Changing the chronic kidney disease landscape: The economic benefits of early detection and treatment

Kidney Health Australia

February 2023

Deloitte Access Economics

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Acknowledgements

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This report

Kidney Health Australia commissioned Deloitte Access Economics to prepare a report on the economic cost of chronic kidney disease in Australia in 2021 and the return on investment that could be achieved through early detection and best practice management of CKD. The report was prepared by Deloitte Access Economics throughout 2022 in collaboration with Kidney Health Australia and consultation with ANZDATA, AIHW and members of Kidney Health Australia's PEAK group.

About Deloitte

Deloitte Access Economics is Australia's pre-eminent economics advisory practice and a member of Deloitte's global economics group. For more information, please visit our website: www.deloitte.com/au/deloitte-access-economics.

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About Kidney Health Australia

Kidney Health Australia is the national peak body for kidney health in Australia and a recognised voice for people living with kidney disease. Kidney Health Australia strives to drive awareness and earlier detection of kidney disease to improve outcomes for patients and lessen the burden on the health system. It is dedicated to improving the quality of life and health outcomes for people living with kidney disease, their families, and carers, through the delivery of high impact programs and services. For over 50 years, Kidney Health Australia has worked with the clinical and research community to support treatment and research improvements and innovations to foster a future without kidney disease.

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Glossary

Acronym	Full name
ACEI	Angiotensin-converting enzyme inhibitor
ACR	Albumin/creatinine ratio
AECC	Australian Emergency Care Classification
AIHW	Australian Institute of Health and Welfare
ANZDATA	Australia and New Zealand Dialysis and Transplant Registry
ANZKX	Australian and New Zealand Paired Kidney Exchange
ARB	Angiotensin receptor blocker
AWE	Average weekly earnings
CKD	Chronic kidney disease
CREDENCE	Canagliflozin and Renal Events in Diabetes with Established Nephropathy Clinical Evaluation
CVD	Cardiovascular disease
DALY	Disability adjusted life year
eGFR	Estimated glomerular filtration rate
GDP	Gross domestic product
GP	General practitioner
IHPA	Independent Hospital Pricing Authority
KHA	Kidney Health Australia
MBS	Medicare Benefits Schedule
NHCDC	National Health Costs Data Collection
NPV	Net present value
PBS	Pharmaceutical Benefits Scheme
QALY	Quality adjusted life year
RAS	Renin-angiotensin-system
ROI	Return on investment
RRT	Renal replacement therapy
SHARP	Study of Heart and Renal Protection
VSLY	Value of a statistical life year
YLD	Years of life lost due to living with disability
YLL	Years of life lost due to present death
WPAI	Work Productivity and Activity Impairment

KEY FINDINGS

FROM THIS REPORT

1. More than **2 million Australian adults** were living with chronic kidney disease (CKD) in 2021. This comprised 1.3 million Australians (63.9%) in early-stage CKD, around 710,000 Australians (34.6%) in mid-stage CKD, and **over 31,000 Australians (1.5%) in stage 5 CKD (kidney failure)** undergoing either kidney replacement therapy (dialysis or transplant) or conservative care.

2. The annual cost of CKD was estimated to be **$9.9 billion** in Australia in 2021, equivalent to an average cost per person living with CKD (across all stages) of **nearly $4,800**. This rises to **over $182,000** for those with stage 5 CKD, owing primarily to the high cost associated with kidney replacement therapy.

3. People living with CKD experience a significant loss of wellbeing. It was estimated that **55,931 disability adjusted life years** were lost due to CKD in 2021. These lost years of healthy life had a non-financial value of **$13.2 billion** in 2021 based on the value of a statistical life year.

4. Investment in targeted early detection could yield a net benefit of **$10.2 billion** in stage 5 CKD and cardiovascular disease (CVD) costs over the next 20 years. This is equivalent to a benefit of over $25,000 per person detected, or **approximately $45 for every $1 invested in early detection**.

5. Investment in targeted early detection would generate an estimated **164,956 years of healthy life** by **preventing 38,200 premature deaths and 237,324 CVD hospitalisations** over the next 20 years.

Executive summary.

Chronic kidney disease (CKD) is both a health issue and an economic issue. More than two million Australians were living with CKD in Australia in 2021at a cost of $9.9 billion in that year. Many people living with CKD stage 1-2 are unaware of their condition, and our modelling suggests that investment in early detection could yield a net benefit of $10.2 billion over 20 years, or $509 million per year.

Chronic kidney disease (CKD) refers to all conditions of the kidney affecting the filtration and removal of waste from the blood for three months or more. The National Health Measures Survey, conducted in 2011-12, showed that ***around 1 in 10 Australian adults exhibited biological symptoms of CKD***.[1] The disease was also shown to become more common as individuals age, affecting around 4 out of 10 adults aged over 75.[1]

CKD can be a serious, life limiting disease that affects an individual's health, ability to work, care requirements and overall quality of life.

CKD stage 1-2 often goes undiagnosed since there are no obvious symptoms. Only around six percent of respondents to the National Health Measure Survey (2011-12) who showed biological signs of CKD reported having the disease.[1] This lack of awareness can mean that many cases of CKD are not detected until they have progressed to a more serious, burdensome, and costly stage.

Kidney Health Australia is a vital part of Australia's kidney research and advocacy community. It is committed to raising awareness of CKD and improving early detection to achieve a future without CKD.

In this context, ***Kidney Health Australia engaged Deloitte Access Economics to estimate the social and economic cost of CKD in Australia in 2021 and the return on investment (ROI) in early detection of CKD.*** This also included projecting the incidence of kidney failure to 2030. The results of this analysis are reported in this paper.

Box i: Staging of CKD

CKD stage 1-2 (early-stage): people in early-stage CKD may not know they have CKD as they often feel well and show no symptomology. People with early-stage CKD will have estimated glomerular filtration rate (eGFR) result of more than 60mL/min/1.73m^2 and a urine albumin to creatinine ratio (ACR) of greater than 2.5 mg/mmol for males and greater than 3.5 mg/mmol for females.

CKD stage 3-4 (mid-stage): people are often diagnosed with kidney disease in the mid-stage, with many people still asymptomatic as waste in the body builds and blood pressure rises. People with mid-stage CKD will have eGFR results between 15-59mL/min/1.73m^2 and may also have an increased urine ACR (> 2.5 mg/mmol for males and > 3.5 mg/mmol for females).

CKD stage 5 (kidney failure): even with the best management, kidney disease can sometimes lead to kidney failure. Patients with kidney failure require dialysis (a treatment that performs the functions of healthy kidneys) or a kidney transplant to stay alive. A proportion of people with kidney failure will not receive either dialysis or transplant, instead undergoing conservative care. Throughout this report, kidney failure refers to all three of these groups unless otherwise specified. People with kidney failure will have eGFR results less than 15mL/min/1.73m^2 and may also have an increased urine ACR (> 2.5 mg/mmol for males and >3.5 mg/mmol for females).

A large proportion of the Australian population is living with CKD

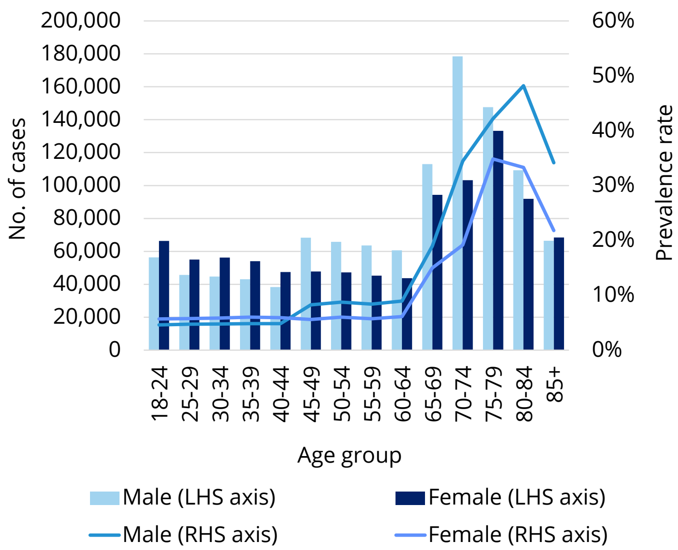
This report estimates that ***over two million Australians (around 10% of the adult population) were living with CKD in 2021***. Most of these cases – around 1.3 million – were in the early stage of the disease, and most of these individuals would not have been aware of their condition. A further 700,000 people were living with mid-stage CKD, while the remaining 30,000 were living with kidney failure.

CKD – particularly in the kidney failure stage – is also associated with substantial mortality. It was estimated that there were nearly 2,200 deaths with kidney failure in 2021. Mortality rates increased with age and were highest amongst males aged 85+.

This does not include deaths for which CKD is a contributing factor– which the AIHW reported to be 17,700 in 2020, of which 4,200 were estimated to be the underlying cause of death.[2]

Chart i shows the prevalence of CKD in 2021, distributed by age and gender. Prevalence rates are shown to be relatively stable from the age of 18 to 64, before a significant increase through the ages up to 84. Males aged 70 to 74 is the age-gender group with the highest overall prevalence, followed by males and females aged 75 to 79.

Chart i: Prevalence of CKD in 2021 by age and gender



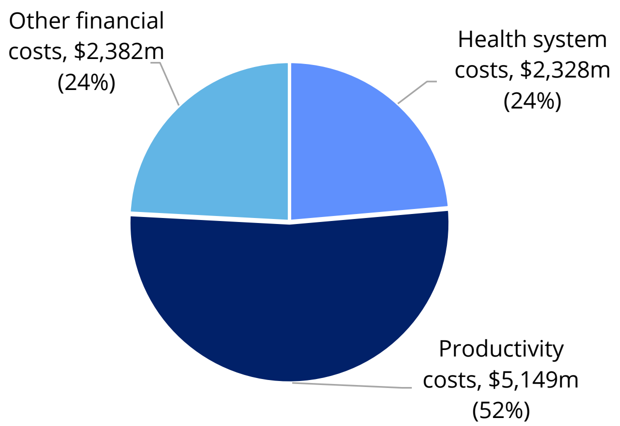
Source: Deloitte Access Economics analysis.

Note: LHS = Left-hand side; RHS = Right-hand side.

CKD creates a significant burden for the Australian economy and for the individual

The total annual cost of CKD was estimated to be $9.9 billion in Australia in 2021. Most of this cost ($5.7 billion or 58%) was attributable to individuals with kidney failure. The remaining cost was attributed to mid-stage ($4.1 billion or 42%) and early-stage ($66 million or 0.7%) CKD.

Chart ii: Economic cost of CKD in 2021 by cost component



Source: Deloitte Access Economics analysis

Chart ii demonstrates the substantial cost that CKD incurs to the health system. Primarily, these were the costs of providing dialysis and kidney transplantation to people with kidney failure. The ***total cost to the health system was estimated to be $2.3 billion in 2021***.

The ability of those living with CKD to participate and be productive in the labour force is also affected. The ***total cost of this lost productivity*** – accounting for reduced employment, increased absenteeism and presenteeism, and foregone future income due to premature mortality – ***was estimated to be $5.1 billion in 2021 (Chart ii)***. The productivity losses were borne by individuals (25%), government (32%) and employers (43%). This is the most expensive component, accounting for 52% of the total cost of CKD.

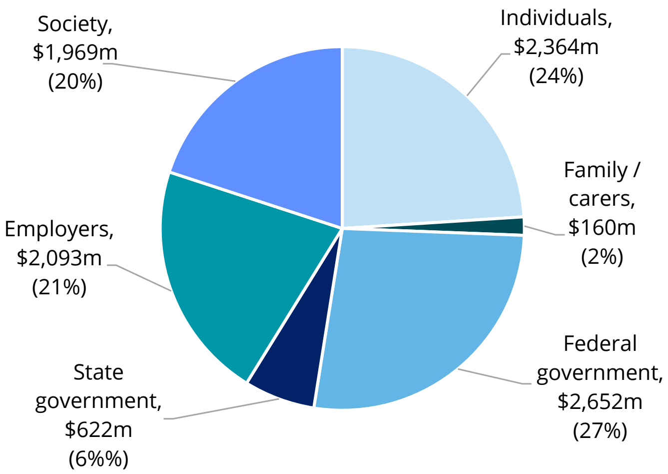
There is also a range of other costs attributable to CKD that are not related to the health system or productivity. This includes the costs arising from management and supportive care, other out-of-pocket items, electricity, water, once-off-training, and deadweight losses. ***The sum of these other financial costs was $2.4 billion in 2021 (Chart ii)***.

Beyond these direct financial and economic costs, CKD also impacts on the quality of life of people living with the disease. ***It was estimated that a total of 55,931 disability adjusted life years (DALYs) were incurred by CKD in 2021. This reduced quality of life can be valued at $13.2 billion in 2021 using the value of a statistical life year.*** The burden of living with CKD is of a similar magnitude to other chronic conditions such as blood and metabolic disorders (66,967 DALYs) and reproductive and maternal conditions (68,803 DALYs).[3]

These costs are borne by different levels of government, employers, society, and the individuals living with CKD themselves. Of the economic costs (health system, productivity and other financial), 27% were borne by the

Federal government (a combination of health system and productivity). State governments bear a further 6% of the costs from health system expenditure. Employers bear the largest share of productivity costs, equivalent to 21% of the total cost of CKD. The remaining 46% was split between society (i.e., taxpayers; 20%), individuals (24%), and family (2%). Meanwhile, 100% of the loss of wellbeing is borne by the individuals.

Chart iii: Economic cost of CKD in 2021 by cost bearer



Source: Deloitte Access Economics analysis.

Substantial value can be realised through investment in early detection of CKD

This report demonstrates that ***there is substantial value in investing in early detection of CKD***. By identifying more cases of CKD at an earlier stage, it is possible to slow or even halt the progression of individuals' disease to costlier, more burdensome stages.

People with increased risk of CKD onset include those with diabetes, cardiovascular disease (CVD), hypertension, family history of CKD, obesity, and smoking. The analysis in this report focused on the benefits that could be realised from earlier detection of CKD and best-practice care of those with diabetes and/or CVD.

Targeted screening and detection of those at high risk of CKD (e.g., patients with comorbidities such as CVD and diabetes) through Kidney Health Checks has the potential to detect many individuals in the early stages of CKD, allowing them the opportunity to receive intervention with best-practice care to stop or slow their disease progression.

Best-practice care for CKD involves a multidisciplinary approach from the healthcare team, including the general practitioner (GP), primary health care nurses, dietitians, and specialists. This will ensure a holistic and comprehensive approach to care is provided to the patient.

The first line management strategy of CKD includes implementing positive lifestyle behaviour changes such as stopping smoking; nutrition in which whole fresh, nutrient dense food predominates and ultra-processed foods and added sugar and salt are avoided; safe levels of alcohol consumption; engagement in physical activity; and sleep and stress management; all of which can have positive effects and are beneficial for CKD outcomes and delay the progression of the disease.

To lower blood pressure and slow the progression of albuminuria, lifestyle changes are recommended (to reduce CVD and progressive CKD risk) often in combination with angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin receptor blockers (ARBs).[4] Statins are also recommended in patients with CKD and an absolute cardiovascular risk of 10% or higher (5% or higher for Aboriginal and Torres Strait Islander peoples).[5] There is substantial evidence to support the use of sodium-glucose cotransporter-2 (SGLT2) inhibitors to slow the decline in eGFR, reduce albuminuria and to slow or reverse the progression of proteinuria.[6]

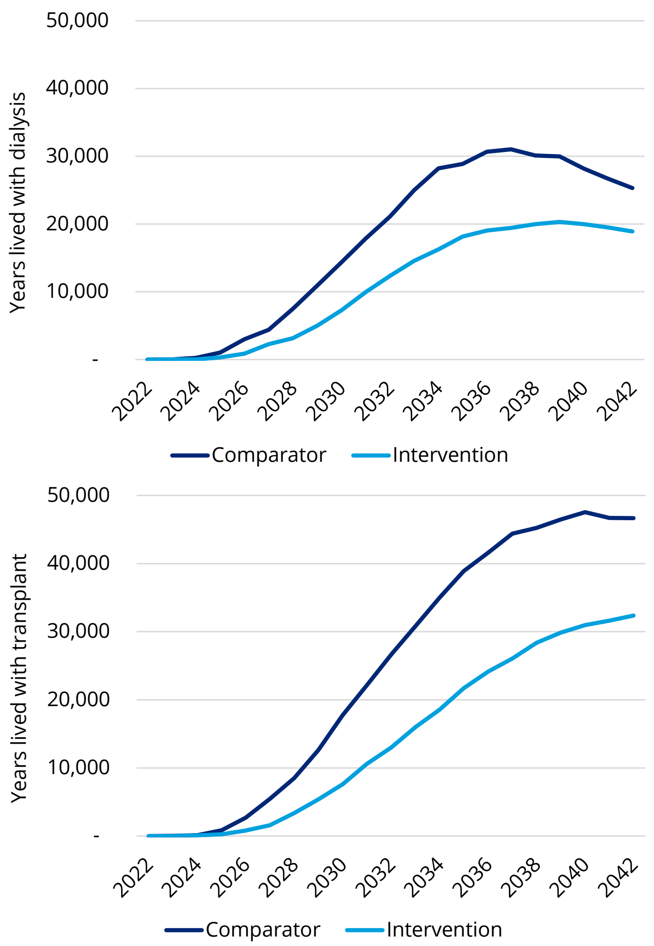
People with mid-stage CKD or kidney failure require an individualised approach to care, to address comorbidities, together with variability in functional status, life expectancy and health proprieties aligned with their care goals.[4]

Changes in an individual's rate of disease progression is considered in terms of their change in eGFR and albuminuria levels.

Benefits of early detection include slowing of CKD disease progression, the decrease in associated CVD events and deaths from kidney failure, reductions in health system costs and gains to the workforce through increased productivity. The costs of early detection include the costs of providing Kidney Health Checks and best practice care at recommended frequencies.

Based on this approach, it was estimated that ***investment in targeted early detection could identify an additional 400,000 cases of CKD.*** There are approximately 860,000 people living with stage 2-4 CKD aged 40-79. Approximately 780,000 of these people are living undiagnosed, and 51% of this population were estimated to have additional risk factors of either diabetes or CVD. This group of approximately 400,000 people with stage 2-4 CKD and either diabetes or CVD represents the cohort most at risk of progression to kidney failure and was therefore taken to be the target population for the screening. ***Early detection and subsequent management of this cohort through best practice treatment was estimated to yield a net benefit of $10.2 billion in kidney failure and CVD costs over the next 20 years.*** This equates to a net benefit of $25,457 per person detected. The cost of implementing screening for early detection was estimated to be $227.8 million.

Chart iv: Person years lived with dialysis (top) and person years lived with transplant (bottom), comparator vs. intervention



Source: Deloitte Access Economics analysis.

Early detection will also significantly improve the quality of life of people living with CKD. Over the 20-year time horizon, 164,956 years of healthy life would be gained, there would be 38,200 fewer premature deaths and 237,324 fewer CVD hospitalisations.

Chart iv highlights the differences in progression to both dialysis and transplant based on a comparator population characterised by limited detection of CKD, and the intervention population where all cases of CKD stage 2-4 are detected early.

As Chart iv highlights, 123,144 years lived with dialysis and 175,524 years lived with transplant would be avoided. The reduction in years lived with transplant and dialysis are greatest several years into the intervention, highlighting the time taken for the target population to reach kidney failure.

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WHY WE SHOULD INVEST IN EARLY DETECTION OF CHRONIC KIDNEY DISEASE

THE ANALYSIS

Deloitte Access Economics developed modelling to consider the return on early, targeted, screening and detection among a population at high risk of chronic kidney disease.

The benefits of early detection including slowing CKD disease progression, decrease in death from kidney failure, and reduction in health system and productivity costs.
Modelled expenses include those associated with detection and provision of best practice care.

