥50	19.4% stages 3–5	Results from collected blood test	None	Single creatinine result
McDonald[34]	2003	237 indigenous Australians from a single remote aboriginal community aged ≥18	12% stages 3–5, 44% with albuminuria	Results from collected blood/urine test	None	Single creatinine or uACR result
Maple-Brown[35]	2005	870 indigenous Australians from an urban area	2.4% stages 3–5, 14.8% with albuminuria	Result from collected blood/urine test	None	Single creatinine or uACR result
Victorian Health Monitor[36]	2009–10	3653 randomly selected adults aged 18–75 years in Victoria	9.1%, 9.0% stages 1–3; 0.1% stages 4–5	Results from collected blood/urine test	Age-sex standardised	Single creatinine or uACR result
Jose[37]	1995–2007	Community pathology records of 369 098 adults ≥18 years in Tasmania	In 2007, 11.4% of women, 8.6% of men stages 3–5	Results from blood test in pathology data	None	Single creatinine result
Razavian[38]	2008	Random sample of 4966 GP attendees aged ≥55	37%; 20% stages 1–2. 17% stages 3–5	Results from collected blood/urine test	None	Single creatinine or single uACR/dipstick
Lawton[39]	2002–2011	Top End of Northern Territory—community pathology results from 127 526 individuals aged ≥15 years	In 2009, 1.1%–2.3% stages 3–5	Results from blood/urine test in pathology records	None	Single creatinine or uACR result
National Health Measure Survey[20]	2011–12	17 042 randomly selected adults aged ≥18 years	11% (7% stages 1–2, 4% stages 3–5)	Results from collected blood/urine test	Age-sex standardised	Single creatinine or uACR result
National Health Survey	2014–15,[7] 2017,[8] 2022[9]	~20 000 randomly selected individuals aged ≥0 years in each survey	2014–15: 0.9% 2017: 1% 2022: 1%	Self-report through face-to-face interview	Age-sex standardised	Self-report
Radford[19]	2016	General practice records of 1 483 416 adults aged ≥18 years	4.1% all stages	Results from blood/urine test recorded in GP records	Age-sex standardised	Two creatinine and uACR results >90 days apart
Li[40]	2013	Northern Territory residents, no age restrictions	4.6% stage 5; 18% for indigenous population, 1.1% for nonindigenous	Combination of hospital records, GP records, registry information and death registrations in Northern Territory	Age standardised	Record of end stage kidney disease in data sources including creatinine results in GP data
Jose[41]	2007–2017	460 737 adults aged ≥18 years in Tasmania	6.5% all stages in 2017	Results from blood/urine test in pathology records	Age standardised	Two creatinine results >90 days apart, single uACR result
Jun[12]	2020	General practice records of 2 720 529 adults aged ≥18 years	3.1%	Results from blood/urine test recorded in GP records	None	Two creatinine and uACR results >90 days apart

*Studies were included above if their prevalence estimates were for the year 2000 or later. Studies focusing on children, or on populations with existing comorbidities (eg, those with diabetes), were excluded.
CKD, chronic kidney disease; GP, general practice; uACR, urine albumin-creatinine ratio.

Remoteness was measured by the Accessibility and Remoteness Index of Australia which divides Australia into five classes of remoteness according to postcode.[17] These classes include major cities, inner regional, outer regional, remote and very remote. Resident population by remoteness areas for adult residents was obtained from the Australian Bureau of Statistics. All analyses were performed using Stata/MP V.18.0 (StataCorp, College Station, Texas).

CIs for prevalence rates were calculated using the Poisson distribution.[18] CIs were used to compare differences in point estimates for significance. Trends in yearly prevalence were calculated using a log-linear regression model to determine the average annual percentage change (AAPC),

Sensitivity analyses

A range of sensitivity analyses were conducted to measure the expected impact of data availability and methodological decision on end results. As pathology data from ACL were only available from 2017, we compared the CKD prevalence in 2017, 2018 and 2019 before and after excluding ACL. Data from PathWest were missing from the final quarter of 2020; to estimate the likely effect of this missing data, a second sensitivity analysis was run excluding PathWest data from the final quarters of 2018 and 2019. Hospital ICD coding was not used for case ascertainment or staging, with our analysis solely using pathology data as the gold standard. A sensitivity analysis was carried out to identify the effect of also using hospital ICD coding to identify and stage cases. Finally, a sensitivity analysis was conducted to determine the effect of allowing CKD regression (both a decrease in CKD stage and a regression to no CKD status) had on prevalence estimates.

