Evidence Compendium

Make *the* Change
for kidney health

This campaign is co-created with the Global Patient Alliance for Kidney Health as well as funded and produced by AstraZeneca.

This material has been developed and funded by AstraZeneca.

We aspire to a future where early diagnosis and treatment empower people affected by Chronic Kidney Disease (CKD) to live better, healthier lives.

Kidneys and Health

- Kidneys play a vital role in the body by removing waste, balancing fluids and regulating essential hormones.[1]
- CKD is characterised by a gradual loss of kidney function, which can lead to high levels of fluid, electrolytes and waste products in the body.[2]

Burden of CKD

- Nearly **850 million people** are affected by CKD globally; however **fewer than 10%** are aware of their disease.[3,4]
- The prevalence of CKD is rising, and is expected to become the world's **fifth leading cause of mortality** by 2040.[5]

Make the Change for Kidney Health

We need to take action now to bring the best possible outcomes for patients, healthcare systems, caregivers, the economy and the planet. **To achieve this vision, we are calling on governments and policymakers to elevate CKD as an urgent global health priority and implement patient-centred and evidence-based policies to:**

1 Detect and diagnose patients at earlier stages

People with late-stage CKD experience a **dramatically shortened life expectancy of 25 years less** than people with normal kidney function.[6]

Delaying diagnosis of stage 3 CKD by one year has been shown to **increase the risk of the deterioration of the condition by 40%**.[7]

By 2032, projections suggest that advanced CKD (stage 3-5) would have affected nearly **125 million people** across 8 countries* – a **25% increase from 2022.**[8]

2 Ensure use of the best available treatment and care to slow progression of CKD

Advanced CKD leads to **fatigue and physical limitations**, with end stage kidney disease (ESKD) **requiring prolonged dialysis or transplant**, which are **time-intensive and invasive.**[9]

The adoption of CKD guidelines in primary and secondary care is estimated to be **below average in 49% of countries.**[4]

Approximately **50% of people with stage 4-5 CKD develop cardiovascular disease** and **80-90% of people with stage 3-5 CKD have hypertension.**[10,11]

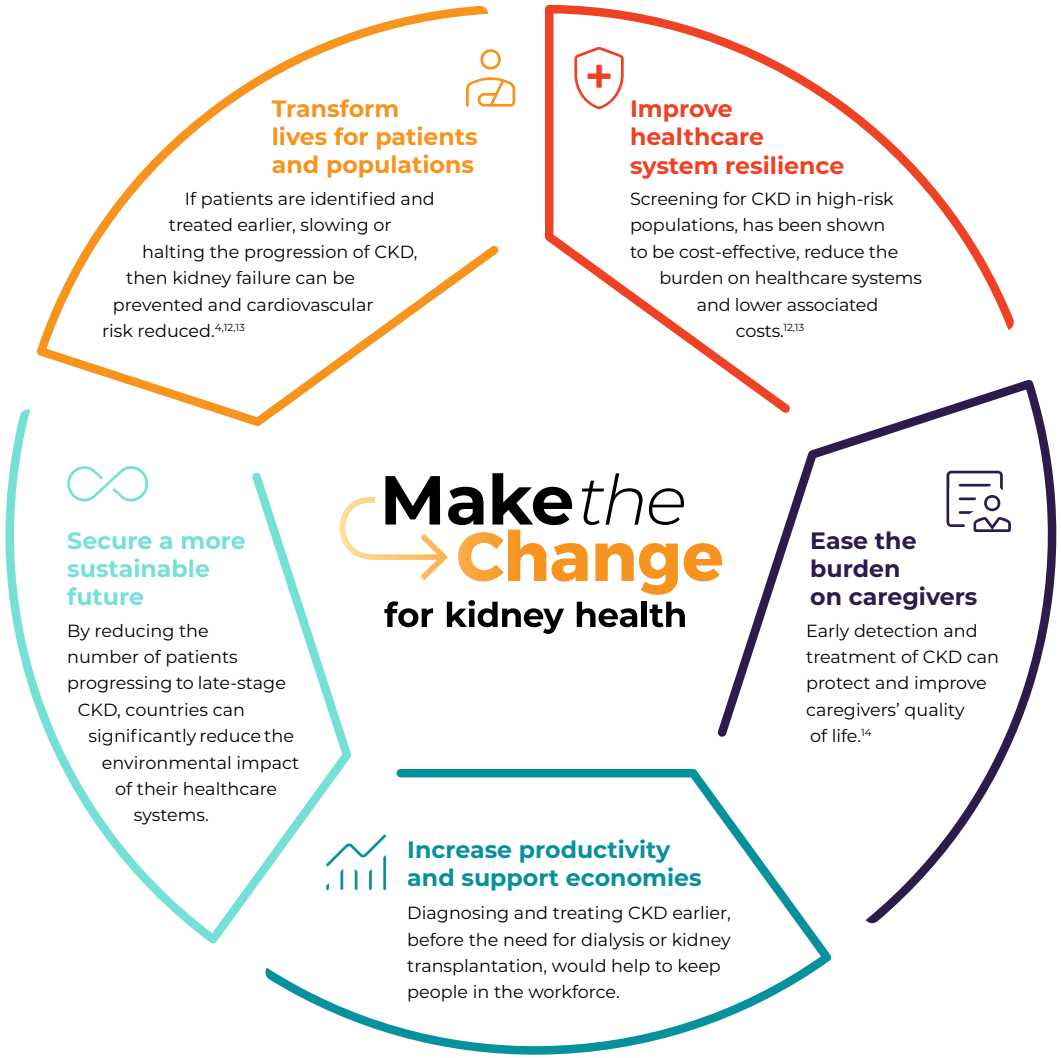
Taking action on Kidney Health will deliver five key benefits

- Transform lives for patients and populations
- Improve healthcare system resilience
- Ease the burden on caregivers
- Increase productivity to support economies
- Secure a more sustainable future

*Australia, Brazil, China, Germany, the Netherlands, Spain, UK, US

Make the case for Change for Kidney Health for:

Patients, healthcare systems, caregivers, the economy and the environment



Make the Change for Kidney Health to:
Transform lives for patients and populations

Early diagnosis and treatment of CKD transforms people's futures by enabling them to live better, healthier lives, helping them stay in work and contribute to their families and society.

Current state

CKD affects almost **850 million people** globally - **more than 10% of the general population**.[3,15]

CKD is highly prevalent in people with hypertension, cardiovascular disease and diabetes.[10,16] An estimated **1.4 million cardiovascular disease-related deaths** and **25 million cardiovascular DALYs were lost** owing to kidney disease and reduced kidney function, in 2017.[17]

Untreated CKD can significantly shorten life expectancy, which in advanced stages is **25 years less** than those with healthy kidney function.[6]

Fewer than 10% of people living with CKD **are aware of their disease.**[4,18]

Health inequalities exacerbate CKD. In the US, **Black Americans and other minorities face a higher burden of ESKD** compared to White Americans.[17,19,20]

The time required to maintain and treat advanced CKD and the severe impact of symptoms can reduce patients' ability to work, which in turn **can negatively affect their quality of life (QoL) and pose a financial risk** to them.[17,21,22,23]

Make the Change for Kidney Health to:
Transform lives for patients and populations

If no action is taken...

CKD is expected to become the world's **fifth leading cause of mortality** by 2040.[5]

The prevalence of CKD is expected to **rise by 5.8%** by 2027 – an estimated **80% of cases are expected to remain undiagnosed**.[24]

As the prevalence of CKD increases, the need for renal replacement therapies (RRT), such as dialysis and kidney transplant, is projected to **increase by up to 23.9% from 2021 to 2026** across 11 countries*.[25]

Delays in diagnosis increase the likelihood that CKD will **progress to late-stage disease by 40%** and **kidney failure requiring replacement therapy by 63%.**[7]

Across 8 countries**, the need for CKD-related dialysis is projected to **rise by more than 75%** by 2032.[26]

*Australia, Belgium, Brazil, Canada, China, Germany, Italy, Japan, Spain, UK, US
**Australia, Brazil, China, Germany, the Netherlands, Spain, UK, US

If we act...

Addressing CKD will help policymakers achieve the World Health Organization's Target 3.4 to **reduce premature mortality from non-communicable diseases by a third** by 2030.[27]

Identifying and treating patients early **can help stop or slow CKD progression** and **improve patient outcomes.**[28,29]

Screening high-risk populations could **reduce cardiovascular events by 44.6-49.1% and reduce the need for dialysis by up to 41.9%** in CKD patients across four countries***.[30]

Early screening and treatment in high-risk populations could **reduce all cause mortality by up to 9.1% by 2032** in CKD patients***.[30]

***Across 4 countries: Germany, the Netherlands, Spain, UK

Make the Change for Kidney Health to:
Improve healthcare system resilience

Catching and treating CKD in its early stages reduces costs and preserves health systems' resources, allowing investment to be redirected to other areas of need.

Current state

High-income countries currently allocate **2–3% of their yearly healthcare budget** towards ESKD treatment for **approximately 0.03% of the population.**[19,31]

Frequent comorbidities, such as anaemia, diabetes and cardiovascular complications, **can further increase the burden and costs associated with CKD.**[32]

Progression of CKD increases costs for healthcare systems and payers, with annual associated costs of dialysis and kidney transplantation ranging from **USD 35,000 to USD 100,000 per patient.**[33]

Kidney failure accounts for **7.2% of all Medicare claims in the US** and kidney disease accounts for **3.2% of total NHS spending** across all four nations in the UK.[34,35]

The financial and resource burden of CKD **increases as the disease progresses** – in the US, between 2014-2016, admission rate among emergency department patients was **2.7 times higher** among those with ESKD than those without.[32,36]

Many countries don't have sufficient CKD care infrastructure – **22% of low- and middle-income countries reported their CKD care infrastructure was poor to extremely poor.**[17]

Make the Change for Kidney Health to:
Improve healthcare system resilience

If no action is taken...