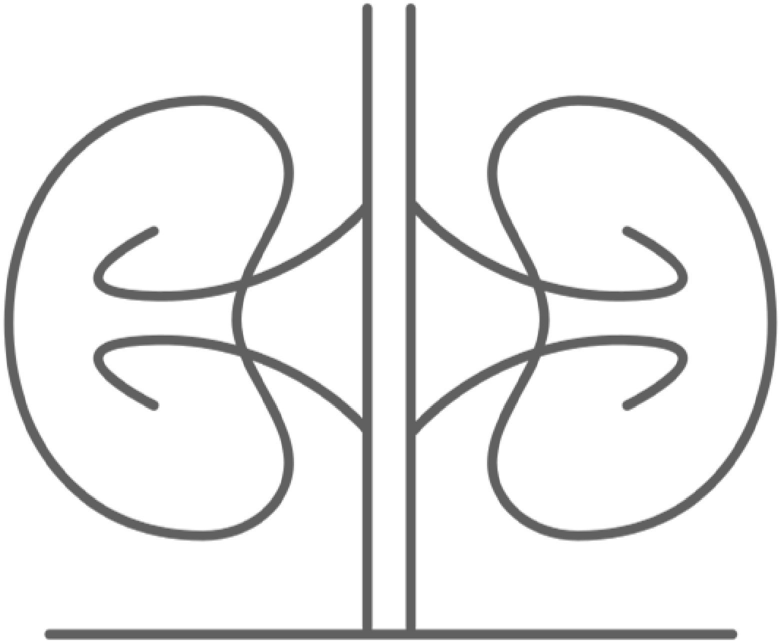
THE MODEL

In a cohort…

Of **400,000** at-risk people

Over a **20-year** time horizon

Average age of the cohort: 55 years
Average eGFR of the cohort: 55mL/min/1.73m²



INVESTMENT YIELDS A NET BENEFIT OF $10.2 BILLION OVER 20 YEARS

BENEFITS ACCRUING OVER 20 YEARS

- **38,200 fewer** premature deaths from kidney failure and CVD
- **237,324 fewer** hospitalisations
- **123,144 fewer** years lived with dialysis
- **175,524 fewer** years lived with transplant
- **$6.9 billion savings** stage 5 CKD costs
- **$3.3 billion savings** cardiovascular event related hospitalisation costs

1 Introduction.

This section presents the project's background and context and outlines the purpose of the report.

1.1 Background

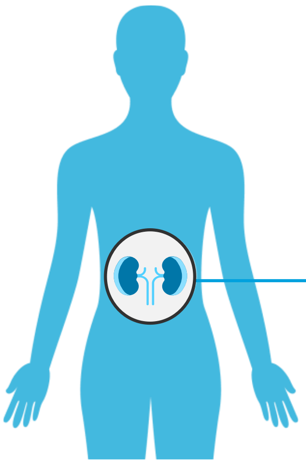
The kidneys are located near the middle of the back, on either side of the spine. Each kidney is made up of approximately one million filtering units called nephrons, which work in a two-step process to firstly filter the blood (through the glomerulus) and then return needed substances to the blood and remove wastes (through the tubule).[7]

The kidneys have five important roles:[8]

1. Clean the blood and circulate a fresh supply around the body 12 times per hour
2. Process excess fluid and unwanted chemicals and waste in the blood resulting in urine which is excreted
3. Regulate blood pressure by expanding and contracting blood vessels in the body
4. Activate Vitamin D into a form that can be used by the body, which is crucial for maintaining strong bones
5. Producing a hormone called erythropoietin that signals to the bone marrow to make red blood cells that deliver oxygen to the body.

Chronic kidney disease (CKD) refers to all conditions of the kidney affecting the filtration and removal of waste from the blood for three months or more. The definition of CKD is summarised in Figure 1.1.[4]

Figure 1.1: Definition of CKD



An estimated or measured glomerular filtration rate (GFR) <60mL/min/$1.73m^2$ that is present for ≥3 months with or without evidence of kidney damage.
OR
Evidence of kidney damage with or without decreased GFR that is present for ≥3 months as evidenced by the following, irrespective of the underlying cause:

- Albuminuria
- Haematuria after exclusion of urological causes
- Structural abnormalities (e.g. on kidney imaging tests)
- Pathological abnormalities (e.g. renal biopsy).

Source: Kidney Health Australia (2020).

1.1.1 Stages of CKD

There are five stages of CKD which can be detected by a Kidney Health Check. A Kidney Health Check is recommended every one to two years for individuals who are at increased risk of CKD. This includes those with diabetes, high blood pressure, obesity, established cardiovascular disease (CVD), a family history of kidney failure, or a history of acute kidney injury, as well as those who smoke, are aged 60 years or older, or are a First Nations Australian aged 18 years or older. A Kidney Heath Check comprises the following three components:

- Blood pressure check: maintain consistently below blood pressure goals.
- Blood test: eGFR calculated from serum creatinine

- Urine test: albumin/creatinine ratio (ACR) to check for albuminuria

Figure 1.2 shows how the five stages of CKD are defined by associated eGFR and albuminuria levels. It also shows the colour-coding associated with each from the CKD Management in Primary Care handbook (which is discussed in detail in Section 1.1.3).[4]

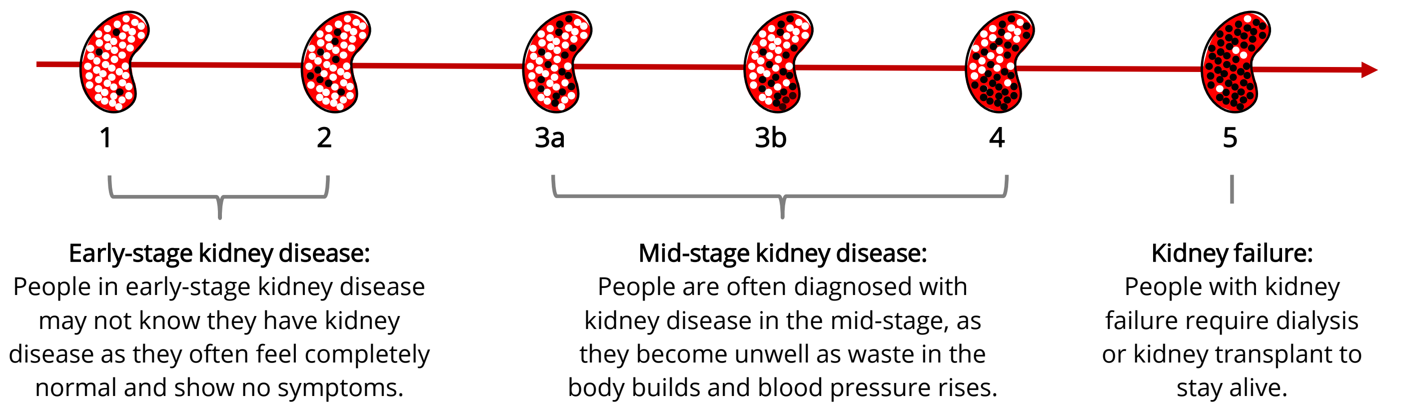
Figure 1.2: CKD functional stages

		Albuminuria stage (urine ACR mg/mmol)		
Kidney function stage	eGFR mL/min/1.73m²	Normal Male: <2.5 Female: <3.5	Microalbuminuria Male: 2.5-25 Female: 3.5-35	Macroalbuminuria Male: >25 Female: >35
1	≥90	No CKD unless haematuria, structural or pathological abnormalities present		
2	60-89			
3a	45-59			
3b	30-44			
4	15-29			
5	<15 or on dialysis			

Source: Deloitte Access Economics using Kidney Health Australia (2020).

CKD is further grouped into categories, comprising CKD stage 1-2 (early-stage), CKD stage 3-4 (mid-stage) and CKD stage 5 (kidney failure) as shown in Figure 1.3. This categorisation of CKD is used throughout this report and in the analysis.

Figure 1.3: Stages of CKD



Source: Deloitte Access Economics using Kidney Health Australia (2020).

1.1.2 Prevalence of CKD in Australia

Most prevalence estimates of CKD in Australia are now outdated. Using national survey data and proxy measures to estimate disease incidence in the absence of linked / registry data, it has been found that 1.7 million (one in ten) Australians aged 18 and over had biomedical signs of CKD in 2011-12.[9] Of these, 97% showed early signs of CKD stages 1-3, with CKD being more common as individuals age, affecting around four out of ten (42%) adults aged 75+. Early-stage CKD is often undiagnosed since there are no obvious symptoms. Only 10% of respondents to the National Health Measure Survey (2011-12) who showed biomedical signs of CKD reported having the disease, indicating that most people are not aware that they have CKD.[9]

1.1.3 Management of CKD

The management of CKD requires a multidisciplinary approach involving general practitioners (GPs), primary health care nurses, dietitians, and specialists to provide holistic and best practice care. The first line management strategy of CKD includes implementing lifestyle changes such as stopping smoking; nutrition in which whole fresh, nutrient dense food predominates and ultra-processed foods and added sugar and salt are avoided; safe levels of alcohol consumption; engagement in physical activity; and sleep and stress management; all of which can have positive effects on CKD outcomes and delay the progression of the disease. The goals and strategies of management across the stages of CKD are designed to provide guidance and clinical tips to help manage an individual's kidney health. An overview of the clinical action plan is shown in Table 1.1.

Table 1.1: Clinical action plan for CKD

Clinical action plan	eGFR ($mL/min/1.73m^2$)	Goals of management	Management strategies
Yellow	≥60 with microalbuminuria or 45-59 with normal albuminuria	• Investigations to determine underlying cause • Reduce progression of CKD • Assessment of absolute cardiovascular risk • Avoidance of nephrotoxic medications or volume depletion	• Frequency of review: every 12 months • Clinical assessment: blood pressure, weight, smoking • Laboratory assessment: urine ACR, eGFR, biochemical profile including urea, creatinine, and electrolytes, HbA1c (for people with diabetes), fasting lipids • Key tasks: Assess CVD risk; blood pressure reduction, treat albuminuria through use of ACE or ARB, lifestyle modification, lipid lowering treatment, glycaemic control, consider use of SGLT2 inhibitor to slow CKD progression, avoid nephrotoxic medications.
Orange	30-59 with microalbuminuria or 30-44 with normal albuminuria	• All goals from yellow category, plus: – Early detection and management of complications – Adjustment of medication doses to levels appropriate for kidney function – Appropriate referral to a Nephrologist when indicated	• Frequency of review: every 3-6 months • Clinical assessment: blood pressure, weight, smoking • Laboratory assessment: urine ACR, eGFR, biochemical profile including urea, creatinine, and electrolytes, HbA1c (for people with diabetes), fasting lipids, full blood count, calcium and phosphate, parathyroid hormone • Key tasks: All tasks from yellow category, plus: appropriate referral to nephrologist when indicated; adjust doses of medications to level appropriate for kidney function
Red	Macroalbuminuria irrespective of eGFR or eGFR <30 irrespective of albuminuria	• All goals from yellow & orange categories, plus: – Prepare for kidney replacement therapy if appropriate – Prepare for non-dialysis supportive care if appropriate	• Frequency of review: every 1-3 months • Clinical assessment: blood pressure, weight, smoking, oedema • Laboratory assessment: urine ACR, eGFR, biochemical profile including urea, creatinine, and electrolytes, HbA1c (for people with diabetes), fasting lipids, full blood count, calcium and phosphate, parathyroid hormone • Key Tasks: All tasks from yellow and orange categories, plus: discuss treatment options for kidney failure with patient; discuss advanced care plans if appropriate.

Source: Deloitte Access Economics using Kidney Health Australia (2020).

1.2 Policy context

Kidney Health Australia, the peak body for kidney health in Australia, was commissioned by the federal government to develop the country's first *National Strategic Action Plan for Kidney Disease (2019)* ("the Action Plan") on behalf of the kidney community. The Action Plan aims to address the significant and growing impact of kidney disease on the health and wellbeing of Australians as well as its economic impact on society.[10] The Action Plan articulates a national vision through 30 actions across three priority areas to address the most pressing needs in kidney disease.

The Action Plan aligns with the Department of Health's *2019 National Strategic Framework for Chronic Conditions* ("the Framework"), with its emphasis on prevention, efficient, effective, and appropriate care and support. The Action Plan reflects the guiding principles of the Framework, to enable the successful prevention and management of kidney disease in Australia. The Framework contributes to achieving the long-term approach to improving the health and wellbeing of all Australians at all stages of life through prevention, as outlined in the Australian Government's *National Preventive Health Strategy 2021-2030* ("the Strategy"). To do this, the Strategy aims to address the wider determinants of health, reduce health inequities and decrease the overall burden of disease.

The Federal Government has also supported several programs and initiatives to help treat or manage problems related to CKD including:[10,11]

- Providing $23 million to the Medical Research Future Fund and the National Health and Medical Research Council for CKD research.
- Working in partnership with New Zealand to set up the Australian and New Zealand Paired Kidney Exchange (ANZKX) Program, which increases access to life-saving kidney transplants.
- Providing $800,000 to Kidney Health Australia to establish a support program for 500 young people aged 15 to 24 who have received a kidney transplant.
- Providing funding to Dialysis Australia to develop and implement specialised home dialysis software (Dialysis Medical Records).
- Funding for the Yarning Kidney Consultations with Aboriginal and Torres Strait Islander health experts, community members, service providers and peak bodies around the country to ensure new guidelines are aligned with community preference and needs.
- Funding for the CARI (Caring for Australians and New Zealanders with Kidney Impairment) Guideline Recommendations for Culturally Safe Kidney Care in First Nations Australians. Aimed at improving the quality of care and outcomes for First Nations Australians with kidney disease by facilitating the development and implementation of trustworthy clinical practice guidelines based on the best available evidence.
- Funding for the development of the National Strategic Action Plan (NSAP) for Kidney Disease. The NSAP provides the blueprint for addressing the most pressing issues around kidney disease in Australia and transforming its care over the next 10 years. This grant was also accompanied by a Public Health and Chronic Disease Program grant of $3.7 million.

Kidney Health Australia

As the national peak body for kidney health in Australia and a recognised voice for people living with kidney disease, Kidney Health Australia strives to drive awareness and earlier detection of kidney disease to improve outcomes for patients and lessen the burden on the health system. We are dedicated to improving the quality of life and health outcomes for people living with kidney diseases, their families, and carers, through the delivery of high impact programs and services. For over 50 years, we have worked with the clinical and research community to support treatment and research improvements and innovations to foster a future without kidney disease.

Our vision: Healthy Kidneys for all Australians.

Our mission: To decrease the incidence of kidney disease and save and improve the lives of Australians affected by kidney disease.

Core values: We care about people; we are aspirational; and we seek impact.

1.3 Previous cost estimation of CKD burden in Australia

There are a select number of studies in the Australian context that have estimated the economic cost of CKD. A previous estimate of the health care cost for providing kidney replacement therapy (KRT) services from 2004 to 2010 was between $4.26 billion and $4.52 billion.[12] This cost excluded providing services to Australians under 25, providing services for co-morbid conditions such as CVD and diabetes, and the indirect or non-health sector costs associated with kidney failure.

Another study estimated that the cumulative cost of treating all current and new cases of kidney failure from 2009 to 2020 to be between $11.3 billion to $12.3 billion in 2010 dollars. The greatest proportion of these costs are attributable to in-centre haemodialysis, incurring more than $1 billion in health care costs annually.[12]

An Australian study has estimated the direct heath care and non-health care costs as well as government subsidies of CKD in Australia.[13] This study found that the health care costs associated with CKD increase progressively as the disease advances. The direct health care costs of early-stage CKD were estimated to be $3,000 per person annually, with costs rising to $15,000 per person annually (excluding the costs of dialysis or transplant) for CKD in stage 4 and 5. The increase in the annual costs per person were found to be driven by increasing rates of hospitalisation as kidney health and function declined over the disease progression.

Haemodialysis and kidney transplantation are the costliest components of CKD care. The annual per person cost of facility-based haemodialysis provision ranges from $80,000 to $120,000.[14] Data from 2010 showed that the cost of kidney transplantation was approximately $80,000 in the first year and $10,000 per year thereafter, with costs increasing with complications.[15]

Many of these costing studies are now over ten years old, and there have since been significant changes to the extent and distribution of CKD in the Australian population and to the diagnosis, treatment, and care pathways for CKD. It is, therefore, unlikely that the previous estimates of the cost and burden of CKD in Australia remain accurate.

1.4 Objective of this report

Kidney Health Australia engaged Deloitte Access Economics to estimate the economic cost of CKD in Australia in 2021 and the return on investment (ROI) in early detection of CKD. This also included projecting the incidence of kidney failure to 2030.

The remainder of the report is structured as followed:

- Section 2 provides an overview of the methodology used to estimate the epidemiology and cost of CKD in Australia in 2021
- Section 3 describes the prevalence, incidence, and mortality of CKD, including the projection of kidney failure to 2030
- Section 4 describes the cost of CKD, including the economic and loss of wellbeing cost of CKD in Australia in 2021
- Section 5 describes the ROI of early detection of CKD in Australia and provides an overview of the current diagnostic and treatment pathway for CKD, and the benefits of early CKD detection.

A technical appendix is included to provide a detailed account of the modelling assumptions and methodology.

2 Methodology.

This section presents the methodological framework and sources used to estimate the prevalence of CKD in the adult population in Australia in 2021 and the associated costs.

2.1 Project scope

This study considers the costs relating to the socioeconomic impact of CKD that occurred in calendar year 2021. It includes the costs incurred during 2021 for people with any stage of CKD. The report focusses on the financial costs of CKD, which directly impact the Australian economy, as well as the lost wellbeing costs, which are a measure of the burden of CKD for individuals living with the condition. While the 2021 calendar year was impacted by the COVID-19 pandemic, the data sources and other inputs used in this report are drawn from earlier years. This means that the estimates presented in this report represents the costs that would have been expected in a year without the influence of the pandemic.

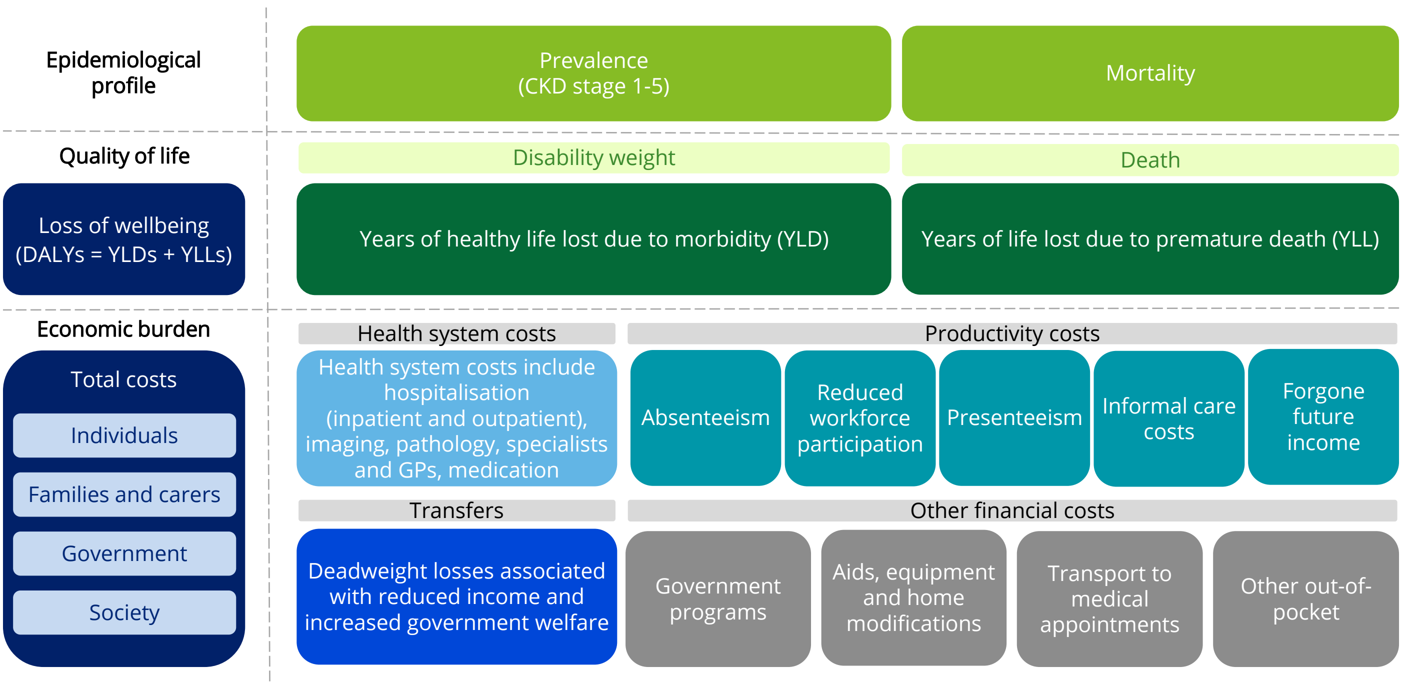
2.2 Summary of methodology

2.2.1 Cost-of-illness methodology

The economic cost of CKD in the adult population in Australia was estimated using a cost-of-illness methodology applying a prevalence approach. This approach involves estimating the number of persons living with CKD (stages 1-5) in the adult population in Australia in a base year (2021) and the costs attributable to CKD in that year. Figure 2.1 provides an overview of the cost-of-illness model framework. The analysis was based on targeted data and literature and the detailed approach to the methodology are described in the following subsections.