Patient and public involvement

Patients and the public were not directly involved in the design of the methods for this study. Consumers with lived experience play an important role within the broader CKD.WA project. The results of this study have been presented and discussed with consumers within the broader project team.

RESULTS

Population characteristics

We analysed data from 2501188 individuals aged ≥18 years who resided in WA between 2010 and 2020. The sociodemographic characteristics of study participants with CKD in the years 2010 and 2020 are presented in table 2. Individuals with CKD were generally older Australians (median age at the start of 2010 and 2020 was 76.5 and 75.5 years, respectively) and were evenly split between sex. More than half of individuals with CKD were classified as CKD stage 3a (55.7% in 2010; 54.0% in 2020). While there were a lower overall number of people in the most socioeconomic disadvantaged group with CKD, this reflected lower overall population numbers in the lowest socioeconomic postcodes.

Table 2 Characteristics of study participants with CKD in 2010 and 2020. Data are presented as n (%) or median (IQR)

Variable	2010	2020
	n=62132	n=114593
Age at the start of the year, median (IQR)	78 (69–85)	77 (68–85)
Sex, n (%) males	28830 (46.4)	56218 (49.1)
Annual eGFR (mL/min/1.73 m^2), median (IQR)	50.1 (39.0–58.6)	55.4 (43.3–69.7)
Annual uACR (mg/mmol), median (IQR)	4.7 (1.2–19.7)	5.1 (1.5–19.4)
CKD stage, n (%)		
1	2064 (3.3)	7926 (6.9)
2	2296 (3.7)	9044 (7.9)
3a	34578 (55.7)	61828 (54.0)
3b	15626 (25.2)	24694 (21.6)
4	5003 (8.1)	7081 (6.2)
5	2565 (4.1)	4020 (3.5)
Socioeconomic status by postcode, quintiles, n (%)*		
1 (most disadvantaged)	8691 (14.0)	14.243 (12.4)
2	15803 (25.4)	28585 (24.9)
3	12802 (20.6)	24239 (21.2)
4	8284 (13.3)	16566 (14.5)
5 (least disadvantaged)	16291 (26.2)	30104 (26.3)
ARIA, n (%)*		
Major cities of Australia	45988 (74.0)	84958 (74.1)
Inner regional Australia	6175 (9.9)	12074 (10.5)
Outer regional Australia	6194 (10.0)	10253 (9.0)
Remote Australia	2436 (3.9)	4302 (3.8)
Very remote Australia	1188 (1.9)	2455 (2.1)

*A number of patients had missing values.
ARIA, Accessibility and Remoteness Index of Australia; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; uACR, urine albumin-creatinine ratio.

Chronic kidney disease prevalence

Unadjusted (crude) CKD prevalence in the study population progressively increased from 2010 until 2019 (3.5% to 5.7%) before a slight decrease in 2020 to 5.6% (online supplemental figure A). Age and sex standardised CKD prevalence is shown in figure 1, which showed a similar increase, from 4.7% in 2010 to 6.3% in 2019 and 6.0% in