Projections suggest an **increase of over 17% in related hospitalisations and a >77% increase in RRT-related costs** across eight countries* from 2022 to 2032.[26,37]

Annual healthcare system costs associated with RRT are projected to increase from **£2.15 billion to £2.60 billion in the UK, and from USD 72.72 billion to USD 94.41 billion in the US**, between 2021 and 2026.[25]

By 2026, it is projected that the proportion of national healthcare expenditure allocated to CKD and RRT will **grow up to 9.2%** across 11 countries**.[25]

RRT costs associated with CKD could reach **up to USD 186 billion** across 8 countries* by 2032.[26]

*Australia, Brazil, China, Germany, the Netherlands, Spain, UK, US
**Across 11 countries studied (Australia, Belgium, Brazil, Canada, China, Germany, Italy, Japan, Spain, UK, US)

If we act...

Earlier detection and treatment of CKD **may reduce costs and resources** that could be redirected to other areas of need.[38]

Early screening and treatment could **prevent the need for RRT for up to 658,000 Americans**.[39]

Regularly monitoring and identifying high-risk populations for potential CKD can **reduce the burden on healthcare systems and lower associated costs**.[40]

Improved diagnosis and treatment adherence could **reduce RRT-related costs by 19.4% to 46.8%** across 8 countries between 2022 and 2047*—including a projected **€171.8 billion in savings** across Europe.[41]

Healthcare systems could save costs by diagnosing and managing the people likely to progress to ESKD, with US health payers and providers expected to **save USD 85.6 billion.**[16,42,43,44,45]

CKD screening has been shown to be cost effective in high-risk populations, such as patients with hypertension or diabetes mellitus.[46]

Make the Change for Kidney Health to:
Ease the burden on caregivers

Early intervention and treatment slowing the progression of CKD can have a positive impact on the psychological, physical, and economic burden that caregivers, including family and friends, often bear.

Current state

Caregivers of individuals with CKD experience **higher rates of depression and anxiety** than the general population – among caregivers of a family member with CKD, **30-50% reported symptoms of anxiety or depression.**[17,47]

Caregivers often experience **increased financial burden**, associated with impaired work productivity due to caregiver responsibilities.[48]

Caregivers of CKD patients **experience lower health-related quality of life** (QoL) - scores were up to 16% for informal caregivers of CKD patients compared with the general population in 4 of the 5 studied countries*.[14]

If no action is taken...

The **emotional, physical and financial burden** placed on caregivers **will continue to increase** as the prevalence of CKD rises further.[49]

Caregivers of patients with CKD in the US have worse health-related QoL compared to caregivers of patients with other major illnesses[50] – **a trend that will continue as CKD prevalence increases**.

Costs associated with **lost income due to caregiver absenteeism** represent a substantial burden, ranging from **€215.6 million ($227 million USD)** in the Netherlands to **$14.9 billion USD** in the United States States between 2022 and 2032.[51]

If we act...

Early action on CKD **can improve caregiver utility and quality of life**, reducing the disparity in utility between caregivers of patients with CKD and the general population, highlighted by a **16% lower utility score in the Mexican caregiver group****.[52]

Reduced caregiver burden **can mitigate negative caregiver health outcomes**, including depression.

Delaying CKD progression benefits caregivers, as caregivers of non-dialysis dependent CKD patients reported fewer quality of life problems than caregivers of dialysis dependent CKD patients**.[52]

*Significant reductions were observed in Germany, Mexico, the US and UK. The fifth country in the study was Taiwan
**In a survey of caregivers undertaken in Germany, Mexico, the US and the UK

Make the Change for Kidney Health to:
Increase productivity to support economies

Earlier diagnosis and more effective treatment of CKD can reduce patient and caregiver absenteeism, increase workforce participation, and promote long-term productivity and economic growth.

Current state

CKD can lead to **absenteeism and diminished work productivity** for both patients and caregivers.[53,54]

65% of stage 3b-5 CKD patients (n=634) of working age in the Netherlands reported only **moderate work ability,** with **37% severely fatigued.**[55]

In 2022, **647 million unpaid full-time carers** worldwide refrained from job-seeking due to their caregiving responsibilities, equivalent to **8% of the global population.**[15,56]

If no action is taken...

CKD patients are expected to **miss over 2.85 billion workdays between 2022 and 2032** in 8 countries*.[26]

Caregivers for those living with CKD across 8 countries* are expected to miss approximately **327 million workdays between 2022 to 2032**.[26]

Patient and caregiver absenteeism may result in **a loss of 37 billion USD in lost tax revenue** by 2032 across 8 countries*.[26]

If we act...

Diagnosing and treating CKD before the need for dialysis or kidney transplantation would help to **keep people in the workforce**, thereby supporting the economy.

Early detection and treatment of CKD could help keep **66.9 million more people in the workforce** across 8 countries between 2022 and 2047*.[41]

Across the same 8 countries, projected socioeconomic gains between 2022 and 2047 include a **1.4% to 10% increase in net tax** revenue after accounting for labor productivity losses associated with CKD.[41]

In Europe, these gains are projected to include **€100 billion in GDP growth and 6.4 million additional full-time workers over the same period.**[41]

*Australia, Brazil, China, Germany, the Netherlands, Spain, UK, US

Make the Change for Kidney Health to:
Secure a sustainable future

Healthcare systems have an opportunity to reduce the need for dialysis, if patients are diagnosed early and kept healthy for longer. This would lower the environmental impact of CKD by reducing the need for fresh water, electricity, carbon emissions, and healthcare waste.

Current state

Healthcare systems contribute **4-5% of global greenhouse gas emissions.**[57]

Dialysis is one of the most resource-intensive medical fields, using **more than 169 billion gallons of water globally per year** – equivalent to almost 13 billion washing machine cycles.[58,59]

Dialysis generates **one billion kilograms of waste** worldwide per year – equivalent to the waste of over 2,650,000 people in the UK.[60,61]

If no action is taken...

Freshwater consumption associated with CKD is projected to reach 440 million m³ by 2032 in eight countries* – equivalent to the annual water usage of 2.7 million households.[26]

By 2032, environmental projections show CKD care will use **11 billion kilograms oil equivalent of fossil fuel** in eight countries*.[26]

CO_2 emissions associated with CKD are expected to reach **29 billion kg of CO_2** equivalent of carbon by 2032 – the same as the CO_2 produced by 17.3 million cars.[26]

If we act...

Early screening and treatment can help stop or slow CKD progression and reduce the number of people requiring RRT. In turn, this can **minimise the environmental impact of kidney care** and help countries and healthcare systems reach their environmental targets.

Between 2022 and 2047, dialysis-related carbon footprint could be reduced by **18.7%** to **49.5%**, with dialysis-related **freshwater consumption projected to decrease by a total of 4.6 billion m³** across 8 countries*.[41]

Over the same period, projections across Europe show **a 40.9% reduction in freshwater use, 38.8% reduction in fossil fuel use, and 39.2% reduction in carbon emissions associated with dialysis**.[41]

*Australia, Brazil, China, Germany, the Netherlands, Spain, UK, US

Evidence Glossary on CKD

Evidence Glossary on Chronic Kidney Disease

Nearly 850 million people are affected by Chronic Kidney Disease (CKD) globally, accounting for more than 10% of the world's population.[3,15] Yet, fewer than 10% of people with CKD are aware of their disease.[4,18,62]

If left undiagnosed and untreated, CKD can eventually lead to end-stage kidney disease (ESKD) or kidney failure, leaving patients in need of a kidney transplant or long-term dialysis.[4] Patients with CKD are also at increased risk of cardiovascular complications, such as heart failure, which share common risk factors like diabetes, obesity and hypertension.[1,63]

We need to act now to bring the best possible outcomes for patients, health systems, caregivers, the economy, and the planet. However, effective policy action is reliant on robust evidence to understand what needs to change and how to achieve the best outcome. Research highlights the current burden of CKD, outlines the expected burden of CKD if we do not act, and reveals what we can hope for if we are successful in making a change for CKD patients.

AstraZeneca has funded and conducted a comprehensive suite of Real-World Evidence (RWE) and modelling studies focused on CKD to expand the understanding of the prevalence, management and impact of CKD on patients, caregivers, health systems, economies and the environment.

This evidence glossary provides a summary of these studies. Each page outlines the study's aim, methods, involved countries, and key outputs, along with a list of relevant publications from each study to date. While the included studies vary in scope, each applies a robust methodology and, like other RWE and microsimulation projection analyses, carries inherent strengths and limitations. Full details on design, methods, assumptions, and limitations are available in the respective published manuscripts.

This glossary is focused on currently published information to ensure validity and usability. This document will be updated as new manuscripts and abstracts are published.

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All studies included in this glossary are funded by AstraZeneca.

Study	Focus area(s)	Research themes						
01. Ca/Re/Me	Patients and populations Health systems	Patient characteristics, clinical outcomes, comorbidities, and healthcare costs.	✓	✓				
02. PaCE CKD	Patients and populations Caregivers Productivity	Caregiver quality of life, patient health-related quality of life, perceived financial burden, self-reported productivity.	✓		✓	✓		
03. REVEAL-CKD	Patients and populations	Prevalence of undiagnosed stage 3 CKD, factors associated with undiagnosed stage 3 CKD, time to CKD diagnosis, selected adverse clinical outcomes, and management and monitoring of CKD.	✓					
04. DISCOVER CKD	Patients and populations Health systems	Patient characteristics, monitoring and management trends, progression of CKD, selected clinical outcomes, healthcare resource utilization, healthcare costs, quality-of-life.	✓	✓				
05. inside CKD	Patients and populations Health systems	Projected future prevalence of CKD by disease stage and projected clinical and economic burden of CKD between 2022 and 2027. Explore the data at **InsideCKD.com**	✓	✓				
06. Impact CKD	Patients and populations Health systems Caregivers Productivity Environment	Policy impact, projected burden of CKD, benefits of policy interventions on future burdens of CKD, prevalence, clinical events, mortality, healthcare costs, productivity, economic indicators, and environmental outcomes.	✓	✓	✓	✓	✓	
07. ENVIRONMENTAL IMPACT OF CKD	Environment	Carbon emissions, fine particulate matter formation, photochemical ozone formation and freshwater usage.					✓	

CaReMe CKD

Patient characteristics, clinical outcomes, comorbidities, and healthcare costs.