Detailed methodology including literature and data sources used are discussed in Appendix A.1.

Figure 2.1: Cost-of-illness model framework overview



Source: Deloitte Access Economics.

The components of the cost-of-illness model framework include:

- The prevalence of CKD, across all stages of the disease.
- Premature mortality attributable to CKD.
- Economic costs including health system costs, productivity costs, other financial costs (such as out-of-pocket costs) and transfer costs.
- Loss of wellbeing (burden of disease) due to years of healthy life lost due to morbidity and years of life lost due to premature death attributable to CKD.

The costs of CKD are borne by individuals, their families, the Government, and society more broadly. The costs incurred by each of these groups has been estimated.

2.2.2 Incidence projection methodology

Incidence refers to the annual number of new cases of kidney failure occurring in a calendar year. The Australian and New Zealand Dialysis and Transplant Registry (ANZDATA) is a clinical quality registry that collects data on incidence, prevalence and outcomes of dialysis and treatment for people with kidney failure.

Incidence projections refer to the estimation of future cases of kidney failure occurring between 2022 and 2030. To estimate the future incidence of kidney failure, an understanding of the historical trends in kidney failure incidence is required. The estimates draw on historical incidence data (2005 to present) from ANZDATA of kidney failure by age, gender, and treatment modality. Two models were used to project the future incidence of kidney failure:

- **Steady state model.** Estimates the future incidence if current age and sex specific incidence rates (based on the most recently available data from ANZDATA) remain constant. Under this model the incidence projections are driven by expected changes in the Australian age/sex population structure.
- **Poisson model**. Considers the existing trend in historical incidence rates based on the previous ten years of data available from ANZDATA. For example, where incidence rates have been increasing over time, future incidence rates are modelled to increase over time in accordance with the historical trend.

Both models are presented within the results to show an indication of the range of possible outcomes. Where incidence rates of kidney failure have been increasing over time, the Poisson model will present a higher estimate than the steady state model.

2.2.3 ROI methodology

ROI modelling aims to estimate the potential return following a financial investment. The purpose of this ROI study was to determine the potential benefits of investing in early detection of CKD (the 'intervention') for an at-risk cohort.

A Markov model (a model used to consider probabilistic outcomes in the future based on the present) was constructed in Microsoft Excel to analyse CKD progression over a 20-year time horizon. The target population included individuals with increased risk of CKD. The analysis models a cohort of 10,000 people with CKD who would otherwise not be diagnosed.

The results of this model were then scaled up to represent the potential benefits that could be achieved if 400,000 people with CKD were detected. The selection of 400,000 people was based on the assumed population with undiagnosed CKD between stages 2-4 and additional risk factors of diabetes or CVD. It was estimated that approximately 1.7 million people with diabetes and/or CVD would need to be screened to identify this population. The modelling evaluated the health system and wellbeing impacts of the 'intervention'. The cohort was on average 55 years of age, with average eGFRs of 55 mL/min/1.73m^2.

The key model drivers were the average annual eGFR decline and the average ACR level over time. Under the intervention model arm, each successfully detected person was diagnosed and provided best practice care to manage and slow progression of CKD. Individuals in the comparator arm of the model remained undiagnosed for CKD until the point in time when they otherwise would have been and subsequently did not have the opportunity for early intervention. It is acknowledged that in practice some of the comparator population would be diagnosed with CKD at an early stage, particularly for those with diabetes where eGFR estimation, urine testing for ACR and BP measurement form part of the care cycle. It is further noted that while the comparator population is assumed to remain undiagnosed for their CKD, they may be receiving treatment for other comorbid conditions which may indirectly slow the progression of CKD. This was accounted for when determining the potential improvement in outcomes that could be achieved through early detection and best practice care.

The model was designed to provide insight into the change in progression of CKD over time and the subsequent impacts on premature mortality, health utility and years lived on dialysis or with transplant due to kidney failure.

Detailed discussion of the ROI methodology is available in Appendix B.

2.2.1 Literature review

A literature scan was conducted to understand the available research on the impact of CKD on the individual, their families and carers and the broader community. These impacts are financial, economic, and intangible in nature and include health system costs, productivity losses, other financial and economic costs (such as costs for home modifications), and loss of wellbeing. Literature and data on prevalence, behaviours and costs were reviewed against an evidence hierarchy, to ensure where possible, high-quality studies were used to inform the methodology.

2.2.2 Stakeholder consultation

Stakeholders from the ANZDATA, Australian Institute of Health and Welfare and Kidney Health Australia were engaged to better understand the data sources available, and potential considerations in estimating the cost of CKD in adults and the approach to the return-on-investment methodology and analysis.

Where literature was not available to inform the inputs required, the approach and assumptions used in the analysis were validated through expert opinion. This included the magnitude of other out-of-pocket costs for stages 3b, 4 and 5 (managed with kidney supportive care) of CKD and the average eGFR decline for the intervention and base case groups to inform the ROI analysis.

3 Prevalence, incidence, and mortality of CKD.

Over 2 million people were living with CKD in Australia in 2021, 31,000 of whom were in the kidney failure stage. It is estimated there will be 3,900 incident cases of people commencing kidney replacement therapy in 2030, up from 3,200 in 2020. CKD was also directly responsible for nearly 2,200 deaths in Australia in 2021 and likely a contributing factor to many more.

3.1 Prevalence of CKD in Australia in 2021

As discussed in Section 1.1.1, CKD is grouped into three broad stages: early-stage, mid-stage, and kidney failure. Prevalence estimates – and, subsequently, cost estimates – are presented in these stages throughout this report.

It was estimated that 2.06 million people were living with CKD in Australia in 2021. The distribution of these cases by stage, age, and gender is provided in Table 3.1. The estimates show that prevalence is higher in males and peaks between the ages of 65 and 84. Age is also a significant predictor of mid-to-late-stage CKD with approximately 90% of these cases occurring in individuals aged 65 or older. Most cases exist at the early disease stage; however, this is also when many people are unaware of their condition. While it is estimated that there are 1.3 million people living with early-stage CKD, it is likely that most of these people are currently asymptomatic and are not diagnosed for CKD.

Approximately 18% of Aboriginal and Torres Strait Islander adults aged 18 and over had biomedical signs of CKD.[16] Aboriginal and Torres Strait Islander adults were more than twice as likely as the general population of adults to have biomedical signs of CKD (22% and 10% respectively) after adjusting for differences in age structure. Compared to the general population, Aboriginal and Torres Strait Islander peoples live with CKD earlier in life and progress faster to kidney failure. The prevalence of CKD is higher for females than males among Aboriginal and Torres Strait Islander peoples,[16] whereas the opposite trend is apparent in the general population (as shown in Table 3.1).

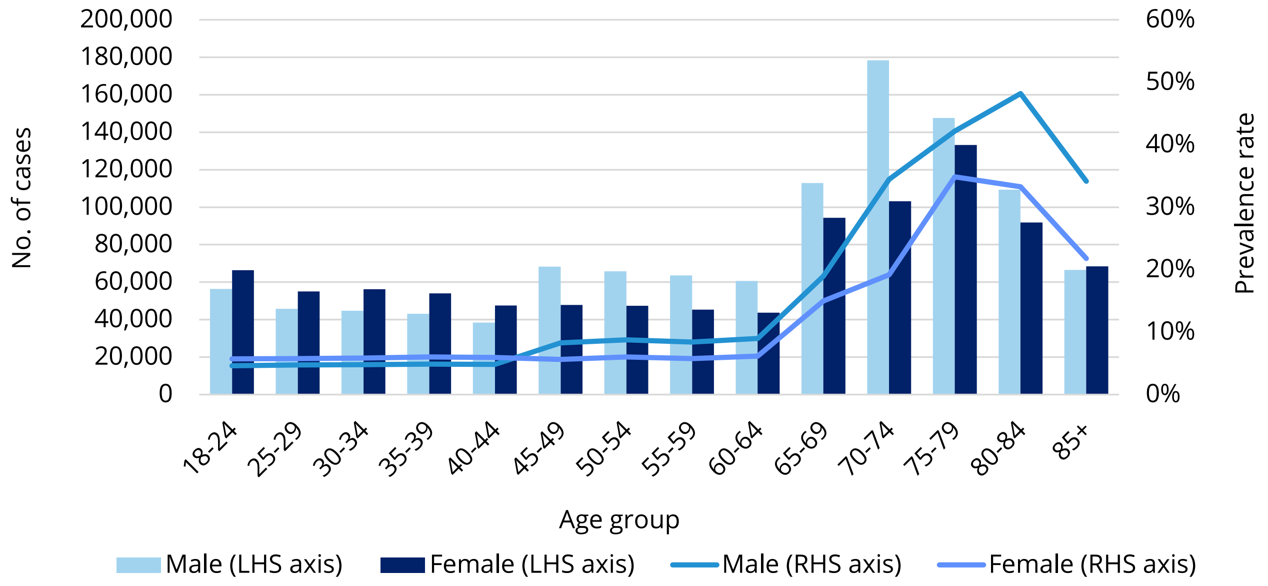
It is noted that the estimates for those aged 18-44 with mid-stage CKD are blank as there are currently no available data on prevalence rates for these groups. While it is expected that some individuals in these groups will have mid-stage CKD, a review of available literature and discussion with stakeholders indicated that this population subgroup is likely to be small. Based on the relationship between mid-stage CKD and kidney failure and early-stage and mid-stage CKD in the 45-54 age group, it is possible that there is a total of approximately 25,000 to 75,000 individuals in this group. No costing has been done on this group due to the uncertainty around its exact size.

Table 3.1: Estimated prevalence of CKD in Australia in 2021 by stage, age, and gender

Age / gender	Early-stage	Mid-stage	Kidney failure	Total
Male				
18-24	56,103	*	307	56,410
25-34	89,714	*	777	90,491
35-44	80,082	*	1,451	81,533
45-54	114,288	16,910	2,916	134,114
55-64	104,234	15,422	4,612	124,268
65-74	145,834	140,239	5,325	291,398
75-84	108,527	145,269	3,169	256,964
85+	29,322	36,561	600	66,483
Male total	*728,103*	*354,400*	*19,156*	*1,101,660*
Female				
18-24	66,157	*	181	66,338
25-34	110,709	*	543	111,252
35-44	100,438	*	1,106	101,544
45-54	81,954	11,200	1,958	95,112
55-64	75,716	10,347	2,959	89,023
65-74	87,421	106,952	3,248	197,621
75-84	52,361	170,988	1,770	225,119
85+	11,384	56,783	300	68,467
Female total	*586,140*	*356,271*	*12,065*	*954,475*
Total	**1,314,244**	**710,671**	**31,221**	**2,056,135**

Source: Deloitte Access Economics analysis based on AIHW data. *While this population has not been estimated due to data limitations, it is acknowledged that there may be between 25,000 and 75,000 people living across the six groups.

Chart 3.1: Prevalence of CKD in 2021 by age and gender



Source: Deloitte Access Economics analysis based on AIHW data.

Note: LHS = Left-hand side; RHS = Right-hand side.

3.2 Incidence of kidney failure from 2021 to 2030

This section presents projections of the incidence of kidney failure from 2021 to 2030. The most recently available data from ANZDATA show that there were 3,259 incident cases in 2020. Previous projections of kidney failure estimated that by 2020 there would be between 3,335 and 4,472 Australians of all ages with kidney failure.[12]

As discussed in Section 2.2.2, two methods were used to make the new projections: a steady-state model and a Poisson model. Both methods use historical data from ANZDATA as a basis for the projections and apply different assumptions on the growth trajectory to produce estimates for future years. Due to these differing assumptions, the two approaches yield substantially different estimates of the incidence of kidney failure. The results for each are presented in Table 3.2.

The projections from the steady state model show that there will be 3,850 new cases of kidney failure in 2030, a considerable increase from the estimated 3,268 new cases in 2021. This represents a nearly 18% increase in the number of annual incident cases over the decade. As the steady state model accounts only for changes in demographics – and not trends in the incidence rate of kidney failure – it is possible that this is an underestimate.

When historical trends in the incidence rate of kidney failure are accounted for, as is done in the Poisson model, the rise in annual incident cases is much more substantial. The Poisson model estimates that there will be 4,760 new cases in 2030, up from 3,348 in 2021. This is a 42% increase in annual incident cases across the decade, much larger than the rise estimated using the steady state model. While the historical trends that underpin this model may not necessarily continue over the coming decade, it does demonstrate the imperative to invest in early detection and treatment of CKD to prevent more people from progressing to kidney failure.

There are also several notable results relating to specific age and gender groups. For example, the Poisson model's projections show that the incidence of kidney failure among younger age groups – both male and female – is expected to rise. In fact, if the trends in historical data for kidney failure continue, it is likely that males aged 25-34 and females aged 25-44 will experience the greatest increase in annual kidney failure cases by 2030 relative to the data in 2020. These two groupings have experienced the most significant growth over time based on historical data, while the total population within these age groups is also expected to grow significantly. This is reflected in the average age of people with kidney failure falling in the Poisson model, from 61.4 years in 2020 to 60.7 years in 2030. The steady state model, however, shows that it may rise slightly to 62.5 years. This reflects that while kidney failure is growing at a faster rate in younger populations, the ageing population within Australia means that there will also be more elderly people living with kidney failure by 2030 than ever before.

The incidence projections presented in Table 3.2 do not account for possible impacts from the COVID-19 pandemic. It is understood that people with CKD are at a higher risk of severe illness or mortality from COVID-19.[17] There may have also been a decrease in incident kidney failure associated with increased mortality in patients with advanced CKD as well as reduced access to care during the pandemic.[18,19] While it is clear that the population with CKD is at a higher risk from COVID-19, the long term implications of this impact on the incidence of kidney failure remain uncertain.

The estimated incidence of kidney failure in 2020 in this report is consistent with previous incidence projections of people commencing dialysis or receiving a transplant in Australia.[12, 1] It should be noted that the projections to 2030 exclude those with kidney failure who elect for a conservative care pathway, as these individuals are not captured in data held by ANZDATA.

[1] The previous report refers to these patients as those on renal replacement therapy (RRT).

Table 3.2: Incidence projections for kidney failure, 2021 to 2030

	Steady state model			Poisson model		
Age / gender	2021	2025	2030	2021	2025	2030
Male						
18-24	28	29	32	29	32	36
25-34	98	104	107	103	138	201
35-44	147	163	177	148	165	189
45-54	306	314	334	318	378	471
55-64	483	495	509	500	587	718
65-74	562	593	645	572	670	816
75-84	415	507	581	411	475	571
85+	68	79	100	70	89	121
Male total	*2,109*	*2,284*	*2,483*	*2,150*	*2,535*	*3,122*
Female						
18-24	16	17	18	16	17	18
25-34	70	74	76	74	95	130
35-44	109	122	134	115	143	187
45-54	182	187	193	186	201	222
55-64	273	282	292	284	332	404
65-74	301	327	360	312	360	433
75-84	185	224	266	187	197	209
85+	23	26	30	24	27	31
Female total	*1,160*	*1,258*	*1,369*	*1,198*	*1,371*	*1,634*
Total	**3,268**	**3,542**	**3,852**	**3,348**	**3,906**	**4,756**

Source: Deloitte Access Economics (2022) based on data from ANZDATA (2022).

Note: These projections exclude individuals with kidney failure who choose a conservative care pathway.

3.3 Deaths from kidney failure in 2021

There were 2,189 deaths from kidney failure in adults aged 18 and over in 2021 according to ANZDATA. Most deaths (89%) were among patients on dialysis, compared to 11% from patients with a kidney transplant. The mortality rate was highest in the 75-84 and 84+ age groups for both male and females. This section presents the mortality estimates for kidney failure in adults aged 18 and over. Table 3.3 presents the estimated breakdown of mortality by age and gender.

It is noted that the figures reported in Table 3.3 may underestimate the total impact of mortality from CKD. The AIHW has estimated that in 2020 there were 17,700 deaths where CKD was a contributing factor. Approximately 24% of these deaths had CKD recorded as the underlying cause of death.[9] CKD may also be under-reported as a cause of death – 53% of people with kidney failure who received KRT and who died between 1997 and 2013 were not recorded as having kidney failure on their death certificate.[20]

Table 3.3: Estimated deaths from kidney failure in Australia in 2021

Age / gender	Mortality rate %	Deaths (dialysis)	Deaths (transplant)	Total deaths
Male				
18-24	1%	3	0	3
25-34	2%	10	2	12
35-44	2%	28	1	29
45-54	4%	103	9	112
55-64	5%	191	34	225
65-74	8%	355	85	440
75-84	13%	388	33	421
85+	26%	152	5	157
Male total	*7%*	*1,230*	*169*	*1,399*
Female				
18-24	1%	2	0	2
25-34	3%	17	1	18
35-44	3%	27	3	30
45-54	4%	66	14	80
55-64	5%	136	18	154
65-74	7%	195	27	222
75-84	12%	202	17	219
85+	22%	63	2	65
Female total	*7%*	*708*	*82*	*790*
Total	**7%**	**1,938**	**251**	**2,189**

Source: Deloitte Access Economics (2022) based on data from ANZDATA (2022).

Note: These values exclude individuals with kidney failure who choose a conservative care pathway.

4 Counting the costs of CKD.

CKD is a serious, life limiting disease that affects an individual's health, ability to work, care requirements, and overall quality of life. We estimate that CKD cost the Australian economy $9.9 billion in 2021, or nearly $5,000 per person living with CKD. This rises to over $182,000 for each person living with kidney failure, demonstrating the value that could be realised through early intervention.

4.1 Economic costs

This report estimated the annual economic cost of CKD in Australia in 2021. The calculated cost includes expenditure on health services; losses arising due to productivity impacts; other financial costs incurred such as medical equipment, home modifications, specific diets; and other out-of-pocket costs.

Table 4.1 provides a summary of the estimated costs of CKD in Australia in 2021. This report estimates the total cost to be $9.9 billion. Productivity costs (including absenteeism, presenteeism, reduced employment and premature mortality) was the costliest component, accounting for just over 52% of the total cost. The overall cost per person living with CKD in 2021 was $4,795, rising to over $182,000 for those with kidney failure. This demonstrates the substantial value that could be achieved through targeted early intervention and best practice treatment to slow or prevent the progression of individuals' disease from early to late stages.