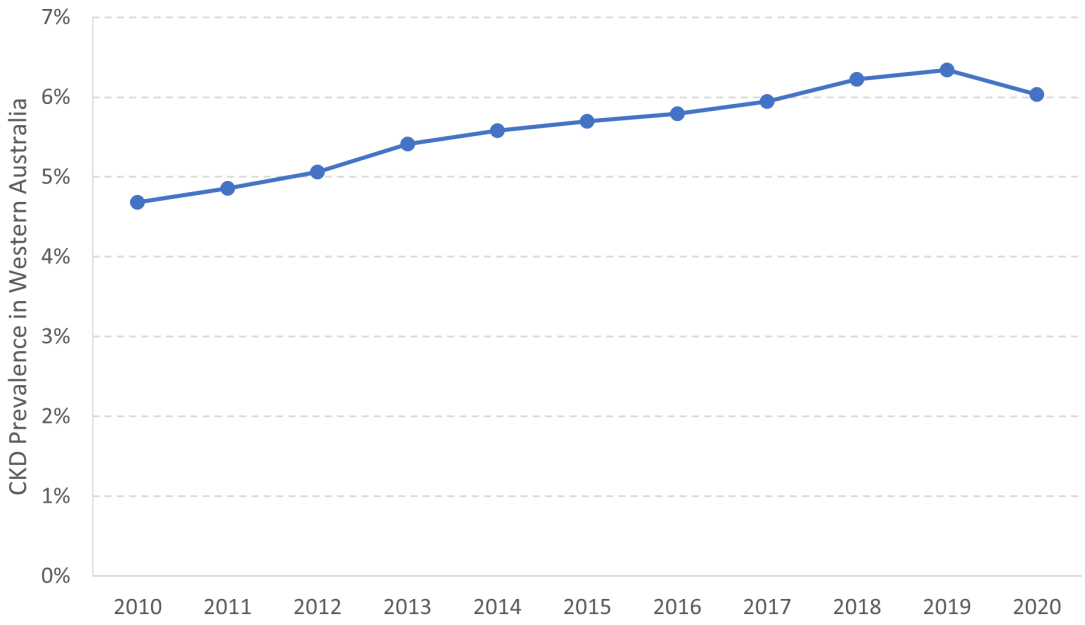

Figure 1 Age-sex standardised annual prevalence of chronic kidney disease from 2010 to 2020.

2020. Adjusted for age and sex, CKD prevalence showed an average annual percentage increase of 3.0% (95% CI: 2.3% to 3.7%).

A total of 62 132 CKD cases were observed in 2010, a figure that nearly doubled to 114 593 in 10 years. In 2020, unadjusted prevalence of stage 3 and above was 4.8%, while unadjusted prevalence of early-stage CKD (stages 1–2) was 0.9%. Low rates of early-stage CKD were due primarily to lower rates of testing for uACR. While 80% of adults in the Western Australian population had a recorded serum creatinine result (and 100% of those over 65 had a serum creatinine result), only 24% of adults had a uACR result recorded, with repeat testing uncommon.

A gradual rise in CKD prevalence was observed for both sexes during the study period with a significantly higher prevalence among women (men: 3.25% (95% CI: 3.21% to 3.29%); women: 3.82% (95% CI: 3.78% to 3.87%)) in 2010, with this gap decreasing over time to 0.1% higher in 2020 (figure 2). Men had a significant faster increase in CKD prevalence over the study period compared with women (AAPC, 95% CI: males 5.9%, 5.4% to 64%; females 4.4%, 3.9% to 4.9%).

CKD prevalence across the different age categories is shown in figure 3. Prevalence increased with age, with prevalence in 2020 for 18–39 years: 0.3%; 40–59 years: 1.7%; 60–79 years: 11.3%; and 80+ years: 49.9%. All age

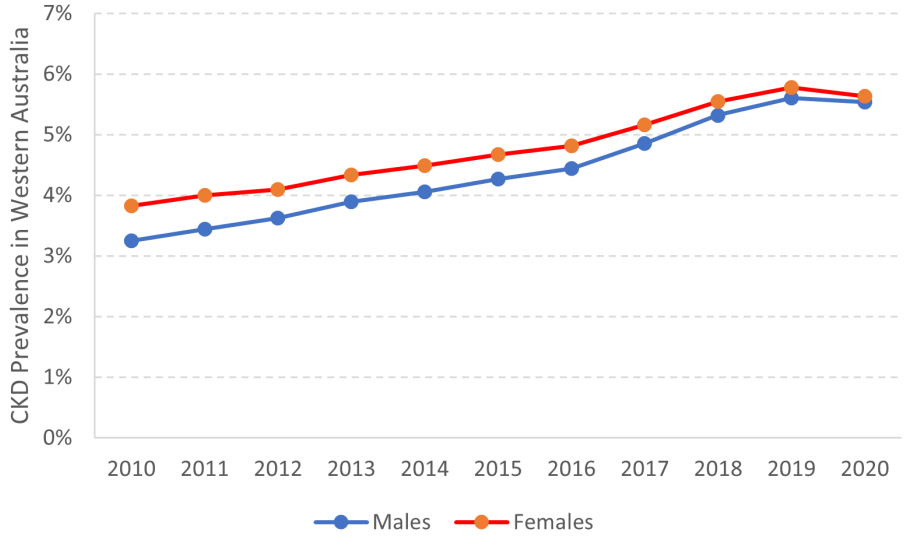

Figure 2 Annual prevalence of chronic kidney disease from 2010 to 2020, stratified by sex.