CaReMe CKD

01. Aim
The CaReMe CKD study aims to provide evidence for the global burden of CKD, specifically on the patient characteristics, prevalence, clinical outcomes and costs to health systems across 11 countries.[64]

02. Design
The CaReMe study collected data from a period of 1 to 5 years on patient care and outcomes directly from health registries. The data collected include patient characteristics, clinical outcomes such as heart failure, stroke or death, and hospital healthcare costs.[64]

03. Countries Involved
Belgium, Canada, Germany, Israel, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

04. Key Outcomes
The CaReMe CKD study shows that CKD prevalence is high across the involved countries', but an associated recorded diagnosis of CKD is very low. The study results highlight the need for early action to better identify and diagnose this large cohort of undiagnosed patients with CKD. In addition, the study shows that:

- 1 in 10 adults in Europe, Canada, and Israel are likely to have CKD.[64]
- Two thirds of patients with CKD identified by laboratory criteria did not have an official CKD diagnosis in their medical records.[64]
- 42% of patients with CKD, identified through laboratory values, were classified as Stage 3A (mild to moderate loss of function[65]); this was fairly consistent across countries.[64]
- CKD and HF were associated with the accumulation of consistently greater hospital healthcare costs over 5 years compared with other major comorbidities.[64]

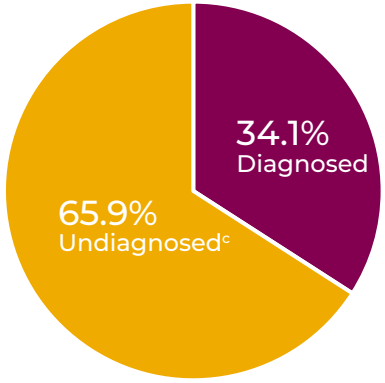
CKD imposes significant economic burden, with renal events and HF being the leading causes of increased costs.

Using primary data from digital healthcare systems across 11 countries, CaReMe CKD estimates that two thirds of CKD patients have not yet been diagnosed[a], with a pooled prevalence of 10% in adults across Europe, Canada, and Israel.

Pooled baseline patient characteristics

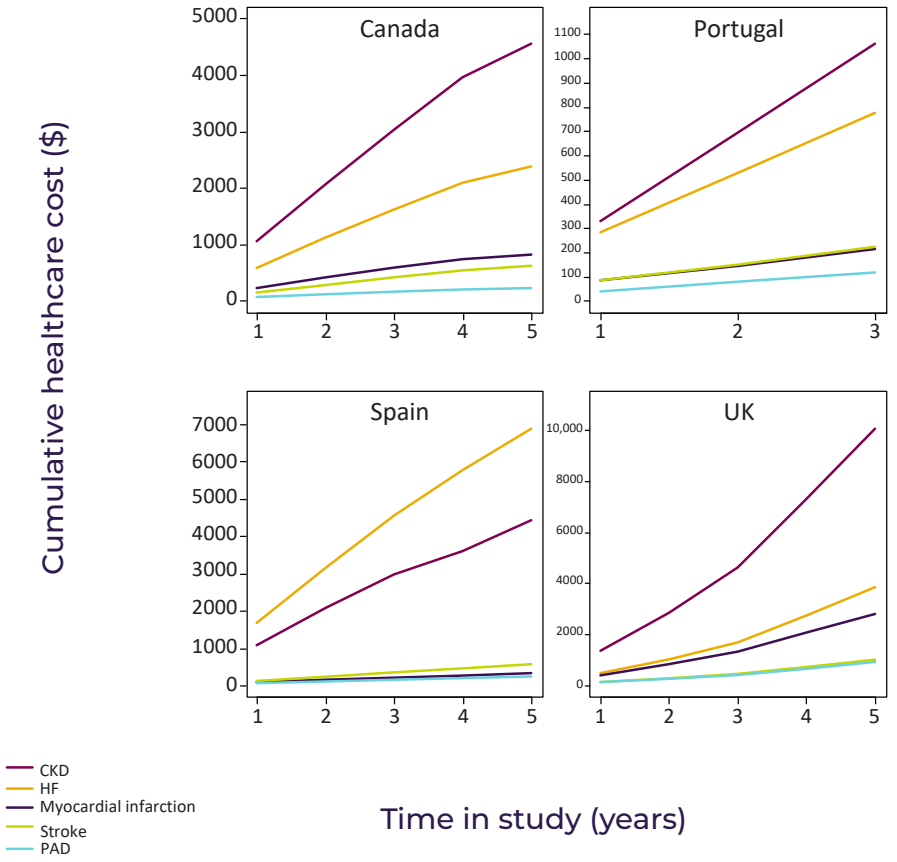
(Measured CKD cohort: N=1,111,836)[b]

Mean age: 74.8 years
Female: 53.2%
Diabetes: 38.0%
Cancer: 23.2%
CAD: 21.4%
AF/flutter: 16.5%
HF: 15.8%
Stroke: 11.8%
PAD: 8.3%



Results

CKD and HF were associated with the accumulation of consistently greater healthcare costs over 5 years compared with other major comorbidities.



[a]Diagnosis defined as presence of a CKD-specific diagnostic code; [b]Defined by having KDIGO-confirmed CKD; [c]Based on random effects model to calculate pooled existing CKD diagnosis
AF, atrial fibrillation; CAD, coronary artery disease; CKD, chronic kidney disease; HF, heart failure; KDIGO, Kidney Disease: Improving Global Outcomes; PAD, peripheral artery disease

1. Sundström J, et al. Lancet Reg Health Eur 2022;20:100438

CaReMe CKD

05. Relevant publications

a. Sundström, J., Bodegard, J., Bollmann, A., Vervloet, M. G., Mark, P. B., Karasik, A., Taveira-Gomes, T., Botana, M., Birkeland, K. I., Thuresson, M., Jäger, L., Sood, M. M., VanPottelbergh, G., & Tangri, N. (2022). Prevalence, outcomes, and cost of chronic kidney disease in a contemporary population of 2·4 million patients from 11 countries: The CaReMe CKD study. The Lancet Regional Health - Europe, 20. https://doi.org/10.1016/j.lanepe.2022.100438

b. Zhang, R., Mamza, J. B., Gao, H., Lochead, K. C., Milne, N., Jani, B. D., Chess, J. A., Sinha, S., Kanumilli, N., & Mark, P. B. (2023, November 2). Prevalence and Outcomes of CKD in England [Conference presentation abstract]. ASN Kidney Week 2023. https://www.asn-online.org/education/kidneyweek/2023/program-abstract.aspx?controlId=3939597

PaCE CKD

Carer quality of life, patient health-related quality of life, perceived financial burden, self-reported productivity.

PaCE CKD

01. Aim
The Patient, Carer, and Economic burden (PaCE) CKD study was developed to assess the relationship between CKD progression and the personal burden felt by the patient and unpaid caregiver populations across 8 countries.

02. Design
The PaCE CKD study used in-depth, semi-structured, qualitative interviews with patients with CKD and unpaid caregivers of patients with CKD, as well as questionnaires to quantify financial and health-related outcomes including financial well-being, work productivity, and quality of life.

03. Countries Involved
Australia, France, Germany, Italy, Mexico, Taiwan, United Kingdom, United States.[21,66]

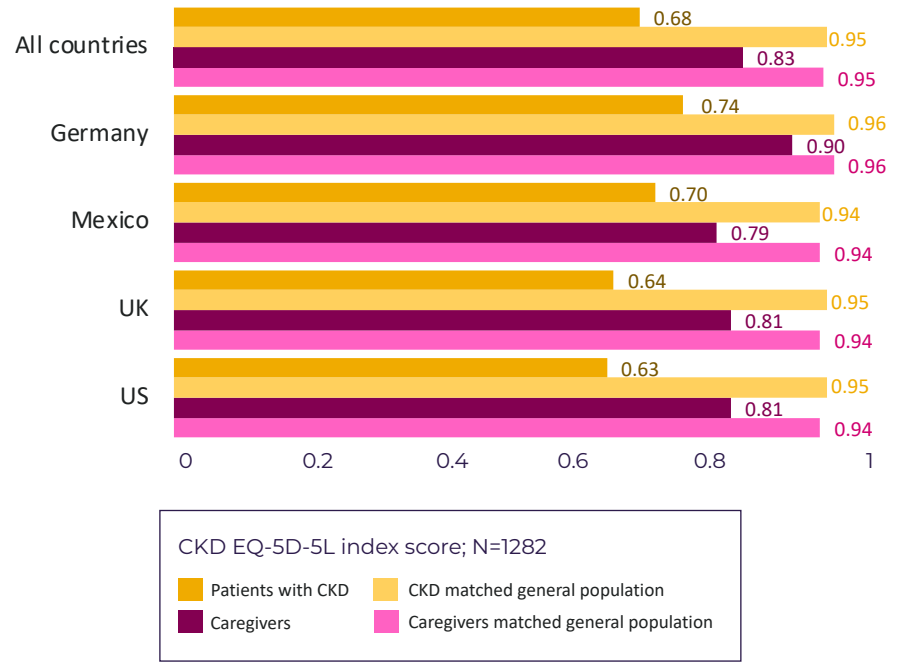
04. Key Outcomes
Published results demonstrated that CKD negatively impacted both CKD patients and their caregivers when compared with the general population.

- Patients with CKD and caregivers of patients with CKD were found to have a lower of quality of life.[14,67] Scores were up to 16% lower for informal caregivers of CKD patients compared with the general population in 4 of the 5 studied countries in an analysis that excluded Australia, France and Italy.[14]
- Results from US data revealed that respondents with CKD or respondents caring for someone with CKD also highlighted substantial financial and emotional difficulties.[48,50]
- Patients highlighted experiencing emotional distress, reduction in work hours and increased financial burden from CKD.[21]
- Caregivers highlighted experiencing increased financial burden, associated with a loss of work hours and earnings.[48]
- Across Germany, Mexico, Taiwan, UK, and USA, when compared with the general population, both patients with CKD and caregivers of patients with CKD experienced impaired quality of life and greater financial burden.[23,52]
- Delaying CKD progression can have a knock-on benefit to caregivers, as caregivers of non-dialysis dependent CKD patients report fewer problems across all CarerQoL domains than caregivers of dialysis dependent CKD patients.[52]

CKD detrimentally affects quality of life and imposes substantial financial and emotional challenges for patients and their carers.