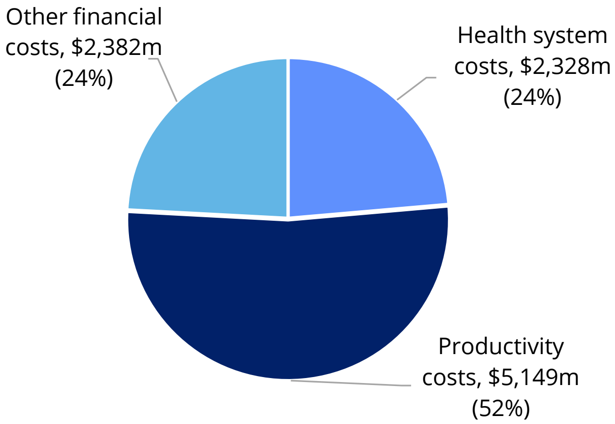
Table 4.1: Summary of economic costs of CKD in Australia in 2021

Cost component	Early-stage	Mid-stage	Kidney failure	Total	% of total
Health system ($ million)	54.2	327.0	1,946.9	2,328.1	23.6%
Productivity ($ million)	-	2,663.1[2]	2,485.7	5,148.8	52.2%
Other financial ($ million)	11.7	1,118.0	1,252.2	2,381.9	24.2%
Total ($ million)	**65.9**	**4,108.1**	**5,684.8**	**9,858.7**	**100.0%**
% of total	**0.7%**	**41.7%**	**57.7%**	**100.0%**	**-**
Cost per person ($)	**50**	**5,781**	**182,084**	**4,795**	**-**

Source: Deloitte Access Economics analysis based on various sources.

[2] The higher productivity costs in mid-stage CKD compared to kidney failure is driven by the higher prevalence cases.

Chart 4.1: Economic costs of CKD in Australia in 2021 by cost component



Source: Deloitte Access Economics analysis.

4.1.2 Health system costs

The health system costs include the following:

- Hospital admission and non-admitted hospital care
- Primary care, including GP, diagnostic tests[3], and medical imaging
- Specialist consultations
- Costs of prescribed and over-the-counter pharmaceuticals
- Allied health services
- Dialysis costs
- Kidney transplant.

Health system costs in Australia are primarily paid for by governments, with individuals and their families contributing through out-of-pocket payments. Private health insurers and other payers (e.g., worker's compensation) also pay for some health services.

Utilisation of services and the proportion of individuals with CKD using the services were estimated by triangulating information from sources including the CKD Management in Primary Care guideline and the literature. [4,5,6] Unit costs for each item were determined via corresponding Medicare Benefits Schedule (MBS) item number,[7] Pharmaceutical Benefits Scheme (PBS) number,[8] and National Health Costs Data Collection (NHCDC).[9]

Where data was limited (non-KRT related hospital admissions, non-admitted hospital care, emergency department (ED), and allied health services), total costs as reported in the AIHW Disease Expenditure in Australia 2018-19 report were assigned to people with CKD based on prevalence (top-down).[10] Key data sources used in the estimating utilisation in each CKD stage

[3] This includes pathology costs.
[4] Kidney Health Australia (2020), Chronic Kidney Disease (CKD) Management in Primary Care, <https://kidney.org.au/uploads/resources/CKD-Management-in-Primary-Care_handbook_2020.1.pdf> access 27 April 2022.
[5] Wyld M et al., (2015) Cost to government and society of chronic kidney disease stage 1–5: a national cohort study, Internal Medicine Journal 45:7, < https://onlinelibrary.wiley.com/doi/10.1111/imj.12797>, access 27 April 2022
[6] Howard, K. et al. (2006) The Cost-Effectiveness of Early Detection and Intervention to Prevent the Progression of Chronic Kidney Disease in Australia. Kidney Health Australia, Melbourne, 2006
[7] MBS Online, <http://www.mbsonline.gov.au/>, access 28 April 2022.
[8] Pharmaceutical Benefits Scheme, <https://www.pbs.gov.au/pbs/home>, access 28 April 2022.
[9] IHPA (2022), National Hospital Cost Data Collection Public Sector, Round 24 (financial year 2019–20)
[10] AIHW (2021), Disease expenditure in Australia 2018-19.

includes the National Chronic Kidney Disease Audit,[11] the Study of Heart and Renal Protection (SHARP),[12] and NHS CKD in England report.[13] Historical costs are inflated to 2021 price using the health price index and Independent Hospital Pricing Authority (IHPA) NHCDC pricing index.[14,15]

Detail on the approach used to estimate each component of the health system costs is provided in Appendix A.2.

The total health system expenditure attributable to CKD in 2021 was estimated to be over $2.3 billion. Hospitalisation (inpatient and outpatient) was the costliest type of health system expenditure, accounting for 73% of the total cost. This cost component, and ED costs, were not estimated for early-stage CKD since most people do not have symptoms at this disease stage. The cost for early-stage CKD accounted for just 2% of the total, while mid-stage accounted for a further 14%. Costs were overwhelmingly concentrated in kidney failure (approximately 84%), reflecting the high cost of providing KRT (dialysis and kidney transplant).

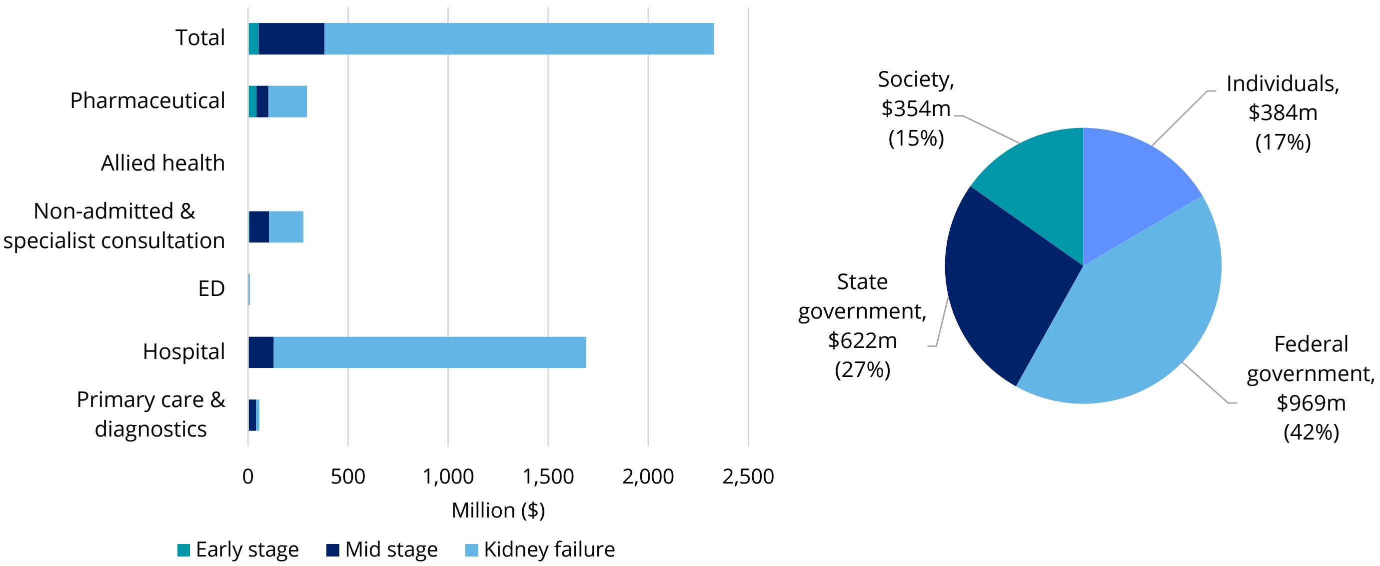
Table 4.2: Annual health system cost of CKD in 2021 by stage

Cost component	Early-stage	Mid-stage	Kidney failure	Total	% of total
GP & diagnostics ($ million)	3.7	36.2	16.5	56.5	2.4%
Hospital ($ million)[16]	-	128.0	1,562.4	1,690.4	72.6%
Emergency department ($ million)	-	4.7	5.1	9.8	0.4%
Non-admitted & specialist consultation ($ million)	7.6	97.7	171.3	276.6	11.9%
Allied health ($ million)	0.1	0.3	0.1	0.5	0.0%
Pharmaceutical ($ million)	42.7	60.1	191.4	294.2	12.6%
Total ($ million)	**54.2**	**327.0**	**1,946.9**	**2,328.1**	**100.0%**
% of total	**2.3%**	**14.0%**	**83.6%**	**100.0%**	**-**
Cost per person ($)	**41**	**460**	**62,358**	**1,132**	**-**

Source: Deloitte Access Economics analysis.

[11] Nitsch, D, Caplin, B, Hull, S and Wheeler, DC (2017) on behalf of the National CKD Audit and Quality Improvement Programme in Primary Care, Part two National CKD Audit Report 2017 < https://www.lshtm.ac.uk/files/ckd_audit_report.pdf>, access 27 April 2022
[12] Kent, S et al., (2015) What is the impact of chronic kidney disease stage and cardiovascular disease on the annual cost of hospital care in moderate-to-severe kidney disease?, BMC Nephrology 16:65, < https://pubmed.ncbi.nlm.nih.gov/25924679/>, access 27 April 2022
[13] NHS Kidney Care (written by Insight Health Economics) (2012) Chronic Kidney Disease in England: The Human and Financial Cost < https://www.england.nhs.uk/improvement-hub/wp-content/uploads/sites/44/2017/11/Chronic-Kidney-Disease-in-England-The-Human-and-Financial-Cost.pdf>, access 27 April 2022
[14] AIHW (2021), Health Expenditure Australia 2019-20.
[15] IHPA (2022) National pricing model technical specifications 2022-23
[16] Hospital costs include costs associated with dialysis (e.g. initial access, revision of access, heamodialysis and peritoneal dialysis) , kidney transplant, and costs for patients admitted with diagnosis code for chronic kidney disease (N18) as reported in the AIHW Disease Expenditure in Australia 2018-19.

Chart 4.2: Health system costs of CKD in 2021 by cost component (left hand side) and payer (right hand side)



Source: Deloitte Access Economics analysis.

The average annual health system expenditure per person with CKD was estimated to be $1,132 in 2021. This rises to over $62,000 annually for those living with kidney failure, up from just $41 at early-stage. The figure for kidney failure can be further disaggregated by looking at different care pathways – the average cost per person receiving dialysis is estimated to be over $76,000. It is noted that other estimates in the literature suggest the cost of dialysis may be as high as $150,000 per person, however the exact values depend on a range of factors such as remoteness.[14] Nonetheless, the significantly higher cost associated with kidney failure demonstrates the substantial opportunity for cost savings if more people can be detected earlier and have their progression towards the later disease stages slowed.

A previous study reported that health system costs per person were $1,829 for those without CKD, $2,719 (early-stage), $3,489 (stage 3), and $14,545 (stage 4-5) in 2012.[13] This 2012 report estimated costs through data collected from 2004/2005 AusDiab participants and did not consider patients receiving KRT but did include health expenditure incurred due to other comorbidities captured in the AusDiab survey. There are several factors contributing to the difference between our report and the previous study:

- The per person costs estimated in this study reflect the average cost for all individuals in their respective stage of CKD, including those who are undiagnosed. The previous study estimated costs for only those who are diagnosed with CKD. The per person health system costs in our study by diagnosed individual results in $914, $6,257, and $62,358 for early-stage, mid-stage, and kidney failure population (inclusive of costs associated with KRT), respectively.
- The estimates of per person health system costs are different than those reported in the previous study as it collected costs through a detailed survey which captured all relevant health related expenditure incurred by people living with CKD and costs associated with living with comorbidities. Our estimate only captures costs relating to people living with CKD, and three major comorbidities: CVD, hypertension, and diabetes.

4.1.3 Productivity costs

CKD can have a significant impact on an individual's ability to engage with and attend work (productivity). CKD may impose a range of productivity costs which affect the individual, their employers and government. These are real costs to the economy.

Five potential sources of productivity losses are:

- **Reduced employment.** Classified as early retirement or workforce withdrawal.
- **Absenteeism.** Where a worker may be unwell more often than average and taking time off work, while remaining in the workforce.
- **Presenteeism.** Where a worker produces less output while at work.

- **Premature mortality.** Where for a person who dies early due to CKD would no longer receive future income streams (in discounted NPV terms).
- **Informal care.** Where support is provided by typically a spouse, friend, or another member of the family.

Detail on the approach used to estimate each of these productivity losses is provided in Appendix Table A.12.

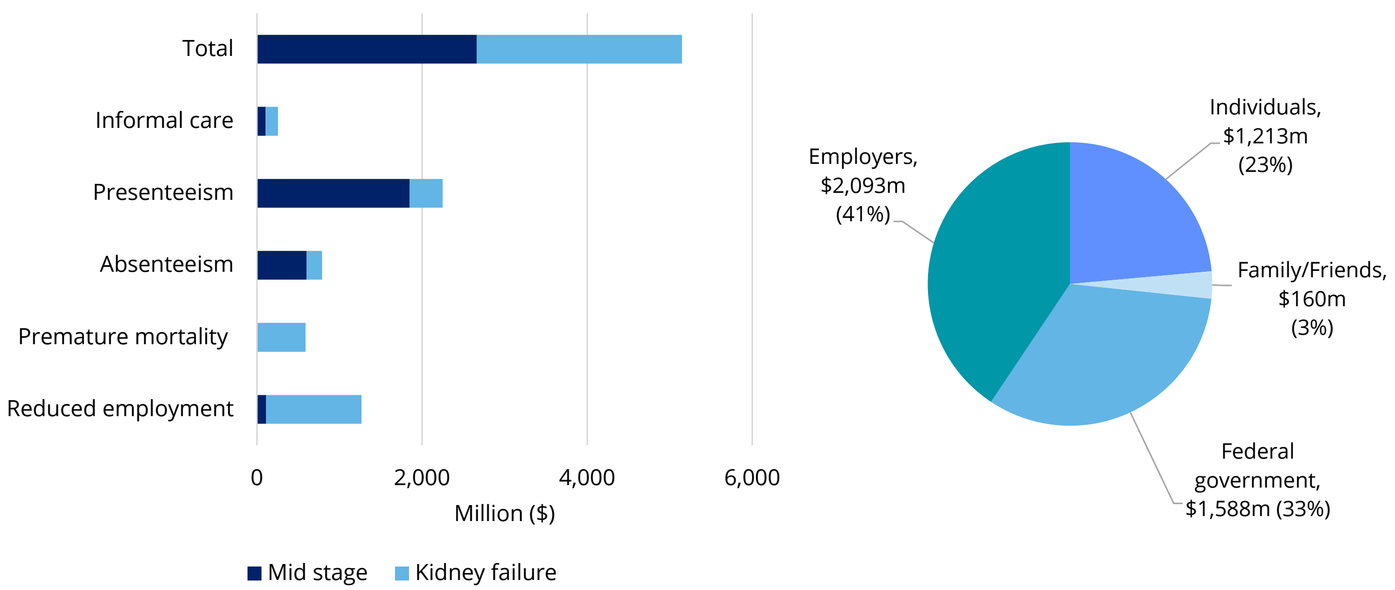
The total cost of productivity losses for CKD was estimated to be $5.1 billion in 2021, or $2,504 per person living with CKD. The largest component of productivity losses was presenteeism for people with mid-stage CKD ($1.8 billion) and reduced employment for people with kidney failure ($1.2 billion). Table 4.3 summarises the total costs of productivity losses attributed to CKD in 2021.

Table 4.3: Summary of productivity costs due to CKD in 2021

Component	Early-stage	Mid-stage	Kidney failure	Total	% of total
Reduced employment ($ million)	0.0	111.1	1,155.6	1,266.7	24.6%
Premature mortality ($ million)	0.0	0.0	588.1	588.1	11.4%
Absenteeism ($ million)	0.0	600.2	187.4	787.6	15.3%
Presenteeism ($ million)	0.0	1,846.8	403.8	2,250.6	43.7%
Informal care ($ million)	0.0	104.9	150.8	255.7	5.0%
Total ($ million)	**0.0**	**2,663.1**	**2,485.7**	**5,148.8**	**100.0%**
% of total	**0.0%**	**51.7%**	**48.3%**	**100.0%**	-
Cost per person ($)	**0**	**3,747**	**79,617**	**2,504**	-

Source: Deloitte Access Economics analysis.

Chart 4.3: Productivity costs of CKD in 2021 by cost component (left hand side) and payer (right hand side)



Source: Deloitte Access Economics analysis.

4.1.4 Other financial costs

There are a range of other financial costs attributable to CKD, including medical equipment, home modifications, specific diets, and other out-of-pocket costs (e.g., transport costs). For people undergoing home dialysis, there are additional costs such as electricity, water, and training costs. Detail on the approach taken to estimate each component of the other financial costs is provided in Appendix Table A.15.

A subset of other financial costs are deadweight losses, defined as a loss of economic efficiency that occurs when equilibrium is not achieved in a market. In the case of CKD, this arises due to the government's need to collect additional tax revenue to fund costs that would otherwise not have been incurred. These costs include the lost consumer, company and informal carer taxes, and Federal and State health expenditure. Detail on the methodology used to estimate deadweight losses are provided in Appendix A.4.2.

The literature covering other financial costs associated with CKD was sparse and, as such, several sources were used to estimate this cost component. No literature has sought to estimate the out-of-pocket costs associated with earlier stages (stage 1-3a) of CKD. This is expected given that the kidneys are still working well, and most people will not show any symptomology in earlier stages of CKD. This was confirmed in a consultation with a nephrologist. As such, other financial costs were not costed for CKD stage 1-3a in the analysis.

Management and supportive care costs (i.e., home and self-care assistance, medical equipment, illness-related home modifications illness-specific diet) were only considered for people undergoing dialysis or transplant, aligned with the approach from another Australia-based study.[21] Other out-of-pocket costs (i.e., costs associated with prescription, non-prescription medications, medical appointments, hospitalisations, medical tests and medically related transport) were considered for all stages of CKD from stage 3b to stage 5. Of note, medically related transport costs were significantly higher for patients with dialysis relative to non-dialysis patients (approximately 50% greater).[21]

People who receive dialysis at home also incur significant utility costs including electricity and water. The annual electricity and water costs for people undergoing home dialysis is estimated from previous analysis undertaken from Kidney Health Australia and inflated to 2021 dollars.[17] Those who are undergoing home dialysis for the first time in 2021, also incur a once-off training cost to be able to manage dialysis safely and accurately in their residence.[22]

The total cost of other financial costs associated with CKD were estimated to be $2.4 billion in 2021, as outlined in Table 4.4.