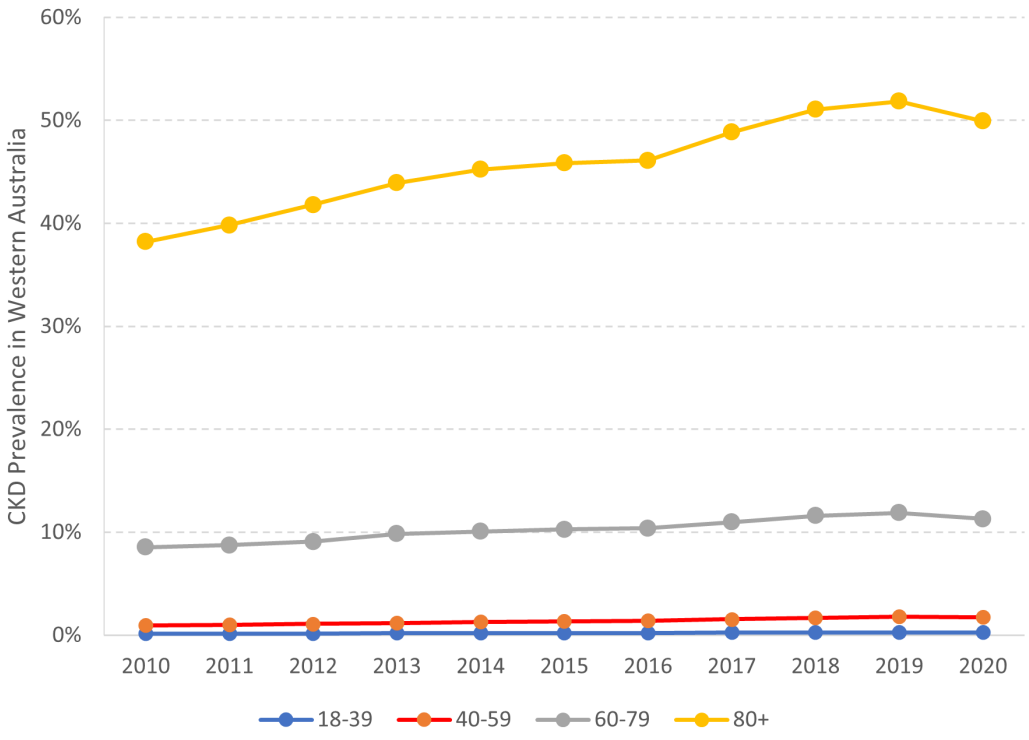

Figure 3 Annual prevalence of chronic kidney disease from 2010 to 2020, stratified by age groups.

bands showed significantly different CKD prevalence rates across all years. Across the study period, prevalence increased across all age groups. Prevalence increased faster for 18–39 year-olds (AAPC, 95% CI: 7.3%, 6.4% to 8.1%) and 40–59 year-olds (AAPC, 95% CI: 7.0%, 6.2% to 7.8%) as compared with 60–79-year-olds (AAPC, 95% CI: 3.3%, 2.7% to 4.0%) and those aged 80 and over (AAPC, 95% CI: 3.0%, 2.4% to 3.6%).

When CKD prevalence was stratified by remoteness, a progressive rise in prevalence was observed across all remoteness levels (figure 4), with rates in remote areas rising faster than those in regional areas and major cities (AAPC, 95% CI: major cities 4.1%, 3.7% to 4.6%; regional areas 4.9%, 4.1% to 5.7%; remote areas 7.3%, 5.8% to 8.8%).

In 2020, higher prevalence was found in both regional (7.0%, 95% CI: 6.9% to 7.1%) and remote areas (6.0%, 95% CI: 5.9% to 6.1%) as compared with major cities (5.3%, 95% CI: 5.3% to 5.4%).