Survey-reported HRQoL in CKD[1,a]

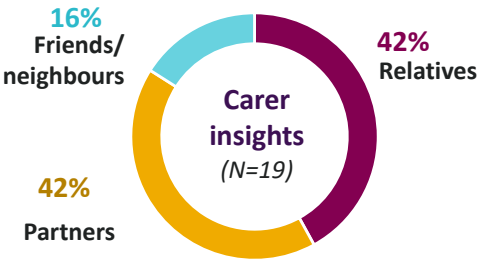
28% decrease in HRQoL vs general population



Interview-reported impact[2,b]

Patient experiences (N=20)

- Extreme fatigue
- Depression
- Shock at diagnosis
- Emotional distress
- Anxiety
- Debilitation
- Limited activity
- Help from carers required



Financial burden was associated with:

- Reduced work hours
- Treatment-related travel
- Disease management

Treatment insights

Patients and caregivers value effectiveness of CKD treatment over other therapy attributes.

[a]Results from non-interventional surveys across Germany, Mexico, the UK, and the USA; [b]Results from interviews with patients with CKD and carers in Australia, France, Germany, Italy the UK, and the USA CKD, chronic kidney disease; HRQoL, health-related quality of life.

1. Esposito C, et al. Presented at 60th European Renal Association (ERA) Congress, June 15–18, 2023. Milan, Italy. Poster; 2. Garcia Sanchez JJ, et al. Presented at World Congress of Nephrology (WCN), February 24–27, 2022. Kuala Lumpur, Malaysia. Poster POS-291

PaCE CKD

05. Relevant Publications

a. Garcia Sanchez, J. J., Kularatne, T., West, B., Rao, N., Wright, J., Hull, R., & Fifer, S. (2022). POS-291 PaCE CKD: Impact of CKD on Patients and Carers – Qualitative Insights From a Series of Multinational Interviews. Kidney International Reports, 7(2). https://doi.org/10.1016/j.ekir.2022.01.311

b. Esposito, C., Chadban, S., Rangaswami, J., Wu, M.-S., Hull, R., Elsayed, H., Reichel, H., Sanchez, J. J. G., Pentakota, S., Kularatne, T., & Fifer, S. (2023). #3990 PACE-CKD: Health-Related Quality of Life of Patients With CKD And Caregivers: Results From a US Survey. Nephrology Dialysis Transplantation, 38(Supplement_1). https://doi.org/10.1093/ndt/gfad063c_3990

c. Chadban, S., Esposito, C., Rangaswami, J., Wu, M.-S., Hull, R., Elsayed, H., Reichel, H., Sanchez, J. J. G., Pentakota, S., Kularatne, T., & Fifer, S. (2023). #4529 PACE-CKD: FINANCIAL BURDEN AND WORK PRODUCTIVITY OF PATIENTS WITH CKD AND CAREGIVERS: RESULTS FROM A US SURVEY. Nephrology Dialysis Transplantation, 38(Supplement_1). https://doi.org/10.1093/ndt/gfad063c_4529

d. Correa-Rotter, R., Hull, R., Elsayed, H. M., Rangaswami, J., Esposito, C., Wu, M.-S., Reichel, H., Garcia-Sanchez, J. J., Chadban, S. J., Pentakota, S., West, B., Mellor, R., Kularatne, T., & Fifer, S. (2023, November 2). PaCE-CKD: Health-Related Quality of Life of Caregivers of Individuals with CKD: Results from a Multinational Survey. ASN Kidney Week 2023.

e. Garcia Sanchez, J. J., Rangaswami, J., Wu, M.-S., Esposito, C., Hull, R., Chadban, S. J., Elsayed, H. M., Reichel, H., Correa-Rotter, R., Pentakota, S., West, B., Mellor, R., Kularatne, T., & Fifer, S. (2023, November 2). Impact of CKD on Patients' Health-Related Quality of Life: Results from PaCE-CKD, a Multinational Survey [Conference Abstract]. ASN Kidney Week 2023.

f. Garcia Sanchez, J. J., Elsayed, H., Esposito, C., Rangaswami, J., Wu, M. S., Hull, R., Chadban, S., Reichel, H., Correa-Rotter, R., Pentakota, S., West, B., Mellor, R., Kularatne, T., & Fifer, S. (2023). PCR208 Pace CKD Financial Burden and Work Productivity Assessment of Chronic Kidney Disease on Patients: Results from an International Survey. Value in Health, 26(12), S489. https://doi.org/10.1016/j.jval.2023.09.2645

g. Garcia Sanchez, J. J., Wu, M. S., Reichel, H., Elsayed, H., Rangaswami, J., Correa-Rotter, R., Hull, R., Esposito, C., Chadban, S., Pentakota, S., West, B., Mellor, R., Kularatne, T., & Fifer, S. (2023). PCR153 Pace CKD: The Impact of Chronic Kidney Disease and Dialysis on Caregivers Financial Status, and Work Productivity: Results from a Multinational Survey. Value in Health, 26(12), S478. https://doi.org/10.1016/j.jval.2023.09.2591

h. Garcia Sanchez, J.J., Reichel, H., Rangaswami, J., Esposito, C., Elsayed, M.H., Wu, M., Hull, R., Chadban, S., Rotter, R.C., Pentakota, S., West, B., Kularatne, T., Fifer, S. (2024) PaCE CKD: Examining health-related quality of life and financial burden in patients with chronic kidney disease: assessing the non-clinical burden of disease. [conference abstract] European Renal Association Congress 2024

i. Garcia Sanchez, J.J., Pentakota, S., Rangaswami, J., Wu, M.S., Hull, R., Esposito, C., Elsayed, M.H., Chadban, S., Reichel, H., Rotter, C.R., West, B., Kularatne, T., Fifer, S. (2024). PaCE CKD: The impact of caregiving on health-related quality of life and work productivity in chronic kidney disease: results from an international survey [conference abstract] European Renal Association Congress 2024

REVEAL CKD

Prevalence of undiagnosed stage 3 CKD, factors associated with undiagnosed stage 3 CKD, time to CKD diagnosis, selected adverse clinical outcomes, and management and monitoring of CKD.

REVEAL CKD

01. Aim
REVEAL CKD aims to determine the prevalence and contributing factors associated with undiagnosed stage 3 CKD, where there is a mild to moderate loss of kidney function[65], and the potential benefits of early CKD diagnosis across 11 countries. The study also assessed differences in the management and monitoring practices and occurrence of clinical outcomes for patients pre- and post-diagnosis.[68,69]

02. Design
The REVEAL CKD study utilised existing data from electronic medical records and claims databases to identify the prevalence of undiagnosed stage 3 CKD. A patient with undiagnosed CKD was characterised as someone with two consecutive eGFR measurements that met guideline criteria without a corresponding ICD 9/10 diagnostic code any time prior to, or 6 months after, meeting the eGFR criteria.

03. Countries Involved
Australia, Brazil, Canada, China, France, Germany, Italy, Japan, Spain, United Kingdom, United States.

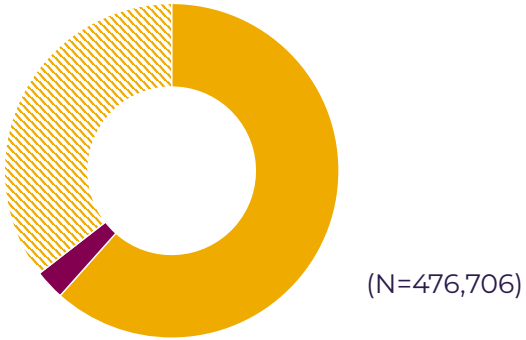
04. Key Outcomes
Published results from the REVEAL CKD study, have thus far demonstrated early-stage CKD is vastly underdiagnosed across the countries evaluated and identified diagnosis as an important first step in improving patient outcomes.

- The proportion of stage 3 patients undiagnosed ranged from 61.6% to 95.5% in France, Germany, Italy, Japan, and USA.[68]
- The proportion of undiagnosed stage 3 patients ranged from 84.9% to 97.1% in Spain, Australia, Canada, and Brazil.[69]
- A diagnosis of stage 3 CKD was associated with improved CKD management, with an observed increase in prescriptions of guideline-directed medical treatment and a delay in disease progression.[7]
- Delays in diagnosis increase the likelihood that stage 3 CKD will progress to late-stage disease by 40% and kidney failure requiring replacement therapy by 63%.[7]
- A patient co-authored commentary developed alongside the REVEAL CKD study, highlights patient and clinician perspectives on the importance of early CKD diagnosis, management and the need for involving and empowering the patient voice in driving policy and practice change to improve CKD care.[70]

Early diagnosis leads to improved prescription rates and slower kidney function decline, yet diagnosis of patients with CKD remains low

CKD diagnosis[1,a]

61.6–95.5% of CKD Stage 3 was undiagnosed

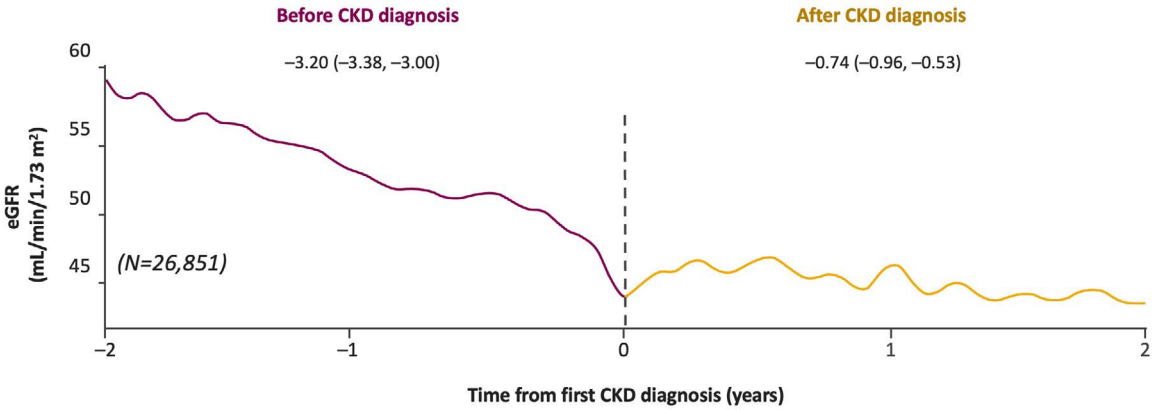


(N=476,706)