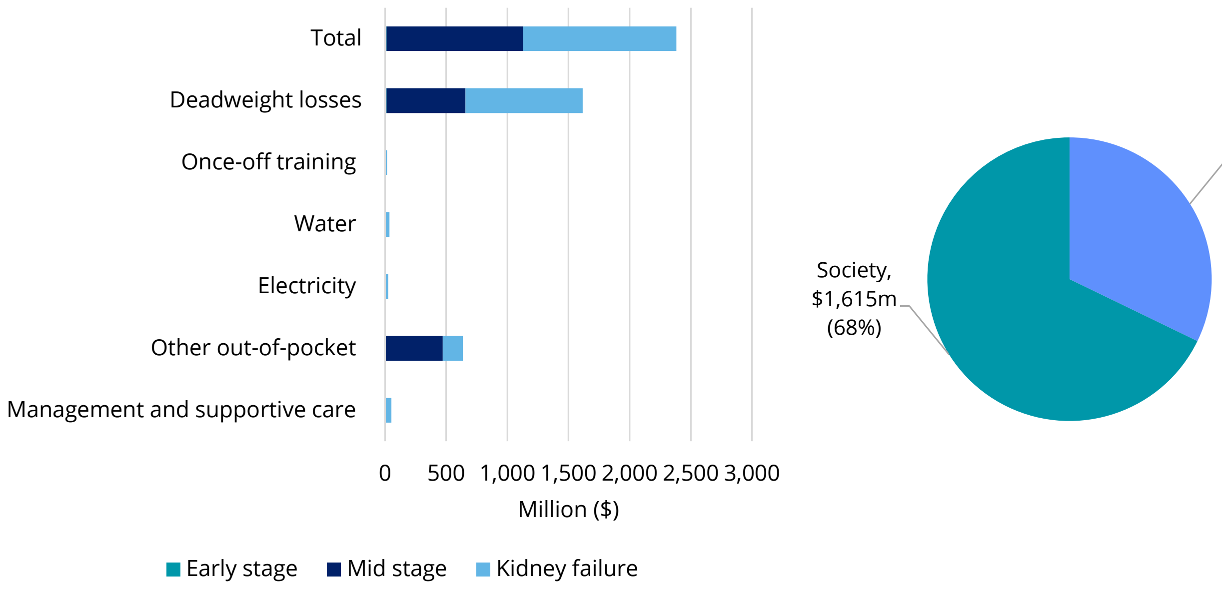
Table 4.4: Other financial costs due to CKD in 2021

Component	Early-stage	Mid-stage	Kidney failure	Total	% of total
Management and supportive care ($ million)	0.0	0.0	51.2	51.2	2.1%
Other out-of-pocket ($ million)	0.0	472.1	164.3	636.3	26.7%
Electricity ($ million)	0.0	0.0	26.8	26.8	1.1%
Water ($ million)	0.0	0.0	35.8	35.8	1.5%
Once-off training ($ million)	0.0	0.0	16.7	16.7	0.7%
Deadweight losses ($ million)[18]	11.7	645.9	957.5	1,615.1	67.8%
Total ($ million)	**11.7**	**1,118.0**	**1,252.2**	**2,381.9**	**100.0%**
% of total	**0.5%**	**46.9%**	**52.6%**	**100.0%**	**-**
Cost per person ($)	**0**	**1,573**	**40,109**	**1,158**	**-**

[17] The source used included a reported range for annual electricity and water costs. The midpoint of the two ranges were used for a conservative estimate.
[18] Deadweight losses are collection of additional tax revenue to fund costs that would otherwise not have been incurred if there was no CKD. Further detail of deadweight losses and how they are calculated in this report are found in Section A.4.

Source: Deloitte Access Economics analysis.

Chart 4.4: Other financial costs of CKD in 2021 by cost component (LHS) and payer (RHS)



Source: Deloitte Access Economics analysis.

4.2 Loss of wellbeing

There is a substantial loss of wellbeing from living with CKD, due to the reduction of quality of life and premature death. This loss of wellbeing is not a financial or monetary cost, but it can be valued using the burden of disease approach.[23]

4.2.1 Valuing life and health

The burden of disease methodology is a non-financial approach to quantifying the loss of wellbeing, where life and health are measured in terms of disability-adjusted life years (DALYs). DALYs combine the years of healthy life lost due to living with a disability (YLD) and the years of life lost due to premature death (YLL). One DALY (the summation of YLD and YLL) is equivalent to one year of healthy life lost.

In the burden of disease methodology, various health states are assigned a disability weight, where zero represents perfect health and one is equivalent to death. Other health states are given a weight between zero and one to reflect the loss of wellbeing from a particular condition relative to perfect health. For example, a disability weight of 0.2 is interpreted as a 20% loss in wellbeing relative to perfect health for the duration of the condition.

DALYs can be converted into a dollar figure using an estimate of the value of a statistical life year (VSLY), an estimate of the value society places on an anonymous life. The Department of Prime Minister and Cabinet (2021) estimated the net VSLY (that is, subtracting financial costs borne by individuals) to be $222,000 in 2021 dollars.[24]

4.2.2 Estimating loss of wellbeing due to CKD

In estimating the total DALYs attributable to CKD, a disability weight of 0, 0.01 and 0.58 were applied to early-, mid- and late-stage CKD.[25] The total DALYs attributable to CKD was estimated to be 55,931 in the CKD adult population in Australia in 2021. The majority of these DALYS were attributable to people with kidney failure (45,802 compared to 10,128 in mid-stage CKD). Converted to a dollar estimate using the VSLY, the total cost associated with this loss of wellbeing was estimated at $13.2 billion. It is important to note that this is a non-financial cost that is not measured within gross domestic product (GDP).

Sources and methodological approach used to estimate loss of wellbeing due to CKD are detailed in Appendix Table A.17.

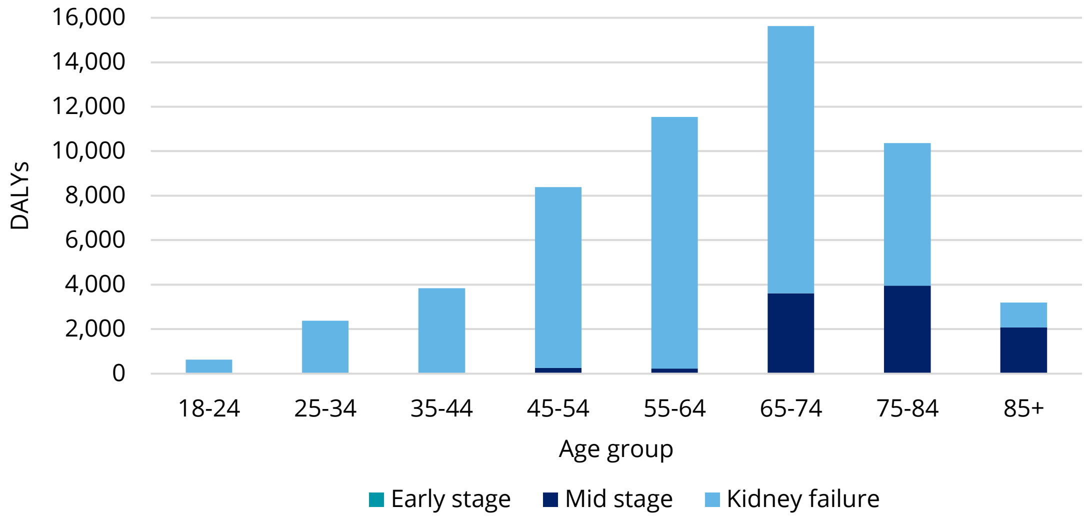
As shown in Table 4.5 and Chart 4.5, there are notable differences in the age distribution of YLLs. This reflects the increasing prevalence of CKD which commences around mid-adulthood.

Table 4.5: DALYs and cost of lost wellbeing due to CKD in 2021 by age, gender, and disease stage

	DALYs				Cost ($ millions)			
Age / gender	Early-stage	Mid-stage	Kidney failure	Total	Early-stage	Mid-stage	Kidney failure	Total
Male								
18-24	-	-	381	**381**	-	-	58.7	**58.7**
25-34	-	-	1,088	**1,088**	-	-	172.3	**172.3**
35-44	-	-	2,025	**2,025**	-	-	349.5	**349.5**
45-54	-	153	4,783	**4,936**	-	34.0	929.6	**963.6**
55-64	-	140	6,782	**6,921**	-	31.0	1,538.7	**1,569.7**
65-74	-	1,603	7,727	**9,331**	-	356.0	2,095.3	**2,451.3**
75-84	-	2,410	4,158	**6,568**	-	535.1	1,321.0	**1,856.1**
85+	-	893	768	**1,662**	-	198.4	286.3	**484.7**
Male total	-	*5,200*	*27,713*	***32,913***	-	*1,154.4*	*6,751.4*	***7,905.8***
Female								
18-24	-	-	241	**241**	-	-	36.1	**36.1**
25-34	-	-	1,289	**1,289**	-	-	178.6	**178.6**
35-44	-	-	1,809	**1,809**	-	-	308.4	**308.4**
45-54	-	101	3,345	**3,446**	-	22.5	648.0	**670.4**
55-64	-	94	4,523	**4,616**	-	20.8	1,027.3	**1,048.0**
65-74	-	2,008	4,286	**6,294**	-	445.9	1,139.4	**1,585.3**
75-84	-	1,547	2,251	**3,798**	-	343.5	707.4	**1,050.8**
85+	-	1,178	348	**1,526**	-	261.5	125.2	**386.7**
Female total	-	*4,928*	*18,090*	***23,018***	-	*1,094.1*	*4,170.3*	***5,264.3***
Person total	**-**	**10,128**	**45,802**	**55,931**	**-**	**2,248.4**	**10,921.7**	**13,170.1**

Source: Deloitte Access Economics analysis.

Chart 4.5: DALYS due to CKD in 2021 by age and disease stage



Source: Deloitte Access Economics analysis.

5 Intervening early to change lives.

Most people living with early-stage CKD are unaware of their condition. Left undiagnosed, these individuals can steadily progress from their relatively asymptomatic disease state to the highly debilitating later stages of CKD. We estimate that total savings of $10.2 billion – or $509 million annually – can be achieved over the next 20 years from investment in early detection of CKD.

This section focuses on the return on investment in targeted early detection of people at increased risk of CKD, particularly those with diabetes and/or CVD. The results presented in this chapter demonstrate that there is significant value to be realised from such investment; by detecting CKD early, initiating best practice treatment, and changing lives.

5.1 The case for early detection

CKD is a commonly undiagnosed condition, particularly during early stages of the disease where most people remain asymptomatic. The 2011-12 Australian Health Survey showed that only 10% of survey respondents with biomedical signs of CKD also reported that they had the condition, indicating that most people are not aware that they have CKD.[1] This presents a significant opportunity to provide targeted screening to individuals at increased risk of CKD.

5.1.1 Population at increased risk

1 in 3 Australian adults is at increased risk of CKD.[26] Individuals with the following risk factors should be offered screening for kidney disease: [27]

- Diabetes
- High blood pressure
- Pre-existing CVD (heart failure, previous heart attack or stroke)
- Current or former smokers
- Family history of kidney failure
- Obesity with a body mass index ≥30 or waist circumference ≥88 for women and ≥102 for men
- Aged 60 years and older or 18 years and older if First Nations Australian
- History of acute kidney injury

The analysis in this study considers targeted, early detection for people at increased risk of CKD, particularly for people with diabetes and/or CVD. Developing either of these significantly increases the risk of subsequently developing comorbid CKD. The presence of comorbid CKD increases the burden of symptoms, the likelihood of hospitalisations, and the rate of premature death.[28] It has been estimated that 29% of Australian adults are affected by CKD, diabetes, or CVD.[29] This equates to approximately 5.2 million people.

It was estimated that investment in early detection of CKD and focussing on people at increased risk of CKD could detect an additional 400,000 people who would otherwise be unaware of their condition. There are approximately 860,000 people living with stage 2-4 CKD aged 40-79. Approximately 780,000 of these people are living undiagnosed, and 51% of this population were estimated to have additional risk factors of either diabetes of CVD. This group of approximately 400,000 people with stage 2-4 CKD and either diabetes or CVD represents the cohort most at risk of fast progression to kidney failure and was therefore taken to be the target population for the screening.

To identify this population, screening of individuals with diabetes and CVD would be necessary. It was estimated that a population of approximately 1.7 million people with increased risk of CKD would need to receive a Kidney Health Check to identify the additional 400,000 cases of CKD.

It is acknowledged that this target population is not the only subset of people requiring early intervention. There are more than 2 million Australians living with early- and mid-stage CKD, the majority of whom remain undiagnosed. Other modelling approaches equally could have been adopted to estimate the benefits of detecting a different subset of this population. For example, the requirement of additional risk factors of diabetes and CVD could be removed to target the 780,000 people with stage 2-4 undiagnosed CKD. This approach was not followed as there would need to be a much broader screening approach to identify this population, which may limit the cost-effectiveness of the intervention.

5.1.2 The opportunity for best practice management and treatment of CKD

The management of CKD is a multidisciplinary approach involving GPs, primary health care nurses, dietitians, specialists, and other healthcare providers to provide holistic and best practice care. The first line management strategy of CKD includes implementing lifestyle changes such as stopping smoking; consuming whole, nutrient dense foods; safe consumption of alcohol; sleep and stress management; and increasing physical activity; all of which can have positive effects on CKD outcomes and delay the progression of the disease.

To lower blood pressure and slow the progression or reduce the degree of albuminuria, lifestyle changes are recommended (to reduce progressive CKD and CVD risk) and treatments available include angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin receptor blockers (ARBs).[4] Statins are also recommended in patients with CKD aged 50 years or older to reduce cardiovascular risk.[4] Prescribing patterns within Australia suggest that these medicines are under prescribed – only 40.8% of patients with CKD aged 50 to 65 years were prescribed statin therapy.[30] There is also substantial evidence to support the use of sodium-glucose cotransporter-2 (SGLT2) inhibitors to slow the decline in eGFR and to slow or reverse the progression of proteinuria.[6]

For patients with mid- to late-stage CKD, an individualised approach to care is required, to address comorbidities, together with variability in functional status, life expectancy and health proprieties aligned with their care goals.[4]

5.2 Changing the trajectory of CKD progression

5.2.1 The benefits of earlier detection

Targeted screening of those at increased risk of CKD provides the opportunity for detection, diagnosis, and intervention with best practice management of the condition (discussed in Section 1.1.3) to slow CKD progression and reduce cardiovascular risk. Early detection of CKD can reduce the number of CVD events, instances of kidney failure and limit premature mortality.

Early treatment is expected to delay progression to late disease stages including kidney failure. The main biometric measurements of disease progression are the patient's eGFR and albuminuria levels. Outcomes for patients with low eGFRs are universally poor and are worsened by increasing albuminuria levels.[31]

5.2.2 The cost of earlier detection

CKD can be detected through regular Kidney Health Checks.[4] A Kidney Health Check comprises of the following three components:

- Blood test: eGFR calculated from serum creatinine
- Urine test: ACR to check for albuminuria
- Blood pressure assessment.

Kidney Health Checks should be conducted annually for individuals with diabetes and / or hypertension. Those with other risk factors (e.g., established CVD, family history of kidney failure, obesity, smoking) are suggested to receive one every two years. An initial Kidney Health Check is recommended for all people aged 60 and over, however further routine testing is not required in the absence of other risk factors. First Nations Australians aged 18 years and over should receive an annual kidney health check as part of Medicare's Aboriginal and Torres Strait Islander peoples health assessment.

The average cost of a Kidney Health Check was estimated to be $109 for the purposes of the modelling. This comprises the costs of blood and urine tests for eGFR (MBS item 66512) and ACR (MBS item 66560) respectively and includes the estimated cost of GP appointments. It is noted that the estimated cost of a kidney health check may vary based on the provider.[32,33,34] The values used to determine the cost of a Kidney Health Check are provided in Table B.1.

5.3 Returns on early detection

This report finds that there is a significant return on investment in early detection of CKD. Such investment could detect an additional 400,000 cases of CKD among people who would otherwise be unaware of their condition. Providing best practice treatment to this cohort is shown to yield substantial benefits over the next 20 years. It was estimated that:

- There would be **38,200 fewer deaths due to kidney failure and CVD-related events**.

- Treatment with transplantation or dialysis is delayed by an average of 5 years, resulting in **123,144 fewer person years lived on dialysis and 175,524 fewer person years living with a transplant**.
- There would be a substantial improvement in wellbeing within the cohort, with the average person gaining 0.41 quality adjusted life years (QALYs) for **a total gain of nearly 165,000 QALYs**.
- This in turn enables the cohort to remain in the workforce for longer, with an estimated **gain of 164,956 productive years of life**.

These benefits translate into significant savings across the health system. Over the next 20 years, health system expenditure on kidney failure would be $6.9 billion lower, and there would be a further saving of $3.3 billion from reduced occurrence of CKD-related CVD hospitalisations. This represents **a total saving of $10.2 billion ($509 million annually) over the 20-year period, or a per person saving of $25,457**. Accounting for the additional expenditure to implement screening and best practice treatment, **the incremental cost effectiveness ratio (ICER) was $14,713/QALY**.

The key findings are summarised in Table 5.1.

Table 5.1: Return on investment in early detection of CKD

Component	Comparator	Intervention	Difference
Premature deaths	145,860	107,660	-38,200
CVD hospitalisations	1,107,256	869,932	-237,324
Years lived with dialysis	348,916	225,772	-123,144
Years lived with transplant	500,564	325,040	-175,524
Dialysis and transplant related expenditure ($ millions)	18,900	12,010	-6,890
CVD related expenditure ($ millions)	14,287	10,994	-3,293
Productive years	3,586,638	3,263,282	+323,356
Total QALYs	3,445,526	3,610,482	+164,956
ICER ($ / QALY)		**14,713**	

Source: Deloitte Access Economics analysis.

Investment in early detection of CKD was modelled to reduce the annual average decline in eGFR from -2.0 mL/min/1.73 m^2 to -1.5 mL/min/1.73 m^2 resulting in a slower average disease trajectory.[19] In addition, early detection was modelled to reduce the average urine ACR within the cohort from a range of 30-300mg/g to a range of 10-30 mg/g. The Kidney Health Australia management guidelines recommend a target reduction in ACR of 50%. Management of an individual's eGFR and uACR levels results in slowed progression to kidney failure and a reduced likelihood of experiencing cardiovascular events. For a person with an initial eGFR of 45 mL/min/1.73 m^2, progression to kidney failure following early detection would take an average of 20 years. Comparatively, without early detection, the person will remain unaware of their CKD for longer, resulting in a faster rate of progression (approximately 15 years on average). With early detection, the individual's risk of experiencing a cardiovascular event is also mitigated. This is a significant improvement in the quality of life of the individual, as this earlier detection could mean that this person avoids additional years lived on dialysis or with a transplant or a hospitalisation due to a cardiovascular event. The progression of CKD over time in the base case and comparator populations is shown in Table 5.2.

[19] Assumption based on evidence presented in section B.1.1. An average eGFR improvement of 25% was agreed upon with the Primary Education Advisory Committee of KHA (PEAK). The starting eGFR decline was assumed to be smaller than those presented in section B.1.1 given the relatively small population samples presented in those trials.

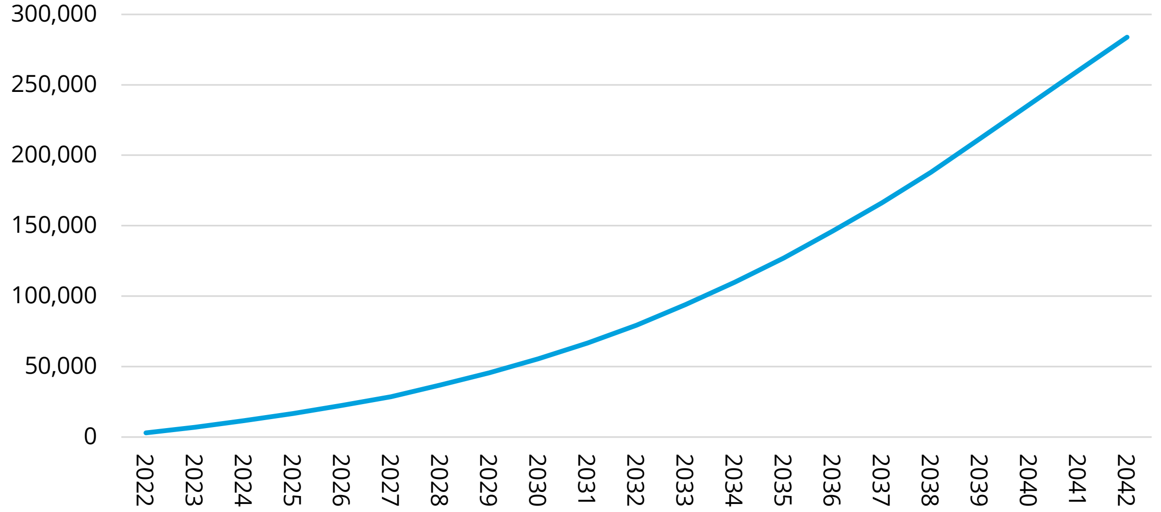
Table 5.2: CKD progression over time, base case, and intervention case (number of people)

CKD stage	2022	2032	2042
Base case			
Stage 1	-	-	-
Stage 2	88,160	30,440	10,400
Stage 3	307,880	169,720	55,640
Stage 4	600	76,640	39,320
Stage 5	-	5,800	6,880
Death	3,360	117,400	287,760
Intervention case			
Stage 1	-	-	-
Stage 2	88,760	41,560	19,360
Stage 3	307,720	197,320	84,240
Stage 4	360	71,000	50,840
Stage 5	-	2,320	4,640
Death	3,160	87,800	240,920

Source: Deloitte Access Economics analysis.