The prevalence of CKD varied by levels of socioeconomic disadvantage (figure 5). CKD prevalence generally increased with greater disadvantage, with the two

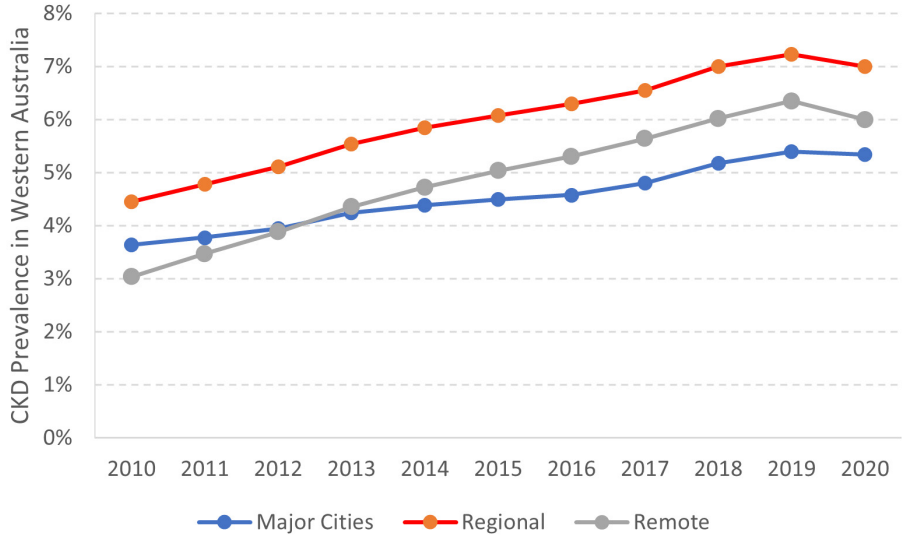

Figure 4 Annual prevalence of chronic kidney disease from 2010 to 2020, stratified by remoteness.

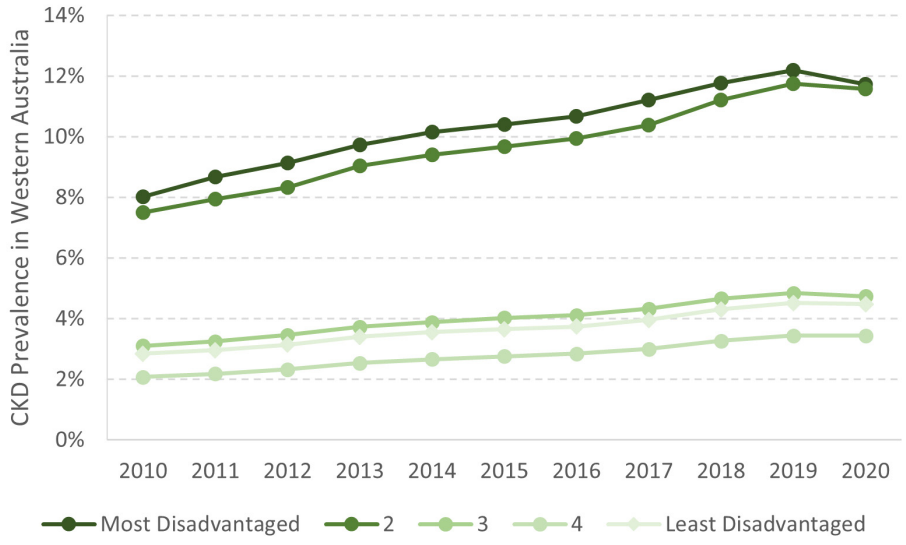

Figure 5 Annual prevalence of chronic kidney disease from 2010 to 2020, stratified by socioeconomic quintile.

most deprived quintiles having CKD prevalence nearly three times greater than the three less deprived quintiles. There were no significant differences in rate of prevalence increase between socioeconomic quintiles.

Sensitivity analyses

A range of sensitivity analyses were conducted to test both the likely impact of data limitations and the impact of choices made regarding CKD identification and staging; these are shown in table 3. Excluding ACL data (SA1) decreased CKD prevalence estimates for 2018–2020 by approximately 5–10%. Based on sensitivity analysis 2, missing PathWest data for the final quarter of 2020 is likely to have resulted in decreasing that year's prevalence estimate by 0.2%. Including hospital diagnosis codes within our CKD definition increased prevalence only slightly, while relaxing the requirement for two uACR tests resulted in the largest CKD prevalence increase of 1.3–1.5 percentage points. Allowing CKD regression reduced overall CKD prevalence by 0.5–0.7 percentage points—these were mainly stage 3a cases with eGFRs hovering around the cut-off point. All sensitivity analyses produced statistically significant changes in prevalence with the exception of including hospital diagnosis codes within the CKD definition (SA4).