Populations least likely to be diagnosed included:

- Females
- Earlier CKD stages
- Fewer comorbidities
- Age <45 years
- Fewer medications

Impact of diagnosis on eGFR decline[2,b]



Recording a diagnosis of CKD Stage 3 led to a preservation of annual **eGFR decline**[2]

[a]Results from France, Germany, Italy, Japan, and the USA; [b]Results from the USA ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; GDMT, guideline-directed medical therapy

1. Tangri N, et al. BMJ Open 2023;13:e067386; 2. Tangri N, et al. Adv Ther 2023;40:2869–2885

REVEAL CKD

05. Relevant Publications

a. Tangri, N., Moriyama, T., Schneider, M. P., Virgitti, J. B., de Nicola, L., Arnold, M., Barone, S., Peach, E., Wittbrodt, E., Chen, H., Järbrink, K., & Kushner, P. (2023). Prevalence of undiagnosed stage 3 chronic kidney disease in France, Germany, Italy, Japan and the USA: Results from the multinational observational REVEAL-CKD study. BMJ Open, 13(5). https://doi.org/10.1136/bmjopen-2022-067386

b. Tangri, N., Peach, E. J., Franzén, S., Barone, S., & Kushner, P. R. (2023). Patient Management and Clinical Outcomes Associated with a Recorded Diagnosis of Stage 3 Chronic Kidney Disease: The REVEAL-CKD Study. Advances in Therapy, 40(6). https://doi.org/10.1007/s12325-023-02482-5

c. Pecoits-Filho, R., de Castro, M. C. R., Cebrian, A., Santamaria, R., Lim, K.-S., Wittbrodt, E., Barone, S., Arnold, M., & Tangri, N. (2023). #3667 REVEAL-CKD: PREVALENCE OF UNDIAGNOSED STAGE 3 CHRONIC KIDNEY DISEASE IN AUSTRALIA, BRAZIL, CANADA AND SPAIN. Nephrology Dialysis Transplantation, 38(Supplement_1). https://doi.org/10.1093/ndt/gfad063c_3667

d. Kushner, P.R., DeMeis, J., Stevens, P. et al. Patient and Clinician Perspectives: To Create a Better Future for Chronic Kidney Disease, We Need to Talk About Our Kidneys. Adv Ther 41, 1318–1324 (2024). https://doi.org/10.1007/s12325-024-02794-0

DISCOVER CKD

Patient characteristics, monitoring and management trends, progression of CKD, selected clinical outcomes, healthcare resource utilization, healthcare costs, quality-of-life.

DISCOVER CKD

01. Aim
The DISCOVER CKD study utilizes data from 6 countries and aims to understand the profiles and experiences of patients with CKD and the practices used in their care, to support efforts to improve management and outcomes in patients with CKD.

02. Design[71]
DISCOVER CKD developed a multinational, longitudinal cohort of patients with CKD and is one of the largest multi-country global cohorts to date. The study includes both retrospective and prospective analysis.

The retrospective aspect of the study collects information from established anonymised datasets. This provides a foundation from which to answer descriptive and longitudinal questions on patient characteristics, comorbidities and complications associated with CKD, management of CKD, and the factors influencing clinical decision making.

The prospective aspect of the study recruited individual patients from participating centres in each country to assess quality-of-life and other patient-reported outcomes.

03. Countries Involved
Italy, Japan, Spain, Sweden, United Kingdom, United States.

04. Key Outcomes
DISCOVER CKD publications have highlighted quality-of-life and healthcare resource utilization differences between early-stage and late-stage CKD patients, revealing worse patient wellbeing outcomes and higher costs for late-stage CKD patients.

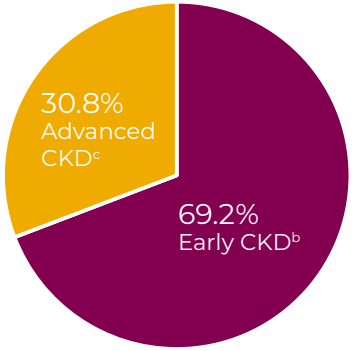
- Patients with late-stage CKD reported lower quality of life, higher symptom severity, and greater impairment in work and activities.[72]
- In the UK, the most severe stage of CKD is associated with annual per-patient costs that are nearly three times greater than the least severe stage, ranging from £4,654-£11,419 per patient.[32]
- Rapid eGFR decline is associated with a greater comorbidity and a significantly higher risk of adverse clinical outcomes.[73]

A rich dataset was explored to generate novel and patient-relevant CKD insights applicable to the real-world CKD treatment landscape[1]

DISCOVER CKD collects data on clinical management, treatment patterns, and patient experiences and QoL[1]

Patient characteristics
(Prospective cohort: N=1051)

Mean age: 62.5 years[2]
Female: 36.9%[2]
Hypertension: 69.9–71.9%[3]
Diabetes: 38.0–42.8%[3]
Hyperlipidemia: 34.3–41.0%[3]
Heart failure: 6.6–9.3%[3]
Median UACR (IQR; mg/mmol): 11.8 (1.9–62.0)[2,a]



Impact on HRQoL[2]

/ Burden was significant across all patients with CKD.
/ Compared with earlier-stage CKD, patients with advanced-stage CKD reported:

[a]N=267; [b]Early CKD = eGFR 30–75 mL/min/1.73 m², advanced CKD = eGFR <15–29 mL/min/1.73 m²; [c]Selected therapies shown. Other medications used by >20% of patients include treatments for anemia, diuretics, calcium channel blockers, beta blockers, anticoagulants, lipid-lowering therapy, and gastroesophageal reflux therapy CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; HRQoL, health-related quality of life; IQR, interquartile range; UACR, urine albumin:creatinine ratio

1. Pecoits-Filho R, et al. Clin Kidney J 2021;14:1570–1578; 2. Pollock C, et al. Presented at World Congress of Nephrology (WCN), March 30–April 2, 2023. Bangkok, Thailand. Poster WCN21-0671;
2. Carrero J, et al. Presented at 60th European Renal Association (ERA) Congress. June 15–18, 2023. Milan, Italy. Poster

DISCOVER CKD

05. Relevant Publications

a. Carrero, J. J., Pollock, C., Kanda, E., Lam, C., Ofori-Asenso, R., Chen, T., Kashihara, N., Fishbane, S., Sanchez, J. J. G., Pentakota, S., Pecoits-Filho, R., & Wheeler, D. C. (2023). #3393 PATIENT-REPORTED OUTCOMES IN EARLY VERSUS ADVANCED CHRONIC KIDNEY DISEASE: EVIDENCE FROM BASELINE DATA IN THE DISCOVER CKD PROSPECTIVE STUDY. Nephrology Dialysis Transplantation, 38(Supplement_1). https://doi.org/10.1093/ndt/gfad063c_3393

b. Pollock, C., James, G., Garcia Sanchez, J. J., Carrero, J. J., Arnold, M., Lam, C. S. P., Chen, H. T., Nolan, S., Pecoits-Filho, R., & Wheeler, D. C. (2022). Healthcare resource utilisation and related costs of patients with CKD from the UK: a report from the DISCOVER CKD retrospective cohort. Clinical Kidney Journal, 15(11). https://doi.org/10.1093/ckj/sfac168

c. Garcia Sanchez, J. J., James, G., Carrero, J. J., Arnold, M., Lam, C. S. P., Pollock, C., Chen, H. (Tony), Nolan, S., Wheeler, D. C., & Pecoits-Filho, R. (2023). Health Care Resource Utilization and Related Costs of Patients With CKD From the United States: A Report From the DISCOVER CKD Retrospective Cohort. Kidney International Reports, 8(4). https://doi.org/10.1016/j.ekir.2023.01.037

d. Pecoits-Filho, R., James, G., Carrero, J. J., Wittbrodt, E., Fishbane, S., Sultan, A. A., Heerspink, H. J. L., Hedman, K., Kanda, E., Chen, H., Kashihara, N., Sloand, J., Kosiborod, M., Kumar, S., Lainscak, M., Arnold, M., Lam, C. S. P., Holmqvist, B., Pollock, C., … Wheeler, D. C. (2021). Methods and rationale of the DISCOVER CKD global observational study. Clinical Kidney Journal, 14(6). https://doi.org/10.1093/ckj/sfab046

e. Heerspink, H., James, G., Nolan, S., Carrero, J. J., Arnold, M., Pecoits-Filho, R., Garcia Sanchez, J. J., Lam, C. S. P., Chen, H., Kanda, E., lainscak, M., Pollock, C., & Wheeler, D. C. (2022). 101 Evaluating Clinical Outcomes in Patients (Pts) With CKD With Rapid and Non-Rapid eGFR Decline: A Report From The DISCOVER CKD Retrospective Cohort. American Journal of Kidney Diseases, 79(4), S31. https://doi.org/10.1053/j.ajkd.2022.01.106

f. Abdul Sultan, A., Heerspink, H., Arnold, M., Pollock, C., Garcia Sanchez, J. J., Carrero, J. J., Pecoits-Filho, R., Lam, C., Kashihara, N., Kanda, E., Kosiborod, M., Fishbane, S., Lainscak, M., Stenvinkel, P., & Wheeler, D. C. (2021). POS-503 EVALUATING CHRONIC KIDNEY DISEASE PROGRESSION: A REPORT FROM THE DISCOVER CKD RETROSPECTIVE COHORT. Kidney International Reports, 6(4), S218–S219. https://doi.org/10.1016/j.ekir.2021.03.531

DISCOVER CKD

g. Pecoits Filho, R., Carrero-Roig, J.J., Kanda, E., Ofori-Asenso, R., Palmer, E., Linder, A., Woodward, H., Pentakota, S., Garcia Sanchez, J.J., Kashihara, N., Fishbane, S., Wheeler, D.C. (2024). WCN24-1543 Patients' Perspective of the Impact of Chronic Kidney Disease: Insights From the Discover CKD Qualitative Study, Kidney International Reports, Volume 9, Issue 4, Supplement, Pages S272-S273, https://doi.org/10.1016/j.ekir.2024.02.557

h. Pecoits Filho, R., Kashihara, N., Fishbane, S., Carrero-Roig, J.J., Ofori-Asenso, R., Hungta, C., Pentakota, S., Garcia Sanchez, J.J., Kanda, E., Pollock, C., Wheeler, D.C. (2024). WCN24-1574 HEALTHCARE RESOURCE UTILIZATION IN PATIENTS WITH CHRONIC KIDNEY DISEASE: INSIGHTS FROM THE DISCOVER CKD PROSPECTIVE STUDY, Kidney International Reports, Volume 9, Issue 4, Supplement, Pages S273-S274, https://doi.org/10.1016/j.ekir.2024.02.559

i. Pecoits Filho, R., Kashihara, N., Ofori-Asenso, R., Chen, T., Pentakota, S., Jarbrink, K., Garcia Sanchez, J.J., Lam, C., Pollock, C., Fishbane, S., Kanda, E (2024). #853 Kidney-protective medication and risk of adverse clinical outcomes in patients with chronic kidney disease: Preliminary findings from DISCOVER CKD [conference abstract]. European Renal Association Congress.