Early targeted detection improves the overall health of the population at risk of CKD. Delayed progression of CKD allows the opportunity for people to remain healthier for longer – allowing the individual to continue with their daily lives. Delayed progression also results in fewer incidents of CVD hospitalisation and the long-term costs associated with stroke, heart disease or heart failure. Early detection also reduces the likelihood that a person will progress to kidney failure, reducing the number of people requiring dialysis or transplantation. The overall utility of the cohort was estimated to improve by 164,956 QALYs over the next 20 years, as shown in Chart 5.1.

Chart 5.1: Cumulative gain in QALYs, intervention cohort relative to comparator cohort



Source: Deloitte Access Economics analysis.

Targeted screening of the at-risk population with a Kidney Health Check and subsequent diagnosis where appropriate was estimated to cost an additional $227.8 million (or approximately $109 per person screened). Health system costs were estimated to increase by $7.7 billion to provide best practice care for individuals with CKD. This is largely due to increased health system costs associated with actively managing CKD and the increased life expectancy within the cohort (meaning that more people are accessing health system services).

When accounting for the improvement in quality of life under the intervention arm, **early detection of CKD was found to be highly cost effective**. When evaluated from an ICER perspective,[20] early detection was expected to cost $14,713 per quality adjusted life year gained. The breakdown of financial costs is provided in Table 5.3.

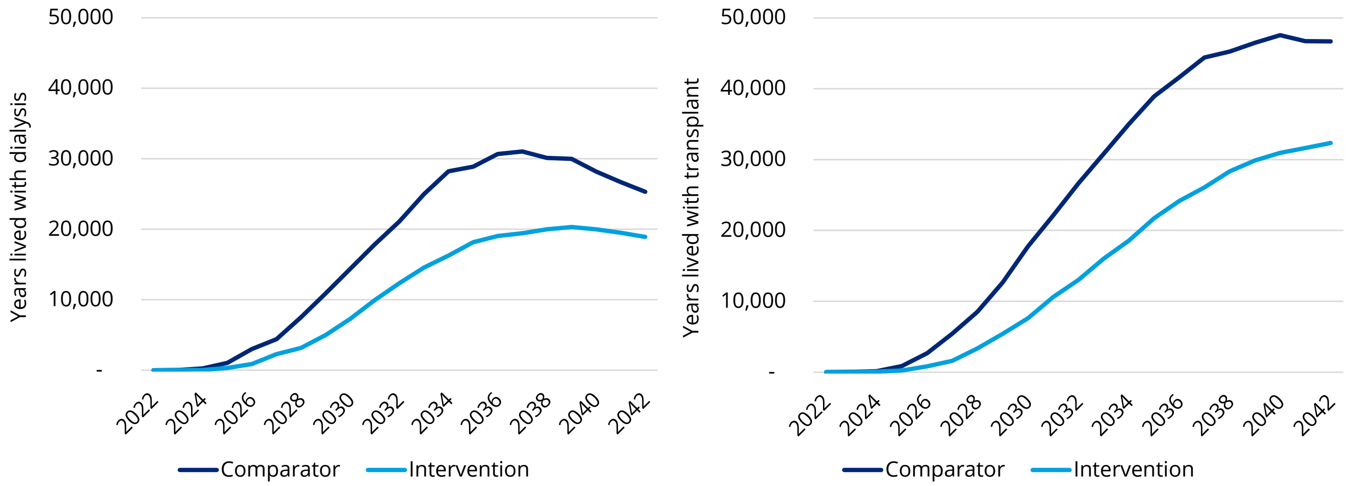
Table 5.3: Financial costs of intervention and comparator cohorts ($ millions)

Component	Comparator	Intervention	Incremental difference
Health system	18,956	26,425	-7,468
Other financial costs	3,357	1,218	2,139
Cost of early detection	0	228	-228
CVD costs	14,294	10,930	3,364
Total cost	**36,608**	**38,801**	**-2,193**

Source: Deloitte Access Economics analysis.

Chart 5.2 shows the years lived requiring dialysis and with a transplant over time. Early detection of CKD was estimated to prevent 123,144 years lived requiring dialysis and 175,524 years lived with a transplant. In the first 5 years of the model there is a relatively small transition to kidney failure in both the comparator and intervention cohorts. This reflects that the average person in the target cohort is unlikely to transition to kidney failure in the short term. However, beyond the first 5 years, the comparator cohort progresses to kidney failure at a faster rate than the intervention cohort, as the comparator population remains undiagnosed and untreated for their CKD. This demonstrates the significant benefits that early detection can derive by delaying the onset of kidney failure amongst a cohort with significant risks for CKD.

Chart 5.2: Years lived with dialysis (left) and years lived with transplant (right)



Source: Deloitte Access Economics analysis.

[20] The incremental cost effectiveness ratio is a measure of the additional expenditure required to yield an additional quality adjusted life year.

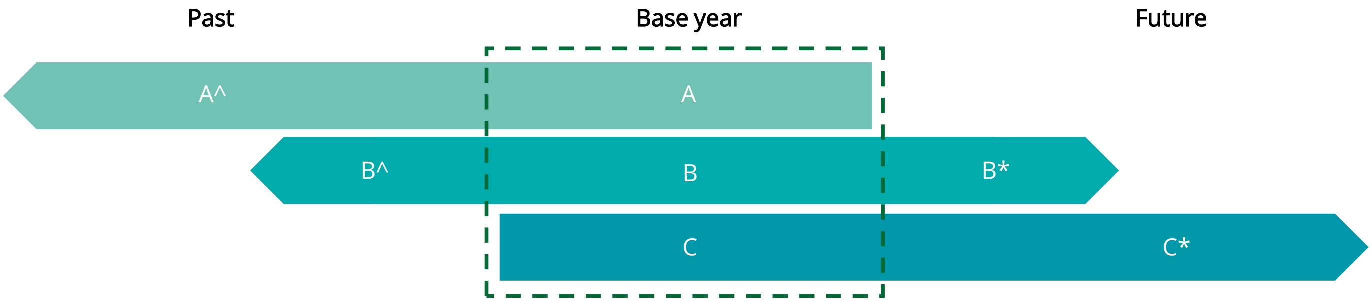
Appendix A: Technical COI appendix

A.1. Time horizons for estimates

The length of time captured in the analysis, known as the time horizon, directly impacts the number of people included in the study. It also has important implications for how impacts are considered, and costs are calculated. Figure A.1 demonstrates the conceptual differences between approaches to measuring the prevalence and costs of CKD. These include:

- People who have CKD in the past and up to the base year, where the associated lifetime costs include A^ and A.
- People who CKD in the base year, the past and in future years, with associated lifetime costs equal to the sum of B^, B and B*.
- People who have CKD in the base year, with lifetime costs equal to the sum of C and C*.

Figure A.1: Conceptual differences between approaches to measuring prevalence



Source: Deloitte Access Economics.

This study is based on case C - people who have CKD in the base year, with lifetime costs equal to the sum of C and C*. It considered the costs associated with CKD that occur in 2021, and future lifetime costs associated with CKD. Costing time horizons vary across cost components. As the horizon grows, there is greater scope for long term outcomes to be confounded by other factors that are not directly associated with CKD. As such, it becomes difficult to precisely estimate the impacts and costs associated with CKD continuing into subsequent years.

A.2. Health system costs

Health system costs for CKD include inpatient hospitalisation, ED admissions, outpatient hospital services (i.e., non-admitted hospital services), primary health care services (e.g., GP, allied health, and pharmaceuticals) and referral medical services (specialists, diagnostic tests, and imaging).

The health system costs described in this report are those borne by the government (both State and Federal) and private health insurance. Out-of-pocket costs associated with receiving or attending health services, which are borne by the individual are captured in the other financial costs component (Section A.4). Where necessary, costs were inflated to 2021 dollars using the health price index and IHPA NHCDC pricing index.[35, 36]

A summary of the estimation approach is provided in Table A.1.

Table A.1: Summary of the health system costs estimation approach

Component	Calculation	Information source	Assumptions
Admitted patient (excluding dialysis)	Apportioned total costs for non-KRT related admissions * admission rate and prevalence in each stage	• AIHW Disease Expenditure in Australia 2018-19 report[37]	• Total hospitalisation cost: $1.05 billion • Total costs across all stages excluding dialysis and transplant: $272 million • Proportion of costs by stage:

Component	Calculation	Information source	Assumptions
		• The National Chronic Kidney Disease Audit[38] • Study of Heart and Renal Protection (SHARP) trial[39] • NHCDC[40]	– Stage 1 and 2 - 0% – Stage 3a - 3.4% – Stage 3b - 13.6% – Stage 4 - 30.2% – Stage 5 (conservative) - 52.9%
Outpatient hospital services	Apportion total costs of outpatient hospital services * reported utilisation and prevalence in each stage	• AIHW Disease Expenditure in Australia 2018-19 report[37] • National CKD Audit Report (Part two)[38]	• Total costs across all stages: $138 million • 50% of the total outpatient expenditure was attributable to CKD stage 3-5 • Proportion of costs by stage: – Stage 1 and 2 - 0% – Stage 3a - 3.4% – Stage 3b - 13.6% – Stage 4 - 30.2% – Stage 5 (conservative) - 52.9%
Emergency department	Apportioned total costs for kidney failure ED * utilisation and prevalence in each stage	• Ronksley et al[40] • AIHW Disease Expenditure in Australia 2018-19 report[37]	• Total costs across all stages: $9.8 million • Proportion of costs by stage: – Stage 1 and 2 - 0% – Stage 3a - 6.1% – Stage 3b - 14.5% – Stage 4 - 27.7% – Stage 5 (conservative) - 26.7% – Stage 5 (dialysis) - 25.0%
General practice, diagnostic tests, and imaging	Utilisation of service per year * unit costs * proportion of people using service * prevalence	• CKD Management in Primary Care[4] • Australian Health Survey 2012[1] • Khanam et al[41]	• GP and diagnostic services per year: – Stage 1, 2, and 3a - 1 – Stage 3b - 2 – Stage 4 and 5 – 4 • Proportion of people using diagnostic services: – Stage 1and 2 - 1.5% – Stage 3a - 5% – Stage 3b - 25% – Stage 4 and 5 - 100% • Proportion of people using GP services: – Stage 1 and 2 - 6.1% – Stage 3a - 20% – Stage 3b-5 - 100%
Dialysis and transplant	Utilisation of service * unit cost * prevalence	• Howard et al.[42] • Medicare Benefits Schedule (MBS)[43] • Pharmaceutical Benefits Scheme (PBS)[44]	• Dialysis costs per annum: – Hospital HD: $106,372 – Home HD: $30,001 – Satellite HD: $44,626 – Peritoneal dialysis: $29,967 • Revision of access (surgery, angioplasty): $2,049 • Outpatient specialist consultation: $955

Component	Calculation	Information source	Assumptions
		• National Health Costs Data Collection (NHCDC)[40]	• Drug costs: $6,390 • Non-admitted hospital for peritoneal dialysis: $320
Specialist consultations	Utilisation of service x unit cost * prevalence of comorbidities	• Medicare Benefits Schedule (MBS)[45] • Prevalence of CKD patients with comorbidities (e.g., CVD, diabetes, and hypertension).[42,46,47] • CKD Management in Primary Care[4]	• Cost per visit: $113 • Stage 3b-5 (conservative) visit nephrologist quarterly • Diabetic and hypertension individuals visit cardiologist, endocrinologist, and ophthalmologist once a year
Pharmaceutical	Medication * unit cost * prevalence	• Pharmaceutical Benefits Scheme (PBS)[48] • Howard et al.[15,42]	• Cost per year – Insulin: $2,161 – Gliclazide: $131 – Metformin: $137 – Atenolol: $165 – Perindopril: $185 – Perindopril/indapamide: $195 – ARB: $251 – Statin/ezetimibe: $307 – Epoetin alfe: $7,591 – Darbepoetin: $2,755 – Iron: $78 – Calcitrol: $103
Allied health	Apportion total costs for kidney failure ED by prevalence	• AIHW Disease Expenditure in Australia 2018-19 report[37]	• Total costs: $528,320 • Assume costs only incurred for Stage 3a-5.

Source: Deloitte Access Economics analysis.

A.2.2. CKD-related hospital admission

There were an estimated 1.8 million hospitalisations where CKD was recorded as the principal and/or additional diagnosis in 2017-18.[49] Dialysis accounted for 79% of these hospitalisations (1.42 million admissions), and non-dialysis accounted for 367,010 admissions. Hospital admission costs in each CKD stage were estimated as described in Section A.2.3.

A.2.3. Hospital admission (excluding dialysis and kidney transplant)

Total CKD hospital admission expenditure was estimated to be $1.05 billion in 2018-19.[37] Costs of dialysis and transplant accounted for 81.7% of admitted hospitalisations.[50] Hospitalisation costs not related to dialysis and transplant were estimated to be $272 million.[37] Hospital admission costs relating to dialysis and transplant were determined separately (detailed in Section A.2.4 and Section A.2.5).

There are no Australian studies regarding the hospital admission rate for each CKD stage. Therefore, two international studies detailing the average utilisation per person were used to apportion the hospitalisation costs to each stage of CKD (detailed in Table A.1 in the admitted patient row).[38, 39] The CKD hospital admissions costs (excluding dialysis and transplant) are shown in Table A.2.

Table A.2: CKD hospital admission costs (excluding dialysis and transplant)

Stage	Total costs ($)
3a	9,176,121
3b	36,704,483
4	82,105,299
5 (conservative)	143,511,897

Source: Deloitte Access Economics analysis.

A.2.4. Dialysis

Dialysis costs are estimated through DRG codes (L61Z and L68Z), which were used to derive unit costs for hospital haemodialysis and peritoneal dialysis, respectively. The unit costs for hospital haemodialysis and peritoneal dialysis were $641 per session and $8,864 per month respectively.[40] Satellite haemodialysis, home haemodialysis, and peritoneal dialysis costs were obtained from the NHCDC cost for Tier 2 10.10,10.15, and 10.16, respectively.[40] Unit costs for satellite haemodialysis was $269 per session, and $2,364, and $2,497 per month for home haemodialysis and peritoneal dialysis. Weighted average of utilisation frequency per year was sourced from ANZDATA.[51] Utilisation and costs associated with procedures and drugs for managing dialyses, including procedures for initial access, revision of access (surgery and angioplasty), and medications were sourced from literature.[15,42,13] The costs for each mode of dialysis are presented in Table A.3.

Table A.3: Annual costs of dialysis per person

Component	Hospital haemodialysis	Satellite haemodialysis	Home haemodialysis	Peritoneal dialysis
Initial access	$12,752	$12,752	$12,752	$11,206
Annual ongoing costs per person (incl. specialists consultations, medications, hospital admissions)	$116,036	$54,289	$39,665	$48,286
Number of people require initial access	767	1,994	307	1,184
Number of people on dialysis	3,012	7,832	1,205	2,468
Total costs	**$358,502,794**	**$448,513,992**	**$51,381,801**	**$131,773,166**

Source: Deloitte Access Economics analysis.

A.2.5. Transplant

Kidney transplant costs were estimated by identifying unit costs for transplant recipients and donors obtained from the NHCDC total cost for AR-DRG L10B, and L04A/B, respectively (Table A.4).[40] Costs associated with procedures and drugs for managing transplants, including specialist consultations, and immunosuppressive medications were sourced from literature.[15,42,13] The unit costs for transplant and total population costs are presented in Table A.4.

Table A.4: Annual costs of transplant per person

Component	Unit cost ($)
Recipient	48,074
Live donor	20,243
Deceased donor	4,241
Year 1 drug costs	20,505

Component	Unit cost ($)
Year 1 management costs (e.g., specialist consultations, biopsies, stents)	6,703
Ongoing drug costs	6,630
Ongoing management costs years (including specialist consultations, and dermatology procedures)	970
Total costs	**175,869,840**

Source: Deloitte Access Economics analysis.

A.2.6. Hospital outpatient and specialist consultations

In 2018-19, the total cost of CKD hospital outpatient was estimated at $138 million.[37] In the absence of an Australian study informing outpatient costs attributable to CKD, it was assumed that 50% of the total outpatient expenditure was attributable to CKD stage 3-5.[38] Therefore, it is assumed that 50% of the $138 million is attributable to CKD stage 3-5 patients. This study assumes that the outpatient utilisation is like hospital admissions described in Section A.2.3.

Specialist consultation costs are estimated through utilisation of services per annum and their corresponding unit costs. Costs of consultation are based on costs for MBS items 110 and 104 for visits to nephrologists, endocrinologists, cardiologists, and ophthalmologists. Costs for both items were average (weighted by the count of services in 2021),[52] at $113 per visit. The utilisation of services is based on primary care for kidney disease guidelines and studies on the prevalence of CKD patients with comorbidities (e.g., CVD, diabetes, and hypertension).[4,42,46,47] The total costs for hospital outpatient and specialist consultations are presented in Table A.5 and Table A.6.

Table A.5: Annual costs of hospital outpatient consultation

Stage	Total costs ($)
3a	4,670,929
3b	18,683,715
4	41,794,132
5 (conservative)	8,774,381
5 (dialysis)	68,745,336
5 (transplant year 1)	1,965,461
5 (transplant ongoing)	28,344,760

Source: Deloitte Access Economics analysis.

Table A.6: Costs of specialist consultations

Stage	Comorbidities	Proportion of CKD	Costs ($)
1	Diabetes	0.208	2,079,828
	Hypertension	0.048	
	CVD	0.032	
2	Diabetes	0.183	1,708,207
	Hypertension	0.079	
	CVD	0.096	
3a	Diabetes	0.120	2,868,384

Stage	Comorbidities	Proportion of CKD	Costs ($)
	Hypertension	0.148	
	CVD	0.250	
3b	Diabetes	0.120	1,432,392
	Hypertension	0.1476	
	CVD	0.2504	
4	Diabetes	0.250	2,645,106
	Hypertension	0.148	
	CVD	0.250	
5	Diabetes	0.437	474,623
	Hypertension	0.148	
	CVD	0.250	

Source: Deloitte Access Economics analysis.

A.2.7. Emergency department presentation

Total expenditure on CKD hospital outpatient was estimated to be $9.8 million in 2018-19.[37] A population-based study found the annual ED presentation counts for stage 3a, 3b, 4, 5, and KRT patients to be 3.8, 9.0, 17.20, 16.60, and 15.50 per person, respectively.[53,40] Utilisation per person reported in the study was used to apportion the ED costs to each stage of CKD. The total costs for ED are presented in Table A.7.

Table A.7: Costs of emergency department presentation

Stage	Total costs ($)
Stage 3a	601,134
Stage 3b	1,423,739
Stage 4	2,720,923
Stage 5 (conservative)	589,531
Stage 5 (dialysis)	2,451,995
Stage 5 (transplant year 1)	132,055
Stage 5 (transplant ongoing)	1,904,421

Source: Deloitte Access Economics analysis.

A.2.8. GP, pathology, and medical imaging

CKD is highly under-diagnosed, especially in stages 1 and 2. The Australian Health Survey (2011-12) reported that only 6.1% of individuals with CKD are aware of their condition.[1] This study assumed that only 6.1% of stage 1 and stage 2 patients are consulting GPs to manage their condition. It is possible that this is a conservative assumption as some individuals may be seeing GPs for management of comorbid conditions and risk factors such as diabetes. However, it is unclear what proportion of people this may be and so a conservative assumption was preferred. Research found only 20% of stage 3 patients had GP documentation of a diagnosed CKD.[41] It is assumed that only 20% of stage 3a individuals utilise CKD related GP services (due to unnoticeable symptoms). Study also showed that only 25% of diagnosed stage 3 CKD patients would complete monitoring (defined as having at least one documented assessment for each of the parameters of blood pressure, urine ACR, eGFR and serum lipids).[41] This study assumed that 25% of diagnosed stage 1-3a CKD patients completed their pathology tests.