DISCUSSION

The prevalence of CKD in WA has steadily increased since 2010, with CKD affecting 5.6% of the population in 2020. While our study focused on the Western Australian population rather than the whole of Australia, studies which have included both state-based and national measurements have shown Western Australian CKD prevalence generally in line with Australian estimates.[12 19]

Our estimates are higher than recent Australian estimates calculated using large-scale general practice data (4.1%[19] and 3.1%[12]) and those derived from self-report, but lower than using a biochemical sample-based approach whose estimates were around 10–11%.[10 20] Taking pathology samples from a random sample of the

Table 3 Sensitivity analyses

Condition	Result
Baseline	CKD prevalence with 95% CI in 2018: 5.4% (5.4% to 5.5%) 2019: 5.7% (5.7% to 5.7%) 2020: 5.6% (5.6% to 5.6%)
SA1: removal of pathology provider ACL for 2017+ (ACL data were not available prior to 2017)	CKD prevalence in: 2018: 5.1% (5.1% to 5.1%) 2019: 5.2% (5.2% to 5.2%) 2020: 5.0% (4.9% to 5.0%)
SA2: exclude final quarter of PathWest data for years 2018–19. (PathWest data was missing for the final quarter of 2020)	CKD prevalence in: 2018: 5.2% (5.2% to 5.3%) 2019: 5.5% (5.5% to 5.5%)
SA3: defining CKD stages 1 and 2 using single uACR measure only	CKD prevalence in: 2018: 6.7% (6.7% to 6.8%) 2019: 7.2% (7.1% to 7.2%) 2020: 7.1% (7.1% to 7.2%)
SA4: including CKD hospital diagnosis codes to define and stage CKD	CKD prevalence in: 2018: 5.5% (5.5% to 5.5%) 2019: 5.8% (5.7% to 5.8%) 2020: 5.7% (5.6% to 5.7%)
SA5: allowing regression of CKD (>2 consecutive tests over 90 days with eGFR/uACR in lower/no stage)	CKD prevalence in: 2018: 4.9% (4.8% to 4.9%) 2019: 5.0% (5.0% to 5.1%) 2020: 4.9% (4.9% to 4.9%)

ACL, Australian Clinical Laboratories; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; uACR, urine albumin-creatinine ratio.

population has the benefit of detecting individuals with undiagnosed CKD, allowing greater capture of early-stage cases. This study, in line with previous studies, found significantly lower testing rates for uACR, indicating potential for underdiagnosis of stage 1 and stage 2 CKD. However, current biochemical sample-based studies have all relied on pathology samples from a single day, despite standard CKD definitions requiring evidence of chronicity with a second pathology sample after 90 days. As such, single sample-based estimates of 10–11% may be overestimating CKD prevalence.

The lower estimates of 3–4% found when using general practice data likely reflect limitations of these datasets. The general practice data do not include inpatient pathology testing as in our dataset, include only a sample of practices and are unlinked, meaning they cannot identify the same individuals between practices. The Australian health system allows individuals to make an appointment at any general practice they wish, and a quarter of Australians see more than one general practitioner.[21] Data quality and completeness issues may make these general practice-based results unreliable.

Results from Australian surveys consistently found 1% prevalence of kidney disease on self-report. It is not clear the extent to which this far lower estimate is caused by response bias, or individuals lack of knowledge of their own condition as opposed to lack of disclosure. However, the same survey through self-report found a prevalence of diabetes of 5%, which is in line with other diabetes prevalence estimates.[22] As such, there may be limited awareness among those with CKD of their condition, suggesting potential for enhancing awareness and management of the condition.

International studies have typically found slightly higher prevalence estimates than those seen in Australia, including the UK[23] (7.7% stages 3+) and China (8.2% stage 3+)[24], while US estimates were closer at 5.6% for stage 3+.[25] However, given the range of populations studied, data collection methods used, and definitions for CKD adopted, it is difficult to be confident that differences found represent true underlying difference in CKD prevalence rather than methodological differences.