INSIDE CKD

Projected future prevalence of CKD by disease stage, CKD associated clinical events, comorbid conditions, projected future healthcare resource utilization, projected future healthcare costs, and the impact of changes in screening policies.

INSIDE CKD

01. Aim

The aim of INSIDE CKD is to provide country-specific projections of the growing clinical and economic burden of CKD and inform evidence-based policymaking to support early action and intervention in CKD across 30+ countries.[34]

02. Design

INSIDE CKD utilises a patient-level microsimulation model to project the clinical and economic burden of CKD over a five-year timespan between 2022-2027. The model utilised country- and region-specific inputs to develop a representative population of 20 million for each country or region. Utilising a range of demographic, epidemiological, and clinical input variables, the INSIDE CKD study projects the disease progression and clinical burden in the representative populations. Microsimulations can complement data from clinical trials by evaluating scenarios that cannot be feasibly researched in a real-world setting due to time, budget or ethical constraints. Policymakers can use microsimulation modelling to conduct population-level analyses, estimate epidemiological trends and project long-term implications for healthcare for a variety of diseases.[34]

03. Key assumptions and limitations

Statistical microsimulations are dependent on the quality of the input data and based on a number of assumptions. This model has been methodologically validated, however the output estimates are subject to limitations. Some key assumptions and limitations have been outlined below, please refer to the published manuscripts for full limitations and use of proxy data inputs.[24,34,75,76]

- Assumes no major changes in the management of CKD between 2022 and 2027
- Assumes no novel therapeutics introduced or changes in the costs or availability of medicines between 2022 and 2027
- Limited publications and/or lack of national registry data necessitated proxy data use for some countries/regions.
- Projections are unable to account for the influence of cultural, societal and economic performance on healthcare systems, which limits the ability to make balanced international comparisons of the data

04. Countries Involved

Australia, Brazil, Canada, China, France, Germany, Italy, Japan, Spain, UK, United States, Belgium, India, Israel, Mexico, Philippines, Saudi Arabia, South Korea, Sweden, Taiwan, Thailand, Turkey, Colombia, Denmark, Greece, Hungary, Netherlands, Poland, Romania, Singapore, UAE.[34]

INSIDE CKD

05. Key Outcomes

Inside CKD projections indicate that the prevalence of CKD and RRT will increase over the next 5 years. Clinical and economic needs associated with a rise in CKD will pose a challenge to healthcare systems.

- Results from INSIDE CKD projected an increase in the prevalence of CKD by up to 16% between 2021- 2026 across 10 countries (AUS, BRA, CAN, CHN, FRA, ITA, JPN, ESP, UK, USA).[76,77]
- As the prevalence of CKD increases, the need for renal replacement therapies (RRT), such as dialysis and kidney transplant, is projected to increase by 1.8-23.9% from 2021 to 2026 across 11 countries.[23]
- Annual costs associated with CKD and RRT are projected to rise between 2021- 2026 by a range of 5.7% to 22.8% across 11 countries.[25]
- Across 31 countries the mean per patient annual treatment costs range from $3,060 at stage 3a to $8,736 at stage 5.[74]
- The mean per-patient annual costs for patients with kidney failure are higher, ranging from $57,334 for haemodialysis to $49,490 for peritoneal dialysis.[74]

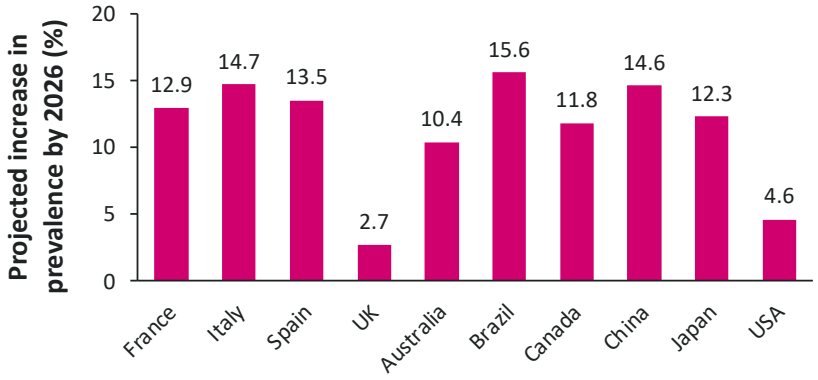
Discover more on the data at www.InsideCKD.com (an AstraZeneca website)

To gain deeper insights into the clinical and economic burden of chronic kidney disease (CKD) across 30+ countries and regions, visit the **Inside CKD dashboard**. The dashboard provides country-specific information on CKD prevalence, treatment costs, and renal replacement therapies from 2022 to 2027 (projected using microsimulation modelling), to help better understand how CKD impacts each region uniquely and support tailored healthcare strategies and informed policymaking.

The burden of CKD on healthcare systems is growing; eGFR and UACR testing offers a realistic and cost-effective solution to mitigate this impact

CKD prevalence[1,2]

Up to **16% increase** in prevalence of CKD by 2026



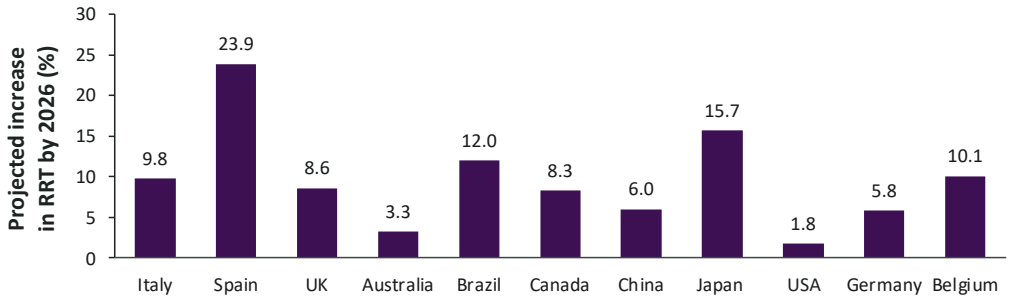
/ The profile of CKD is expected to shift towards more advanced stages of CKD over time[2]

/ Progression of CKD is associated with increased risk of ESKD, CV events, and premature mortality[2]

/ Screening both UACR and eGFR is cost-effective and facilitates earlier identification and treatment of patients[4]

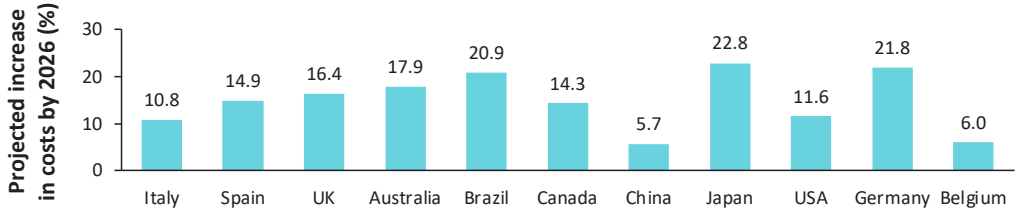
Dialysis and transplantation[3]

Up to **24% increase** in dialysis and kidney transplantation by 2026



Annual costs associated with CKD and RRT[3]

Up to **23% increase** in annual costs associated with CKD and RRT by 2026



CKD, chronic kidney disease; CV, cardiovascular; eGFR, estimated glomerular filtration rate; ESKD, end-stage kidney disease; RRT, renal replacement therapy; UACR, urine albumin:creatinine ratio.

1. Power A, et al. Presented at the International Society of Nephrology's World Congress of Nephrology (WCN), April 15–19, 2021. Virtual meeting. Poster WCN21-0657; 2. Tangri N, et al. Presented at the International Society of Nephrology's World Congress of Nephrology (WCN), April 15–19, 2021. Virtual meeting. Poster WCN21-0668; 3. Mennini F, et al. Presented at ISPOR Europe, November 30–December 3, 2021. Virtual meeting. Poster POSB68; 4. Tangri N, et al. [Draft manuscript – Inside CKD: Cost-effectiveness of screening strategies in CKD]