The utilisation of GP services and pathology are based on primary care for kidney disease guideline.[4] Costs per GP visit is based on MBS item 23 at $39 per consultation. Pathology tests include urine ACR, eGFR, measurement of creatinine, urea, electrolyte, HbA1C, fasting lipids, and full blood count. Renal ultrasound is performed once per annum as part of the CKD management process in stage 1-4. The utilisation, unit costs, and total costs of GP, diagnostic tests and medical imaging are presented in Table A.8.

Table A.8: Annual utilisation and costs of GP, diagnostic tests, and medical imaging

Diagnosis & GP visits	MBS Fee	MBS item number	Stage 1	Stage 2	Stage 3a	Stage 3b	Stage 4	Stage 5 (conservative)	Stage 5 (dialysis)	Stage 5 (transplant year 1)	Stage 5 (transplant ongoing)
Urine ACR	$20.35	73844	1	1	1	2	4	4	4	4	4
eGFR	$9.70	66500	1	1	1	2	4	4	4	4	4
Creatinine, urea, electrolyte	$17.70	66512			1	2	4	4	4	4	4
HbA1C	$16.80	73839			1	2	4	4	4	4	4
Fasting lipids	$11.65	66503			1	2	4	4	4	4	4
Full blood count	$16.95	65070			1	2	4	4	4	4	4
Renal ultrasound	$113.95	55036	1	1	1	1	1				
GP visits	$39.10	23	1	1	1	2	4	4	4	4	4
Total costs			**$2,192,304**	**$1,544,567**	**$6,693,777**	**$12,950,980**	**$16,565,695**	**$1,983,750**	**$7,679,493**	**$444,360**	**$6,408,306**

Source: Deloitte Access Economics analysis.

A.2.9. Pharmaceutical

Pharmaceutical costs include the costs of drugs prescribed to manage CKD patients' comorbidities (i.e., diabetes, hypertension, and CVD). Treatment regimens are based on previous reports.[42,15] Costs are determined using the latest PBS costs, including insulin, metformin, gliclazide, ACE inhibitor, ARB, diuretic, and statin/ezetimibe. Medication costs for dialysis and transplant include iron, calcitriol, erythropoietin stimulating agents (ESA), immunosuppressive drugs (Tacrolimus, MMF, Prednisone), prophylactic drugs (trimethoprim/sulfamethoxazole; valganciclovir) and proton pump inhibitors.[15,42] The annual drug costs for managing comorbidities and total costs are presented in Table A.9 and Table A.10.

Table A.9: Annual drug costs per person

Comorbidities	Annual costs ($)
Hypertension	447
Diabetes	358
CVD	306

Source: Deloitte Access Economics analysis.

Table A.10: Pharmaceutical costs for managing CKD

Stage	Total costs ($)
1	20,154,019
2	22,554,578
3a	42,874,645
3b	9,948,367
4	7,269,520
5 (conservative)	1,121,504
5 (dialysis)	17,224,122
5 (transplant)	80,317,430
5 (transplant ongoing)	20,154,019

Source: Deloitte Access Economics analysis.

A.2.10. Allied health

Costs of allied health services used by people with CKD were derived from the AIHW Disease Expenditure in Australia 2018-19 report.[37]

Costs of allied health are estimated through a top-down approach, from the AIHW Disease Expenditure in Australia 2018-19 report. In 2018-19, total allied health costs were estimated at $490,555. Costs are allocated to stage 3-5 of CKD based on the prevalence, assuming that stage 3-5 patients are the main users of allied health. The total costs for allied health are presented in Table A.11.

Table A.11: Allied health costs for managing CKD

Stage	Total costs ($)
3a	152,865
3b	137,835
4	86,636

Stage	Total costs ($)
5 (conservative)	18,135
5 (dialysis)	70,204
5 (transplant)	4,062
5 (transplant ongoing)	58,583

Source: Deloitte Access Economics analysis.

A.3. Productivity costs

A human capital approach was adopted to estimate productivity losses. This involves the calculation of the difference in employment or production of survivors of CKD compared to that of the general population, multiplied by average weekly earnings (AWE). Productivity losses from premature mortality are estimated in terms of the net present value (NPV) of the foregone stream of future income.

Mid-to-late-stage CKD can have a significant impact on an individual's productivity. It is noted that there was no evidence of productivity impacts for stages 1-2 of CKD. This is because CKD is largely asymptomatic during early stages of the condition and as such does is not likely to affect a person's productivity to a measurable degree. For this reason, this section does not refer to productivity impacts from early-stage CKD.

Table A.12: Calculation method and data sources for productivity losses

Component	Calculation	Source	Assumptions
Reduced employment	Hazard ratio for early workforce withdrawal * general population unemployment rate	• Klarenbach et al (2002) • Savira et al (2020)	• This analysis used hazard ratios to determine the likelihood of early labour force withdrawal. • For stage 4 CKD a hazard ratio of 5.4 was used, and a hazard ratio of 7.9 for kidney failure. • Hazard ratios are a measure of increased risk. A hazard ratio of 1 would indicate that the chance of early labour force withdrawal in the CKD population is equal to the probability of labour force withdrawal in the general population. • A hazard ratio of 1 was assumed for stages 1-3 CKD.
Absenteeism	Absenteeism days * Average weekly earnings * 52	• Van Haalen et al (2020)	• Absenteeism reflects the work time missed due to impairment from CKD. It is calculated as hours missed as a percentage of total work hours. • Absenteeism estimates were generated using the Work Productivity and Activity Impairment (WPAI) score for absenteeism which presents the total loss in productivity as a percentage. • The WPAI is calculated as hours missed as a percentage of total work hours (measured over a 7-day recall period). For example, a WPAI score of 7.1 reflects a 7.1% loss of productivity due to absenteeism. See Table A.13 for further detail.
Presenteeism	Presenteeism days * Average weekly earnings * 52	• Van Haalen et al (2020)	• People living with CKD may be less productive while at work compared to their colleagues. Presenteeism captures this loss in productivity due to CKD by multiplying the estimated loss of productive time by average earnings. • Presenteeism estimates were derived from the WPAI score for presenteeism which presents the total loss in productivity as a percentage. • The WPAI for presenteeism is calculated using patient reported impact of CKD on productivity, using a scale of 0 (no

Component	Calculation	Source	Assumptions
			impact) to 10 (prevented the person from working). The average score is then multiplied by 10 to convert to an estimated percentage impact. • Similar to absenteeism, the WPAI score for presenteeism was multiplied by 240 to estimate the workdays lost in a single year due to presenteeism. See Table A.14 for further detail.
Premature mortality	Number of deaths * expected lifetime earnings	• ANZDATA data request (2022)	• There were an estimated 2,189 deaths due to CKD in 2021. • Based on the age and gender distribution of these deaths and incorporating employment rates and average lifetime earnings for different age-gender groups, the present value of lost earnings due to premature mortality was estimated. • It is noted that only deaths due to kidney failure were included within this analysis. • It is acknowledged that patients with CKD are at a significantly increased risk of experiencing a cardiovascular death, the cost of which is not included within this report.
Informal care	Hours of informal care per week * employment probability * average weekly earnings	• De Vries et al (2021), Turchetti et al (2017)	• People living with CKD may require additional support in their everyday lives. This support may be provided by an informal carer, typically a spouse, friend or another member of the family. • Though informal care is provided free of charge, the services are not free from an economic perspective. There is an opportunity cost to providing informal care, which is measured by what the carer could have earned had they been in the workforce. • Reported average hours of informal care per week were significantly higher for dialysis patients (9.25 hours of care) relative to transplant patients (2.8 hours per week). • Informal care costs were also included for stage 4 CKD (approximately 3 hours per week). No informal care costs were attributed to people with stage 1-3 CKD.

Source: Deloitte Access Economics.

Table A.13: Absenteeism impact of CKD

Stage	WPAI score (%)	Absenteeism (days)
3a	7.1	17.04
3b	5.1	12.24
4	8.3	19.92
5	12.2	29.28

Source: Deloitte Access Economics analysis and Van Haalen et al (2020) .

Table A.14: Presenteeism impact of CKD

Stage	WPAI score (%)	Presenteeism (days)
3a	18.8	45.12
3b	19.6	47.04
4	27.9	66.96
5	34.7	83.28

Source: Deloitte Access Economics analysis and Van Haalen et al (2020).

A.4. Other financial costs

Table A.15: Calculation method and data sources for other financial cost due to CKD

Component	Calculation	Source	Assumptions
Management and supportive care	Number of CKD by stage * unit cost	• Essue et al (2013)[21]	• To estimate the annual cost of management and supportive care, the findings reported from this study were multiplied by four (as the findings report the cost for a three-month period) and inflated to 2021 dollars. • This source only costs management and supportive care costs for dialysis and transplant patients. This approach has been used in our analysis in the absence of any other literature. • This is equivalent to $2,208 for patient undergoing dialysis and $1,476 per transplant patient in 2021 dollars.
Other out-of-pocket	Number of CKD by stage * unit cost	• Essue et al (2013)[21]	• To estimate the annual cost of other out-of-pocket costs, the findings reported from this study were multiplied by four (as the findings report the cost for a three-month period) and inflated to 2021 dollars. • Other out-of-pocket costs for stage 3 to stage 5 (pre-dialysis) were not disaggregated by stage. It is assumed that these costs are driven by patients in stage 5 (pre-dialysis) due to worsening kidney health. As such, the other out-of-pocket cost finding for stages 3 to 5 (pre-dialysis) as reported in this source has been applied to stage 5 (conservative care) in our modelling approach and inflated to 2021 dollars. • Stakeholder consultation indicated that the out-of-pocket costs for stage 4 would be similar to those for stage 5. Further, as stage 4 and stage 5 CKD are under the same management plan, it is assumed that the frequency and health service and type used to manage CKD would be largely similar, and therefore incur similar out-of-pocket costs. • Out-of-pocket costs for stage 3b were assumed to be half of those for stage 4. According to Kidney Health Australia's Kidney Health Check plan, patients with CKD stage 3 are recommended to have a kidney check every 3-6 months, compared every 1-3 months for a patient with CKD stage 4. It is assumed that a patient with CKD stage 3 would use services half as often and therefore incur only half the other out-of-pocket costs. • Out-of-pocket costs for dialysis and transplant patients were obtained from this source and inflated to 2021 dollars. • This is equivalent to out-of-pocket costs of $2,837 for stage 3b, $5,673 for stage 4, $5,673 for stage 5 (conservative care),

Component	Calculation	Source	Assumptions
			$5,472 for dialysis patients and $4,906 for transplant patients in 2021 dollars.
Electricity	Number of home dialysis patients * unit cost	• KHA (2011)[54] • ABS (2021)	• The mid-point of the range reported in the Kidney Health Australia report was used as a conversative estimate and inflated to 2021 dollars using the Australian electricity inflation index. • This is equivalent to $1,845 in 2021 dollars.
Water	Number of home dialysis patients * unit cost	• KHA (2011)[54] • ABS (2021)	• The mid-point of the range reported in the Kidney Health Australia report was used as a conversative estimate, and inflated to 2021 dollars using the Australian water and sewage inflation index. • This is equivalent to $2,464 in 2021 dollars.
Once-off training	Number of home dialysis patients * unit cost	• Pearse et al (2008)[22]	• This is equivalent to $1,153 in 2021 dollars.

Source: Deloitte Access Economics.

A.4.2. Deadweight losses methodology

Deadweight losses are defined as a loss of economic efficiency that occurs when equilibrium is not achieved in a market. In the case of CKD, this arises due to the government's need to collect additional tax revenue to fund costs that would otherwise not have been incurred. These costs include the lost consumer, company and informal carer taxes, and Federal and State health expenditure

There are frictions associated with the collection of this additional tax revenue. Specifically, levying taxes reduces the efficiency with which resources are allocated within an economy. This may be through higher income taxes, which increases the price of work relative to leisure and, therefore, creates a disincentive to work. Additionally, higher sales taxes increase the cost of goods and services and results in a loss of sales to businesses. These mechanisms result in a reduction in consumer and producer surplus, respectively, which is known as the deadweight loss, or excess burden, of tax.

Deadweight losses increase when taxes are raised above the level that they would otherwise have been in the absence of CKD. This study assumes that the government maintains a budget neutral position despite the decreased tax revenue and increased government spending (e.g., to pay for additional health services).

Maintaining the budget neutral position requires the government to levy taxes on other members of society to:

- Maintain the same amount of tax revenue despite a smaller pool of taxable income from individuals and taxable profits from businesses
- Pay for additional government spending in areas such as health care as a result CKD.

The respective tax rates used in the calculation of deadweight losses were:

- 22.3% average personal income tax rate and 15.1% average indirect tax rate
- 29.2% average company tax rate.

These tax rates were calculated by dividing the net income tax and net indirect tax by the taxable income, based on data from the Australian Taxation Office.[55] This method was also used to derive the average company tax rate, using the net tax for companies divided by the total taxable income for companies.

Table A.16 presents the estimated increase in health expenditure and reduction in taxation income, the applied efficiency loss of raising taxation and the resulting deadweight loss in Australia in 2021. All rates of efficiency loss included a 0.8% administrative loss which covers expenses of administering taxation.

Table A.16: Deadweight losses due to CKD in Australia in 2021

Cost component	Total costs ($ million)	Rate of efficiency loss (%)	Deadweight loss ($ million)
Federal health expenditure	968.5	42.6%	412.9
State health expenditure	621.6	38.3%	621.6
Lost consumer taxes	1,938.2	22.3%	142.9
Lost company taxes	4,344.4	50.7%	437.8
Total	**7,872.7**	**-**	**1,615.1**

Source: Deloitte Access Economics analysis.

A.5. Loss of wellbeing

Table A.17: Calculation method and data sources for loss of wellbeing due to CKD

Component	Calculation	Source	Assumptions
YLDs	YLD rate per case of CKD * number of people diagnosed with CKD * VSLY	• IHME 2020, GBD Study 2017 Data Resources • Department of Prime Minister and Cabinet (2021)	• YLD rate per case is the same for all individuals within in the same stage of CKD
YLLs	Number of premature deaths * expected years of life remaining x VSLY	• ANZDATA data request (2022) • ABS 3302.0.055.001 - Life Tables, States, Territories and Australia, 2016-18 • Department of Prime Minister and Cabinet (2021)	• Age at death is the midpoint of the five-year age group within which the death occurred (e.g., 67 for the 65-69 age group)

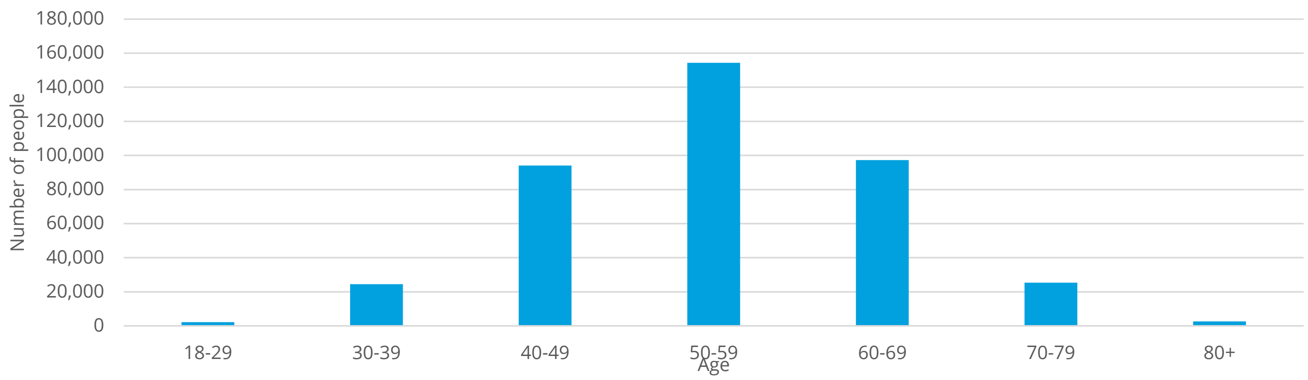
Source: Deloitte Access Economics.

Appendix B: Technical ROI appendix

B.1. Methodology

The purpose of this return-on-investment study was to determine the potential benefits of providing screening and diagnosis of CKD to an at-risk cohort. A Markov model was constructed to analyse CKD progression over a 20-year time horizon. The target population included individuals with increased risk of CKD as discussed in Section 5.1.1. While this target population could be several million Australians, the analysis models a hypothetical cohort of 400,000 people with CKD who would otherwise not be diagnosed. The modelling used a twenty-year time horizon and evaluated the health system and wellbeing impacts of the intervention. The hypothetical cohort was on average 55 years of age, with average eGFRs of 55 mL/min/1.73m^2. The age distribution of the cohort is provided in Chart B.1.

Chart B.1: Age distribution of representative cohort



Source: Deloitte Access Economics analysis.

There were two arms of the model, the 'intervention' and 'comparator'. Under the intervention arm, the target population received two Kidney Health Checks three months apart. Those who had positive test results were diagnosed with CKD. The cost of each Kidney Health Check is provided in Table B.1.

Table B.1: Estimated cost of kidney health check and subsequent diagnosis

Component	Source	Cost
Blood test: eGFR calculated from serum creatinine	MBS item 66512[56]	$17.70
Urine test: ACR to check for albuminuria	MBS item 66560[57]	$20.10
GP visit	MBS item 23[58], MBS item 36[59]	$71.07
Total cost	-	**$108.87**

Source: Deloitte Access Economics analysis of cited sources.

Once diagnosed, the population receives 'best practice care' (discussed in Section 1.1.3) for their CKD. The comparator population is assumed to remain undiagnosed for CKD as they do not receive a Kidney Health Check. This means that the comparator population may continue undiagnosed for CKD for a significant period – consistent with the current understanding that approximately 90% of CKD patients are unaware of their condition. For the proportion of the comparator population that progresses to kidney failure, it is assumed that these people commence best practice care, albeit after they have already progressed to kidney failure. One limitation of this modelling approach is that it may overestimate the extent to which the comparator population remains undiagnosed.

This modelling assumes that screening and detection of all 400,000 people occurs in the first year of the intervention. It is acknowledged that there may need to be a ramp up period for appropriate early detection to be put in place – effectively meaning that the benefits of early detection may not be realised fully in the first year. Additionally, there would be additional cases of CKD which would be detectable over time. There were approximately 770,000 Australians with stage 1 CKD in 2021. The subset of these people with diabetes and/or CVD would fall under the target population for this intervention once they progress to stage 2 CKD. It is noted that the modelling only estimates the effect of early detection in the first year of the model and does not consider the additional cases of CKD which would be detectable over time.

B.1.1. Model drivers for CKD progression

Best practice care for CKD is likely to differ for each individual and may include any of the treatments discussed in Section 1.1.3. It is noted that the individuals with CKD who remain undiagnosed (within the comparator population) may be receiving a similar suite of treatments for other conditions such as diabetes or hypertension. For this reason, the modelling assumes an improvement in the standard of care for the individual, which can only be achieved through the additional CKD diagnosis. The primary metrics for estimating the value of the improved standard of care is the person's annual eGFR decline and their ACR.

eGFR decline has been measured as an outcome for various treatments of CKD. For example, the effect of dapagliflozin on a sample of 1,272 individuals (mean age 62.2 years, 64.9% with type 2 diabetes, 38.2% with CVD, 11.4% with heart failure) was shown to decrease the annual eGFR decline from -3.83 mL/min/1.73 m^2 to -2.88 mL/min/1.73 m^2 (approximately a 25% improvement). [60] It is noted that participants in this trial had eGFRs ranging from 25-75 mL/min/1.73 m^2, indicating that the findings are not applicable to those with eGFR less than 25 mL/min/1.73 m^2.