The increasing CKD prevalence over time partly reflects an ageing population in WA. However, age-sex standardised prevalence rates are also increasing at 3% per year, indicating factors other than age are significantly contributing. Of note is the near doubling of prevalence rates in those under age 60, although from a far lower baseline. Key risk factors for CKD including hypertension and diabetes have remained relatively constant over the last 10 years,[26 27] with obesity seeing only slight increases.[28] As such, the drivers for increasing CKD prevalence are not clear.

Higher CKD prevalence was found in regional and remote areas as compared with major cities. CKD prevalence was also increasing at a faster rate in remote areas, where it doubled over the study period (7.3% per year). Higher prevalence in more regional and remote areas is likely driven by higher rates of modifiable risk factors, including higher rates of smoking, insufficient physical activity and uncontrolled high blood pressure.[29] Indigenous Australians, making up a larger proportion of the population in regional and remote areas, are known to have significantly higher rates of CKD.[30] Limited access to healthcare resources and preventative services in remote regions may contribute to delayed diagnosis and suboptimal risk factor management, exacerbating the disparities observed.

Those from the two most socioeconomically disadvantage quintiles had nearly three times the CKD prevalence as those from the three least deprived quintiles (around 12% as compared with 4%). This finding is broadly in line with meta-analysis on the relationship between socioeconomic status and CKD prevalence;[31] however, the level of disparity is higher than regularly reported. Higher modifiable risk factors are the likely causes (smoking rates triple from the lowest to highest quintile).[32]

Strengths and limitations

This study examined pathology results from over 27 million pathology collections, for over 2 million individuals, making it one of the largest studies of its kind. By gaining access to essentially all creatinine test results within the state over the timeframe, we were able to gain an accurate population-level picture of the extent of known CKD in WA. Nevertheless, there were some caveats with the large-scale data used for this study. The data reflect testing rates in the community and thus exclude people who have not received a measure of renal function, potentially biasing the data. The study was missing data for the last 3 months of 2020 for PathWest, one of the largest providers in the state; sensitivity analysis suggested this decreased our 2020 prevalence estimate by 0.2 percentage points and is thus responsible for the slight decrease in prevalence seen in 2020 as compared with 2019. uACR tests were missing from one provider, reducing our early-stage CKD estimates. Another provider could only provide results from 2017 onwards. Sensitivity analysis suggests prevalence figures from prior to 2017 are likely to be underestimated and should be treated with caution, but the underlying trend of increasing CKD prevalence over time is accurate. CKD prevalence is known to be much higher among indigenous Australians;[30] however, as indigenous status was not recorded on pathology datasets, we were not able to explore this.

CKD prevalence has been explored a multitude of ways within the literature, with differences in data collection (collection biochemical measures from a sample compared with routine data collection methods), definitions of CKD (multiple tests over 90 days compared with a single test) and differences in populations studied (over a certain age, or of particular cohorts). These differences appear to have a large effect on resulting prevalence estimates, making it difficult to compare nationally or internationally. A robust standard for measuring CKD

prevalence, whether for routine or sample-based data collection, would go a long way to solve these issues.

CONCLUSION

CKD prevalence is increasing, with CKD affecting 5.6% of the Western Australian population in 2020, up from 3.5% of the population in 2010. These findings are likely indicative of wider Australian trends. The findings highlight the significant burden CKD imposes on the Australian population, underscoring the need for targeted public health interventions and policies aimed at addressing the key modifiable risk factors. The study has highlighted populations exhibiting significant increases in CKD prevalence, including those under 60 and those in remote areas, as well as the significant socioeconomic gradient in CKD prevalence. A focus on primary care prevention will likely be the most effective method to reduce CKD prevalence. Further research to investigate the drivers for increasing CKD prevalence is needed. Effective management of risk factors such as diabetes and hypertension through lifestyle adjustments, improved medication adherence and regular monitoring is paramount to effectively control CKD. Through ensuring equitable access to healthcare services, including among those in remote and socioeconomically deprived areas, healthcare systems can effectively alleviate the escalating burden of CKD and enhance the well-being of affected individuals.

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