INSIDE CKD

05. Relevant Publications

a. Tangri, N., Chadban, S., Cabrera, C., Retat, L., & Sánchez, J. J. G. (2023). Projecting the Epidemiological and Economic Impact of Chronic Kidney Disease Using Patient-Level Microsimulation Modelling: Rationale and Methods of Inside CKD. Advances in Therapy, 40(1). https://doi.org/10.1007/s12325-022-02353-5

b. Jha, V., Al-Ghamdi, S. M. G., Li, G., Wu, M. S., Stafylas, P., Retat, L., Card-Gowers, J., Barone, S., Cabrera, C., & Garcia Sanchez, J. J. (2023). Global Economic Burden Associated with Chronic Kidney Disease: A Pragmatic Review of Medical Costs for the Inside CKD Research Programme. Advances in Therapy, 40(10). https://doi.org/10.1007/s12325-023-02608-9

c. Mennini, F., Cabrera, C., Card-Gowers, J., Chertow, G., de Nicola, L., Halimi, J., Nolan, S., Power, A., Retat, L., Vesga, J., Webber, L., Wish, J., Xu, M., & Garcia Sanchez, J. (2022). POSB68 Inside CKD: Projecting the Economic Burden of Chronic Kidney Disease Using Patient-Level Microsimulation. Value in Health, 25(1), S73. https://doi.org/10.1016/j.jval.2021.11.341

d. Garcia Sanchez, J. J., Abdul Sultan, A., Ärnlöv, J., Cabrera, C., Card-Gowers, J., de Nicola, L., Halimi, J.-M., Mennini, F. S., Navarro-González, J. F., Nolan, S., Power, A. J., Retat, L., Webber, L., & Xu, M. (2021). MO498 INSIDE CKD: MODELLING THE CLINICAL AND ECONOMIC IMPACTS OF TARGETED URINARY ALBUMIN-TO-CREATININE RATIO SCREENING IN EUROPEAN COUNTRIES. Nephrology Dialysis Transplantation, 36(Supplement_1). https://doi.org/10.1093/ndt/gfab087.0018

e. Abdul Sultan, A., Ärnlöv, J., Cabrera, C., Card-Gowers, J., de Nicola, L., Garcia Sanchez, J. J., Halimi, J.-M., Mennini, F. S., Navarro-González, J. F., Nolan, S., Power, A. J., Retat, L., Webber, L., & Xu, M. (2021). MO494 INSIDE CKD: MODELLING THE ECONOMIC BURDEN OF CHRONIC KIDNEY DISEASE IN EUROPE USING PATIENT-LEVEL MICROSIMULATION. Nephrology Dialysis Transplantation, 36(Supplement_1). https://doi.org/10.1093/ndt/gfab087.0014

INSIDE CKD

f. Garcia Sanchez, J. J., Abdul Sultan, A., Batista, M. C., Cabrera, C., Card-Gowers, J., Chadban, S., Chertow, G., Kanda, E., Li, G., Nolan, S., Retat, L., Tangri, N., Webber, L., Wish, J., & Xu, M. (2021). MO486 INSIDE CKD: MODELLING THE IMPACT OF IMPROVED SCREENING FOR CHRONIC KIDNEY DISEASE IN THE AMERICAS AND ASIA-PACIFIC REGION. Nephrology Dialysis Transplantation, 36(Supplement_1). https://doi.org/10.1093/ndt/gfab087.006

g. Abdul Sultan, A., Batista, M. C., Cabrera, C., Card-Gowers, J., Chadban, S., Chertow, G., Garcia Sanchez, J. J., Kanda, E., Li, G., Nolan, S., Retat, L., Tangri, N., Webber, L., Wish, J., & Xu, M. (2021). MO518 INSIDE CKD: MODELLING THE ECONOMIC BURDEN OF CHRONIC KIDNEY DISEASE IN THE AMERICAS AND THE ASIA-PACIFIC REGION USING PATIENT-LEVEL MICROSIMULATION. Nephrology Dialysis Transplantation, 36(Supplement_1). https://doi.org/10.1093/ndt/gfab087.0038

h. Garcia Sanchez, J. J., Tangri, N., Abdul Sultan, A., Batista, M. C., Cabrera, C., Chadban, S., Chertow, G., Kanda, E., Li, G., Nolan, S., Retat, L., Xin, S., Webber, L., Wish, J., & Xu, M. (2021). POS-322 INSIDE CKD: PROJECTING THE FUTURE BURDEN OF CHRONIC KIDNEY DISEASE IN THE AMERICAS AND THE ASIA-PACIFIC REGION USING MICROSIMULATION MODELLING. Kidney International Reports, 6(4), S138–S139. https://doi.org/10.1016/j.ekir.2021.03.338

IMPACT CKD

Policy impact, projected burden of CKD, benefits of policy interventions on future burdens of CKD, prevalence, clinical events, mortality, healthcare costs, productivity, economic indicators, and environmental outcomes.

IMPACT CKD

01. Aim

The IMPACT CKD study aims to evaluate the multifaceted impact of CKD on patients, healthcare systems, and broader society with continued current practice and following policy interventions. By projecting the future implications of CKD through to 2032 under current clinical practice (Phase 1), and extending the model to 2047 to assess the potential benefits of targeted screening, improved diagnosis and adherence to guideline-directed medical therapy (GDMT) (Phase 2), the study seeks to illuminate the significant benefits of policy interventions on patient health, healthcare resource allocation, economic stability, workforce productivity, and environmental sustainability. Ultimately, IMPACT CKD aspires to bolster health system evaluations and inform health policy decisions, enhancing awareness and care for individuals afflicted with CKD.[37,41]

02. Design

Employing an individual-level microsimulation approach, Phase 1 of the IMPACT CKD study forecasts the clinical, economic, societal, and environmental burden of CKD under current clinical practice over a decade (2022-2032). Utilizing both local and surrogate (if local was unavailable) data, the study constructs a demographic of 1 million individuals (diagnosed, undiagnosed, and non-CKD) for each participating country, simulating disease progression and its consequent impact. The findings are then combined and scaled to mirror the entire population of each country involved, providing a comprehensive view of CKD's potential trajectory.[37]

In Phase 2, the time horizon was extended to 25 years (2022-2047) given the slow and progressive nature of CKD requiring models to evaluate policy interventions on similar time scales. The model was expanded to simulate the following four policy intervention scenarios reflecting population-level targets in screening, diagnosis, and GDMT adherence. These scenarios were then assessed against current practice to estimate the long-term clinical, economic, societal, and environmental benefits of implementing recommended CKD policies:

- increase in CKD-diagnosed population by 25%,
- 75% adherence to GDMT,
- increase in CKD-diagnosed population by 25% combined with 75% adherence to GDMT, and
- targeted CKD screening every year for patients with comorbidities (including diabetes mellitus, hypertension, heart failure, history of myocardial infarction, and history of stroke), and over the age of 45 years combined with 75% adherence to GDMT.[41]

This dual-phase design enables comparison of projected burdens under status quo care with the potential impact of proactive health policy implementation.

IMPACT CKD

03. Key assumptions and limitations

The IMPACT CKD model has been validated by over 60 cross-functional experts but carries limitations inherent to microsimulation modelling, including certain simplifying assumptions due to data availability and heterogeneity across countries. Some key limitations are outlined below, and full details are available in the published manuscripts.[37,41]

- Variation in data sources across countries, including differences in quality, population, and timepoint required use of proxy data where local inputs were unavailable and limited the feasibility of probabilistic sensitivity analyses.
- Limited availability of data on undiagnosed CKD by stage and lack of dynamic population growth (births or immigration) increase uncertainty around total prevalence estimates.
- Health system outcomes reflect only diagnosed CKD and may be underestimated, especially in countries where CKD is primarily managed in outpatient settings.
- The model assumed no major changes to treatment guidelines or introduction of new therapies.
- Albuminuria-related treatment effects were not included, potentially underestimating the full clinical impact of increased GDMT adherence.
- Most lifestyle interventions were excluded due to limited evidence, with only physical activity incorporated.
- Environmental projections were based on current care models and did not account for system-level changes such as decarbonization efforts or wider telemedicine adoption.
- Policy interventions were not costed due to uncertainty around implementation specifics and local variability.

04. Countries Involved

Australia, Brazil, China, Germany, Netherlands, Spain, United Kingdom, United States.[37,41]

IMPACT CKD

05. Key Outcomes from Phase 1: Projected Burden of CKD from 2022 to 2032
The findings highlight a substantial increase in the clinical, economic, societal, and environmental burden of CKD across 8 countries by 2032, providing insight into the global and country-specific trends that draw attention to the importance of acting now on CKD.

- By 2032, projections suggest that CKD (stage 3-5) will affect nearly 125 million people across 8 countries—a 25% increase from 2022.[37]
- An associated surge is projected in patients undergoing dialysis across these countries, with RRT costs potentially reaching $186B USD by 2032.[37]
- Due to increased prevalence and progression to late-stage CKD, emergency room visits and hospitalizations are also projected to rise by more than 20% among patients with CKD in 7 of the 8 countries between 2022 and 2032.[51]
- As a result, a substantial increase in associated health care system costs is also projected, with the economic toll of CKD (stages 3–5, non-RRT) across 8 countries estimated to reach $470 billion USD by 2032.[51]
- CKD symptoms are also expected to cause 2.85 billion missed workdays between 2022 to 2032, with caregivers missing an additional 319.15 million workdays.[37] Patient and caregiver absenteeism is projected to lead to a loss of $4.16 trillion USD in gross domestic product and 37 billion USD in lost tax revenue by 2032 across the 8 countries.[37]
- By 2032, the environmental burden associated with CKD across the 8 IMPACT CKD countries will grow across these countries. For example:
  - Freshwater consumption associated with RRT is projected to reach 440 million m^3 by 2032—equivalent to the annual water usage of 2.7 million households.[37]
  - RRT will use 11 billion kg oil equivalent of fossil fuel use.[37]
  - CO_2 emissions associated with RRT are expected to reach 29 billion kg of CO_2 equivalent of carbon—the same as 17.3 million cars.[37]

IMPACT CKD

06. Key Outcomes from Phase 2: Projected Impact of Policy Interventions from 2022 to 2047

Over a 25-year horizon, the modelling projects significant clinical, socioeconomic and environmental benefits from annual targeted screening in high-risk populations (e.g. patients with comorbidities and adults over 45), combined with improved adherence to guideline-directed medical therapy (GDMT) reaching 75%.