The Canagliflozin and Renal Events in Diabetes with Established Nephropathy Clinical Evaluation (CREDENCE) trial assessed the effects of the SGLT2 inhibitor canagliflozin on renal outcomes in patients with type 2 diabetes and albuminuric CKD.[61] Patients received an oral SGLT2 inhibitor, at a dose of 100 mg daily or placebo. All patients had an estimated GFR between 30-90 mL/min/1.73 m^2. Patients receiving canagliflozin were estimated to lose -1.85 mL/min/1.73 m^2 per year, whereas the placebo population were estimated to lose -4.6 mL/min/1.73 m^2 eGFR per year (approximately a 60% improvement). Participants in this trial had eGFRs ranging from 30-90 mL/min/1.73 m^2, indicating that the findings are not applicable to those with eGFR less than 30 mL/min/1.73 m^2.

Lifestyle modifications such as diet, physical activity, smoking habits weight reduction may also be effective strategies to manage CKD progression. In a cohort of patients with type 2 diabetes, people who self-reported daily physical activity had a significantly reduced risk of eGFR decline >5% per year, kidney failure and micro or macroalbuminuria relative to sedentary participants.[62] Smoking has been independently associated with prevalent micro or macroalbuminuria,[63] and a greater annual decline in eGFR (-0.77 vs -0.18 mL/min/1.73m^2).[64]

The comparator population were assumed to have an annual eGFR decline of -2.0 mL/min/1.73m^2. Based on the available evidence presented in section Table B.2, it was assumed that the early detection of CKD could improve best practice care such that there was a 25% improvement in the reduction in annual eGFR decline.

Greater levels of ACR are an independent predictor of mortality risk.[65] Hazard ratios for cardiovascular mortality by ACR level are provided in Table B.2. It was assumed that best practice care would limit progression of the ACR level to between 10-30 mg/g whereas the undiagnosed comparator population would have higher average ACRs ranging from 30-300 mg/g. The Kidney Health Australia management guidelines recommend a target reduction in ACR of 50%. These hazard ratios were applied to general population cardiovascular mortality rates.[66]

Table B.2: Hazard ratios for albumin to creatinine ratio and cardiovascular mortality

ACR	Hazard ratio
5	1.00 (Reference)
10	1.27
30	1.77
300	2.43
1000	2.81

Source: Chronic Kidney Disease Prognosis Consortium (2010).

B.1.2. Transition probabilities

The modelling uses annual transition probabilities to model the cohorts CKD progression over time. In any year an individual can transition into premature mortality due to a natural death, a kidney failure death or due to a cardiovascular death. Where the individual's eGFR is <15 mL/min/1.73m^2 they will transition into one of three treatment pathways. The patient can either receive dialysis treatment, receive a transplant or they will commence conservative care (not receiving dialysis or transplant). In each year an individual may experience a non-fatal cardiovascular event. Where an individual does not experience any of the above, they are assigned 'no event', indicating that they remained in the same state as the previous year.

The transition probabilities are dependent upon the person's age, current eGFR and current ACR. For example, as an individual ages over time, their likelihood of death due to natural causes, kidney failure, or from a CVD event increases substantially. A table of example transition probabilities is provided in Table B.3.

Table B.3: Example transition probabilities by individual characteristics

Individual characteristics	Death (natural cause)	CVD hospitalisation	CVD death	Kidney failure death	No event
Age: 60, stage three CKD, intervention cohort	0.5%	7.1%	0.2%	0.0%	92.1%
Age: 75, stage four CKD, intervention cohort	2.0%	36.4%	2.6%	0.0%	59.0%
Age: 80, stage five CKD (dialysis), intervention cohort	3.6%	37.3%	3.4%	19.9%	35.8%
Age: 60, stage three CKD, comparator cohort	0.5%	9.8%	0.3%	0.0%	89.4%
Age: 75, stage four CKD, comparator cohort	2.0%	49.8%	3.5%	0.0%	44.7%
Age: 80, stage five CKD (dialysis), comparator cohort	3.6%	37.3%	3.4%	19.9%	35.8%

Source: Deloitte Access Economics analysis.

The average initial GFR level was assumed to be 55 mL/min/1.73m^2. In the intervention cohort the annual GFR decline was assumed to be -1.5 mL/min/1.73m^2. The comparator population was assumed to have an annual GFR decline of -2.0 mL/min/1.73m^2. In the intervention cohort the hazard ratio for a cardiovascular event (hospitalisation or death) was 1.52 relative to the general population based on the average hazard ratio for ACR levels between 10-30 mg/g as described in Table B.2. The comparator population was assigned a hazard ratio of 2.1 for cardiovascular events based on the average hazard ratio for ACR levels between 30-300 mg/g as described in Table B.2.

B.1.3. Health related quality of life

Each stage of CKD was assigned a health state utility weight representing the quality of the individual's life. Health state utility weights decreased with CKD progression and decreased due to cardiovascular events. Health state utility weights range from 0 to 1, with 1 representing the valuation of perfect health and 0 representing the value assigned to death. Table B.4 provides an overview of the health state utility weights used within the modelling.

Table B.4: Health state utilities by health state

Health state	Utility weight
Stage 1 CKD	0.85
Stage 2 CKD	0.85
Stage 3 CKD	0.80
Stage 4 CKD	0.74
Stage 5 CKD	0.54
Post-transplant	0.83
Dialysis	0.67
Cardiovascular events	0.57

Deloitte Access Economics calculations derived from Cooper et al (2020).

B.1.4. Financial costs

Financial costs of CKD were derived from the cost-of-illness analysis presented in Section 4.1.4. Costs under the intervention arm were higher due to the use of intensive treatment strategies. This is particularly evident in early-stage CKD where the undiagnosed comparator population are assumed not to be actively treating their CKD. Table B.5 presents the relevant financial costs by CKD stage.

Table B.5: Financial costs of CKD by stage ($)

CKD stage	Comparator	Intervention
CKD stage 1	1,381	330
CKD stage 2	1,381	330
CKD stage 3	6,292	4,640
CKD stage 4	9,178	5,882
CKD stage 5 (conservative)	44,233	43,671
CKD stage 5 (dialysis)	71,085	70,523
CKD stage 5 (transplant)	16,461	15,899

Source: Deloitte Access Economics analysis.

Endnotes

[1] Australia Bureau of Statistics (2013) Australian Health Survey: Biomedical Results for Chronic Diseases, <https://www.abs.gov.au/statistics/health/health-conditions-and-risks/australian-health-survey-biomedical-results-chronic-diseases/latest-release>, accessed 30 May 2022.

[2] Australian Institute of Health and Welfare (2019) National Mortality Database, <https://www.aihw.gov.au/about-our-data/our-data-collections/national-mortality-database>, accessed 30 May 2022.

[3] Australian Institute of Health and Welfare (2022) Australian Burden of Disease Study 2022, <https://www.aihw.gov.au/reports/burden-of-disease/australian-burden-of-disease-study-2022/contents/interactive-data-on-disease-burden/burden-of-disease-in-australia>, accessed 16 February 2022.

[4] Chronic Kidney Disease (CKD) Management in Primary Care (4th edition), Kidney Health Australia, Melbourne, 2020.

[5] CARI Guidelines, Management of lipid-lowering therapy in CKD, 2020.

[6] Bailey, C. J., et al. (2022) Renal Protection with SGLT2 Inhibitors: Effects in Acute and Chronic Kidney Disease. *Current Diabetes Reports*, pp.1-14.

[7] National Institute of Diabetes and Digestive and Kidney Diseases (2018), Your Kidneys & How They Work, <https://www.niddk.nih.gov/health-information/kidney-disease/kidneys-how-they-work>, accessed 02 May 2022.

[8] Kidney Health Australia (2022) Know your kidneys, <https://kidney.org.au/your-kidneys/know-your-kidneys>, accessed 02 May 2022.

[9] Australian Institute of Health and Welfare (2020) Australia's Health 2020, Chronic Kidney Disease: Australian facts, <https://www.aihw.gov.au/reports/chronic-kidney-disease/chronic-kidney-disease/contents/summary.

[10] Department of Health (2020) What we're doing about kidney disease, <https://www.health.gov.au/health-topics/chronic-conditions/what-were-doing-about-chronic-conditions/what-were-doing-about-kidney-disease>, accessed 02 May 2022.

[11] CARI Guidelines (2022) About CARI Guidelines, <https://www.cariguidelines.org/about/>, accessed 27 June 2022.

[12] Cass A., et al. (2010) The economic impact of end-stage kidney disease in Australia: Projections to 2020. Kidney Health Australia, Melbourne, Australia.

[13] Wyld M. L. R., et al. (2015) Cost to government and society of chronic kidney disease stage 1-5: a national cohort study. *Int Med J*, 45(7):741-747.

[14] Gorham G, Howard K, Zhao Y, et al. Cost of dialysis therapies in rural and remote Australia - a micro-costing analysis. BMC Nephrol. Jun 25 2019;20(1):231. doi:10.1186/s12882-019-1421-z.

[15] Howard K., et al. (2010) Cost-effectiveness of screening and optimal management for diabetes, hypertension, and chronic kidney disease: a modelled analysis. *Value in Health*, 13(2):196-208.

[16] Australian Institute of Health and Welfare (2011) Chronic kidney disease in Aboriginal and Torres Strait Islander people 2011, https://www.aihw.gov.au/reports/indigenous-australians/profiles-of-aboriginal-and-tsi-people-with-kidney/summary>, accessed 27 June 2022.

[17] Gibertoni D., et al (2021) COVID-19 incidence and mortality in non-dialysis chronic kidney disease patients. *PLoS One*, 16(7): e0254525

[18] Geetha D., et al (2022) Impact of the COVID-19 pandemic on the kidney community: lessons learned and future directions. *Nature Reviews Nephrology,* pp. 1-14.

[19] Ward H., et al (2021) SARS-CoV-2 antibody prevalence in England following the first peak of the pandemic. *Nature communications,* 12(1), pp. 1-8.

[20] Australian Institute of Health and Welfare (2015) Incidence of end-stage kideney disease in Australia 1997-2013, < https://www.aihw.gov.au/reports/chronic-kidney-disease/incidence-of-end-stage-kidney-disease-in-australia-1997-2013/summary>.

[21] Essue B., et al. (2013) How are patients managing with the cost of care for chronic kidney disease in Australia? A cross-sectional study, *BMC Nephrology* 14(5) 1-9.

[22] Pearse J., Mazevska D., and Hachigo A. (2008) NSW Dialysis Costing Study 2008. Volume 1: Main Report Version 1.3.

[23] Murray C., and Lopez A. (1996), The Global Burden of Disease: a comprehensive assessment of mortality & disability from diseases, injuries & risk factors in 1990 & projected to 2020, Harvard School of Public Health, Boston.

[24] Department of the Prime Minister and Cabinet (2021). Best Practice Regulation Guidance Note Value of statistical life <https://obpr.pmc.gov.au/resources/guidance-assessing-impacts/value-statistical-life>, accessed 26 April 2022.

[25] Institute for Health Metrics and Evaluation (2020) Global Burden of Disease Study 2017 Data Resources, <http://ghdx.healthdata.org/gbd-2017>.

[26] Baker Heart and Diabetes Institute, AusDiab. Available at < https://baker.edu.au/impact/ausdiab>.

[27] Kidney Health Australia, Risk factors of kidney disease. Available at <https://kidney.org.au/your-kidneys/know-your-kidneys/know-the-risk-factors>.

[28] Sullivan, M.K., et al. 2020. Associations between multimorbidity and adverse clinical outcomes in patients with chronic kidney disease: a systematic review and meta-analysis. *BMJ open*, *10*(6), p.e038401.

[29] White SL. Chronic Kidney Disease, Diabetes & Cardiovascular Disease: Evidence Report 2021.

[30] Bezabhe, W. M., et al. 2020. Medication prescribing quality in Australian primary care patients with chronic kidney disease. *Journal of clinical medicine*, *9*(3), p.783.

[31] Levin, A. and Stevens, P.E., 2011. Early detection of CKD: the benefits, limitations and effects on prognosis. *Nature Reviews Nephrology*, *7*(8), pp.446-457.

[32] MBS Online, Medicare Benefits Schedule – Item 66512 <http://www9.health.gov.au/mbs/fullDisplay.cfm?type=item&q=66512&qt=item>.

[33] MBS Online, Medicare Benefits Schedule – Item 66560 <http://www9.health.gov.au/mbs/fullDisplay.cfm?type=item&q=66560&qt=item>.

[34] I-screen, Kidney Check <https://www.i-screen.com.au/tests/kidney-function-test>.

[35] Australian Institute of Health and Welfare (2021), Health Expenditure Australia 2019-20, <https://www.aihw.gov.au/reports/health-welfare-expenditure/health-expenditure-australia-2019-20/contents/summary>.

[36] Independent Hospital and Aged Care Pricing Authority (2022) National pricing model technical specifications 2022-23, <https://www.ihacpa.gov.au/resources/national-pricing-model-technical-specifications-2022-23>.

[37] Australian Institute of Health and Welfare (2021), Disease expenditure in Australia 2018-19, <https://www.aihw.gov.au/reports/health-welfare-expenditure/disease-expenditure-australia/contents/summary>.

[38] Nitsch, D., et al. (2017) on behalf of the National CKD Audit and Quality Improvement Programme in Primary Care, Part two National CKD Audit Report 2017 < https://www.lshtm.ac.uk/files/ckd_audit_report.pdf>, access 27 April 2022

[39] Kent, S., et al. (2015) What is the impact of chronic kidney disease stage and cardiovascular disease on the annual cost of hospital care in moderate-to-severe kidney disease?, BMC Nephrology 16:65, < https://pubmed.ncbi.nlm.nih.gov/25924679/>, access 27 April 2022

[40] Independent Hospital and Pricing Authority (2022), National Hospital Cost Data Collection Public Sector, Round 24 (financial year 2019–20), <https://www.ihacpa.gov.au/resources/national-hospital-cost-data-collection-nhcdc-public-hospitals-report-round-24-financial-year-2019-20>.

[41] Khanam, M., et al. (2019), Chronic kidney disease monitoring in Australian general practice, <https://www1.racgp.org.au/ajgp/2019/march/chronic-kidney-disease-monitoring-in-australian-ge>, accessed 27 April 2022.

[42] Howard, K., et al. (2006) The Cost-Effectiveness of Early Detection and Intervention to Prevent the Progression of Chronic Kidney Disease in Australia. Kidney Health Australia, Melbourne, 2006

[43] MBS Online, <http://www.mbsonline.gov.au/>, access 28 April 2022.

[44] Pharmaceutical Benefits Scheme, <https://www.pbs.gov.au/pbs/home>, access 28 April 2022.

[45] MBS Online, <http://www.mbsonline.gov.au/>, access 28 April 2022.

[46] Radford J., et al. (2019) Epidemiology of chronic kidney disease in Australian general practice: National Prescribing Service MedicineWise MedicineInsight dataset, Nephrology 24:10.

[47] Rao M. V., et al. (2008) Hypertension and CKD: Kidney Early Evaluation Program (KEEP) and National Health and Nutrition Examination Survey (NHANES), 1999-2004, American Journal of Kidney Diseases, 51:4.

[48] Pharmaceutical Benefits Scheme, <https://www.pbs.gov.au/pbs/home>, access 28 April 2022.

[49] Australian Institute of Health and Welfare (2020) Chronic Kidney Disease-Hospital care for chronic kidney disease, <https://www.aihw.gov.au/reports/chronic-kidney-disease/chronic-kidney-disease/contents/hospital-care-for-chronic-kidney-disease> access 27 April 2022

[50] Australian Institute of Health and Welfare (2009) Health care expenditure on chronic kidney disease in Australia 2004-05, <https://www.aihw.gov.au/getmedia/f1d9cde2-6753-48ef-aa1b-aeb519ddfecd/phe-117-10789.pdf.aspx?inline=true>.

[51] Australia and New Zealand Dialysis and Transplant Registry (2021), ANZDATA 44th Annual Report 2021, <https://www.anzdata.org.au/report/anzdata-44th-annual-report-2021-data-to-2020/>.

[52] Services Australia, Medicare Item Reports <http://medicarestatistics.humanservices.gov.au/statistics/mbs_item.jsp>, access 27 April 2022

[53] Ronksley, R., et al., Emergency Department Use among Patients with CKD: A Population-Based Analysis (2017) Clinical Journal of the American Society of Nephrology 12(2) 304-14.

[54] Kidney Health Australia (2011), Consumer Perspectives on Dialysis, First National Census.

[55] Australian Taxation Office (2020). Taxation Statistics 2017-18. <https://www.ato.gov.au/About-ATO/Research-and-statistics/In-detail/Taxation-statistics/Taxation-statistics-2017-18/?anchor=NationalMapPostcodeDT#NationalMapPostcodeDT>

[56] MBS Online, Medicare Benefits Schedule – Item 66512 <http://www9.health.gov.au/mbs/fullDisplay.cfm?type=item&q=66512&qt=item>.

[57] MBS Online, Medicare Benefits Schedule – Item 66560 <http://www9.health.gov.au/mbs/fullDisplay.cfm?type=item&q=66560&qt=item>.

[58] MBS Online, Medicare Benefits Schedule – Item 23 <http://www9.health.gov.au/mbs/fullDisplay.cfm?type=item&q=23&qt=ItemID>.

[59] MBS Online, Medicare Benefits Schedule – Item 36 <http://www9.health.gov.au/mbs/fullDisplay.cfm?type=item&q=36&qt=ItemID>.

[60] Heerspink, H.J., Jongs, N., Chertow, G.M., Langkilde, A.M., McMurray, J.J., Correa-Rotter, R., Rossing, P., Sjöström, C.D., Stefansson, B.V., Toto, R.D. and Wheeler, D.C., 2021. Effect of dapagliflozin on the rate of decline in kidney function in patients with chronic kidney disease with and without type 2 diabetes: a prespecified analysis from the DAPA-CKD trial. *The Lancet Diabetes & Endocrinology*, *9*(11), pp.743-754.

[61] Perkovic, V., Jardine, M.J., Neal, B., Bompoint, S., Heerspink, H.J., Charytan, D.M., Edwards, R., Agarwal, R., Bakris, G., Bull, S. and Cannon, C.P., 2019. Canagliflozin and renal outcomes in type 2 diabetes and nephropathy. *New England Journal of Medicine*, *380*(24), pp.2295-2306.

[62] Dunkler, D., Kohl, M., Heinze, G., Teo, K.K., Rosengren, A., Pogue, J., Gao, P., Gerstein, H., Yusuf, S., Oberbauer, R. and Mann, J.F., 2015. Modifiable lifestyle and social factors affect chronic kidney disease in high-risk individuals with type 2 diabetes mellitus. *Kidney International*, *87*(4), pp.784-791.

[63] Parving, H.H., Lewis, J.B., Ravid, M., Remuzzi, G. and Hunsicker, L.G., 2006. Prevalence and risk factors for microalbuminuria in a referred cohort of type II diabetic patients: a global perspective. *Kidney international*, *69*(11), pp.2057-2063.

[64] De Boer, I.H., Sibley, S.D., Kestenbaum, B., Sampson, J.N., Young, B., Cleary, P.A., Steffes, M.W., Weiss, N.S. and Brunzell, J.D., 2007. Central obesity, incident microalbuminuria, and change in creatinine clearance in the epidemiology of diabetes interventions and complications study. *Journal of the American Society of Nephrology*, *18*(1), pp.235-243.

[65] Chronic Kidney Disease Prognosis Consortium, 2010. Association of estimated glomerular filtration rate and albuminuria with all-cause and cardiovascular mortality in general population cohorts: a collaborative meta-analysis. *The Lancet*, *375*(9731), pp.2073-2081.

[66] Australian Institute of Health and Welfare, 'Heart, stroke and vascular disease – Australian facts' available at < https://www.aihw.gov.au/reports/heart-stroke-vascular-diseases/hsvd-facts/contents/explore-the-data>.

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This report is prepared solely for the use of Kidney Health Australia. This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purposes of estimating the social and economic cost of kidney disease (all stages including kidney failure), the return on investment of early detection of chronic kidney disease and producing kidney failure projections to 2030. You should not refer to or use our name or the advice for any other purpose.

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