- Targeted screening and improved GDMT adherence were projected to prevent more than 15 million deaths and reduce major cardiovascular (CV) events by 37.3% to 48.1% across 8 countries.[41]
- Over 25 years, these interventions were also projected to lower dialysis use by 27.2% to 55% across these countries, leading to a 19.4% to 46.8% reduction in RRT costs.[41]
- In a European aggregate population analysis (Germany, Netherlands, Spain, United Kingdom), the same strategy was projected to:
  - Reduce dialysis use by 43.8%, with an associated 38.0% reduction in RRT costs-equivalent to €171.8 million.[41]
  - Deliver additional clinical benefits, including a 43.8% reduction in CV events and a 4.6% drop in all-cause mortality.[41]
  - Lead to environmental benefits, with reductions in freshwater consumption, fossil fuel use, and carbon emissions by 40.9%, 38.8%, and 39.2%, respectively.[41]
- The model also projected broader socioeconomic gains in Europe, including a €100 billion rise in net GDP contribution and 6.4 million additional full-time workers over 25 years, reflecting gains in productivity and workforce participation after accounting for CKD-related absenteeism and presenteeism.[41]
- Similar trends were observed across all 8 countries. Trends held at the 10-year mark, albeit with smaller magnitude, underscoring the long-term value of early and consistent intervention.[41]
- Less frequent screening (every 3-5 years) led to smaller reductions in dialysis, cardiovascular events, mortality, and environmental burden. Annual targeted screening consistently yielded the greatest impact.[41]

A 360° view of CKD demonstrates the unprecedented toll of CKD over the next 10 years, and the potential impact of policy intervention

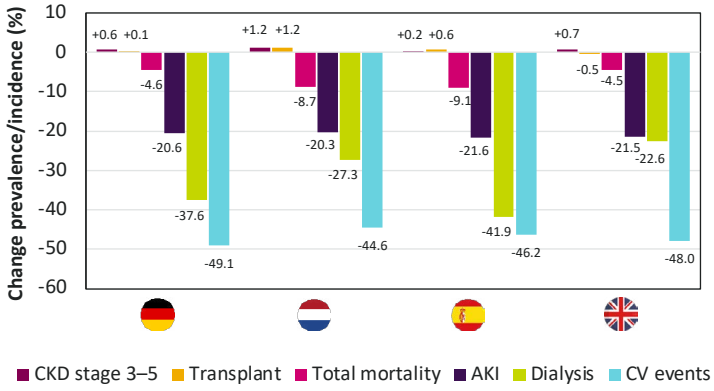
Projected Burden of Disease[1]

Clinical	Overall prevalence of CKD is projected to range from **11.7–16.5%**, reaching **~322 million** in 2032 · CKD stage 3–5 will increase by **25%**
Economic	By 2032, there will be: · **75% to 170%** increase in dialysis and RRT costs · Up to a **58%** increase in CKD-associated hospitalizations and ER visits[a]
Societal	Over 10 years: · **~2.85 billion** workdays will be missed by CKD patients · **~$37 billion USD** of lost tax revenue due to CKD-associated absenteeism
Environmental	By 2032, there will be: · **440 million m³** of freshwater consumption · **11 billion kg oil eq.** of fossil fuel use · **29 billion kg CO_2 eq.** of carbon use

The impact of targeted CKD screening followed by guideline-directed medical therapy on the prevalence of CKD and incidence of CKD-associated events

Clinical impact[2]

Change in CKD prevalence and incidence of CV events, AKI and death in high-risk populations with T2D and/or HTN by 2032



CKD, chronic kidney disease; ER, emergency room; RRT, renal replacement therapy

1. Rao N, et al. Presented at World Congress of Nephrology; April 13–16, 2024. Buenos Aires, Argentina. Poster; 2. Rao N, et al. Presented at 61st European Renal Association Congress; May 23–26, 2024. Abstract 2617

Projected CKD burden over 25 years with targeted screening and improved GDMT

From 2022 to 2047 across eight Wave 1 countries:

- **27.2%** to **55%** reduction in dialysis prevalence
- **37.3%** to **48,1%** reduction in all major CV events
- **19.4%** to **46.8%** reduction in RRT costs
- **18%** to **51%** reduction in RRT-related environmental burden
- **1.4%** to **10%** increase in net tax revenue*

From 2022 to 2047 in a European aggregate population analysis (Germany, Netherlands, Spain, United Kingdom):

- Increase in total net workdays by up to **7.1%** among caregivers
- Increase in net GDP contribution by **1.0%***
- Increase in total net FTE by **5.0%***
- Increase in net tax revenue by **4.7%***

** Net figures account for labor productivity loss associated with CKD due to absenteeism/presenteeism in patients and absenteeism in caregivers. Tax revenue is based on country-specific net income by CKD stage and OECD tax wedge inputs. GDP is based on productivity-adjusted GDP per hour worked by patients with stage 3+ CKD and their caregivers.*

CKD, chronic kidney disease; GDMT, guideline-directed medical therapy; CV, cardiovascular; RRT, renal replacement therapy; GDP, gross domestic product; FTE, full-time equivalents.

1. Tangri N., Priest S., Zara A., Long B.R., Chen J., Rao N., Froguel C.E., Robson B., Guldemond N., Eckelman M., Moura A.F., Audehm R., Adshead F., Zhao M., Wanner C. & Chadban S. (2025). Impact of improved diagnosis and treatment on holistic CKD burden. Kidney International Reports. In press. Journal Pre-proof. doi:10.1016/j.ekir.2025.05.039. Available at: https://www.sciencedirect.com/science/article/pii/S2468024925003420

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06. Relevant Publications

a. Sanchez, J. J. G., Wheeler, D. C., Brown, S., Priest, S., Guiang, H., Webber, C. J., Wharton, G., Barone, S., & Grima, D. (2023). #4271 THE GROWING BURDEN OF CHRONIC KIDNEY DISEASE IN THE UK: AN IMPACT CKD ANALYSIS. Nephrology Dialysis Transplantation, 38(Supplement_1). https://doi.org/10.1093/ndt/gfad063c_4271

b. Priest, S., Guiang, H. A., Johnston-Webber, C., Rao, N., Chen, J., Bhandary, D., Berria, R., Brown, S., Grima, D., & Skolnik, N. (2023, November 3). IMPACT CKD: Projecting the Growing Environmental Burden of CKD in the United States. ASN Kidney Week 2023. https://www.asn-online.org/education/kidneyweek/2023/program-abstract.aspx?controlId=3945715

c. Bermudez, I. B., Webber, C. J., Sanchez, J. J. G., Wharton, G., Duncan, N., Fluck, R., Javaid, Y., Roderick, P., Wheeler, D. C., & Mcguire, A. (2023). #4167 THE HEALTH, SOCIOECONOMIC AND ENVIRONMENTAL IMPACT OF CKD IN THE UK: BUILDING A CONCEPTUAL FRAMEWORK. Nephrology Dialysis Transplantation, 38(Supplement_1). https://doi.org/10.1093/ndt/gfad063c_4167

d. Rao, N., Wheeler, D., Brotons-Munto, F., Brown, S., Grima, D., Priest, S., Moura, A.F., W.H.Kocks, J., Zhao, M., Obolensky, K., Chen, J., Chadban., S. (2024). #1204 Multidimensional Burden of Chronic Kidney Disease in Eight Countries: Insights from the IMPACT CKD Study [conference abstract]. World Congress of Nephrology. https://doi.org/10.1016/j.ekir.2024.02.540

e. Rao, N., Guiang, H., Priest, S., Brown, S., Wyman, C., Cases, A., Chadban, S., Tangri, N. (2024). #2617 Impact of CKD screening in high-risk populations and guideline-directed therapy on RRT, CV events, and mortality in Europe: an IMPACT CKD analysis [conference abstract]. European Renal Association Congress.

f. Rao, N., Guiang, H., Priest, S., Brown, S., Wyman, C., Tangri, N., Chadban, S. (2024). #2766 Impact of CKD screening in high-risk populations and guideline-directed therapy on CV event occurrence and costs in Europe: an IMPACT CKD analysis [conference abstract]. European Renal Association Congress.

g. Rao N., Brutos-Munto F., Moura A.F., Kocks J.W.H., Zhao M., Chadban S., Guiang H., Priest S., & Brown S. (2025). Holistic Impact of CKD: A Clinical, Economic, and Environmental Analysis by IMPACT CKD. Kidney International Reports, 2468-0249. https://doi.org/10.1016/j.ekir.2025.03.051

f. Tangri N., Priest S., Zara A., Long B.R., Chen J., Rao N., Froguel C.E., Robson B., Guldemond N., Eckelman M., Moura A.F., Audehm R., Adshead F., Zhao M., Wanner C. & Chadban S. (2025). Impact of improved diagnosis and treatment on holistic CKD burden. Kidney International Reports. In press. Journal Pre-proof. doi:10.1016/j.ekir.2025.05.039. Available at: https://www.sciencedirect.com/science/article/pii/S2468024925003420

Environmental impact of chronic kidney disease

Carbon emissions, fine particulate matter formation, photochemical ozone formation and freshwater usage.

Environmental impact of chronic kidney disease

01. Aim
This study provides a comprehensive analysis of the CKD patient care pathway across different stages of CKD to identify areas with high environmental impact and guide policy interventions to mitigate impact at all CKD stages.

02. Design
This study utilised a Life Cycle Assessment (LCA) methodology to investigate the impact of the complete healthcare pathway at each stage of CKD. The LCA methodology generates an environmental profile of the care pathway, utilising local data where possible to illustrate the CKD treatment pathway including healthcare visits, hospitalisations, transport, and kidney replacement treatment modalities.

The study evaluates measures such as fine particulate matter, fossil fuel depletion, and freshwater consumption as a result of the CKD care pathway.

03. Countries Involved
Australia, Belgium, Brazil, Germany, Japan, Italy, Netherlands, Spain, United Kingdom, United States.

04. Key Outcomes
Preliminary findings from this study have revealed the significant environmental burden of in-centre haemodialysis in the UK.

- The carbon footprint from in-centre haemodialysis, evaluated per patient, was estimated to be 3,900 kg CO_2 equivalents which is roughly equal to the average UK person's annual carbon emissions.[78]
- 93,600 litres of water and 3,058 kWh electricity was estimated per patient on in-centre haemodialysis annually in the UK.[78]

05. Relevant Publications
a. Zoccali, C., Barraclough, K., Eckelman, M., Amenos, A. C., Germond-Duret, C., Pecoits-Filho, R., Sanchez, J. J. G., Selvarajah, V., Hubbert, L., & Nicholson, L. (2023). #2695 THE ENVIRONMENTAL IMPACT OF CHRONIC KIDNEY DISEASE INTERNATIONALLY: RESULTS OF A LIFE CYCLE ASSESSMENT. Nephrology Dialysis Transplantation, 38(Supplement_1). https://doi.org/10.1093/ndt/gfad063c_2695

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