Research Square

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Burden of Chronic Kidney Disease in India: Past, Present, and Future Projections to 2040 from the Global Burden of Disease 2021 Study

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Abstract

Background:

Chronic kidney disease (CKD) is among the fastest-rising causes of mortality in India, yet national projections of its future burden are scarce. We quantified the current CKD burden and forecast trajectories to 2040 under alternative scenarios.

Methods:

Using Global Burden of Disease (GBD) 2021 estimates, we assessed CKD outcome data. Projections to 2040 were generated under: (i) flat-rate (stable age-specific rates), (ii) trend (continuing average annual percent change from 2010–2021), and (iii) policy scenario (achieving risk factor control targets), with population forecasts from the Institute for Health Metrics and Evaluation.

Results:

In 2021, CKD caused 175,637 deaths (ASR 12.4 per 100,000; 95% UI 10.4–14.9) and 6.49 million DALYs (ASR 459 per 100,000; UI 393–534). Prevalence reached 128.0 million cases (9.3% of the population), with 2.24 million incident cases. Under flat-rate projections, CKD deaths will rise to 396,000 (UI 332,000–473,000) and DALYs to 14.6 million (UI 12.5–17.0 million) by 2040. In the trend scenario, deaths escalate to 556,000 (UI 465,000–671,000) and DALYs to 17.8 million (UI 15.4–20.7 million). Compared with the trend, achieving policy targets could avert 83,000 deaths and 2.3 million DALYs annually by 2040.

Conclusion:

By 2040, CKD is projected to become a top-five cause of death in India, with mortality potentially exceeding half a million annually. The contrast between trend and policy scenarios highlights a substantial preventable burden. Strengthening diabetes and hypertension control, integrating an early CKD detection program, and ensuring equitable access to renal replacement therapy are urgently needed to bend the trajectory.

Introduction

Chronic kidney disease (CKD) has become a leading noncommunicable disease (NCD) challenge worldwide. It is the third fastest rising cause of death globally, and one of the few major NCDs with persistently increasing age-standardized mortality.[1] In 2021, CKD accounted for an estimated 1.5 million deaths worldwide more than tuberculosis or HIV/AIDS[2] and affects nearly one in ten adults globally.[3] CKD is closely linked to diabetes and hypertension, and also amplifies cardiovascular risk, making it a central player in the global NCD agenda.[4]

India, home to nearly one-sixth of the world's population, is undergoing a rapid epidemiological transition. Mortality from infectious diseases has declined, while NCDs dominate the disease burden.[5] CKD has shown one of the steepest increases among Indian NCDs: by 2019 it ranked among the top 10 causes of death nationally, compared with being outside the top 15 in 1990.[6] The burden is fuelled by India's rising prevalence of diabetes (second highest globally), high rates of uncontrolled hypertension, environmental exposures such as air pollution, and

population aging.[7,8] Access to renal replacement therapy remains limited despite national initiatives like the Pradhan Mantri National Dialysis Programme (2016),[9,10] and most patients with kidney failure die prematurely due to treatment unaffordability.[11]

Despite the growing recognition of CKD, India lacks national projections of future CKD burden. Previous Global Burden of Disease (GBD) analyses have highlighted the global rise of CKD,[12,13] but few have disaggregated the Indian burden by age, sex, and etiology or forecast future scenarios. Projections are critical for policy and health system planning, as CKD is expected to climb further in the cause-of-death rankings. Understanding whether CKD deaths will rise by one-third or nearly double by 2040 has direct implications for dialysis capacity, transplant programs, financial protection schemes, and integration into national NCD strategies.

Therefore, in this study, we used the GBD 2021 dataset to provide the most up-to-date national estimates of CKD burden in India and to project outcomes to 2040 under alternative scenarios: (i) a flat-rate demographic scenario, (ii) a trend scenario extrapolating recent increases, and (iii) a policy scenario assuming improved control of risk factors. These projections quantify the avoidable CKD burden if India strengthens diabetes and hypertension control, scales up early CKD detection, and expands access to renal replacement therapy. The findings aim to inform policymakers and clinicians alike on the urgency of addressing CKD within India's broader NCD response.

Methods

Data sources and case definition

We obtained data from the Global Burden of Disease (GBD) 2021 study, which provides annual estimates for causes of death, disability-adjusted life years (DALYs), prevalence, and incidence across 204 countries, including India.[14] CKD in GBD is defined as stages 1–5 disease due to five underlying causes: type 1 diabetes, type 2 diabetes, hypertension, glomerulonephritis, and other/unspecified causes. Patients with treated end-stage kidney disease (dialysis or transplant) are not separately captured under CKD mortality, but are included within prevalence and DALY estimates. The data was downloaded on 1 Sept 2025, and is available as public open access source for reproducibility: https://doi.org/10.5281/zenodo.17036630

Measures and disaggregation

For India, we extracted the following measures from 1990 to 2021: Cause-specific mortality due to CKD, DALYs, decomposed into years of life lost (YLLs) and years lived with disability (YLDs), Prevalence of CKD (all stages), and Incidence of new CKD cases per year. The estimates were stratified by age group, sex, and CKD etiology. We report both all-age counts and age-standardized rates (ASR) per 100,000 population, with 95% uncertainty intervals (UIs) generated from 1,000 draws in the GBD model.

Projection scenarios

We projected CKD burden in India from 2022 to 2040 using three approaches: 1) Flat-rate scenario — assumes age-specific rates remain constant at 2021 levels, with future changes driven only by population growth and aging. 2) Trend scenario — extrapolates recent average annual percent changes (AAPC, 2010–2021) in CKD mortality and DALY rates forward to 2040. 3) Policy scenario — assumes attainment of improved risk factor control targets

(notably hypertension and diabetes management), leading to gradual reduction in CKD mortality and DALY rates relative to the trend. Population forecasts by age and sex were obtained from the Institute for Health Metrics and Evaluation (IHME) reference scenario.[15]

Analytical approach

For each scenario, projected deaths, DALYs, prevalence, and incidence were estimated by applying age-specific rates to projected populations. The difference between the trend and policy scenarios was calculated to estimate avoidable deaths and DALYs. Figures present national trajectories for 1990–2021 (historical) and 2022–2040 (projected).

Statistical analysis

All analyses adhered to the GATHER reporting guidelines for health estimates. Data extraction and processing were performed in R (v4.2) and Python. Detailed methods, including regression models for AAPC estimation, propagation of uncertainty, and sensitivity analyses, are provided in the Supplementary Appendix.

Ethics and funding

This study used de-identified, publicly available data and did not require ethics approval. No specific funding was received.

Results

Current burden in 2021

In 2021, chronic kidney disease (CKD) was responsible for 175,637 deaths in India (95% UI, 146,072–208,715), accounting for 2.5% of all deaths nationally. The corresponding age-standardized mortality rate (ASMR) was 12.4 per 100,000 population (95% UI, 10.4–14.9), nearly double the global average.(**Fig. 1**) CKD also contributed 6.49 million disability-adjusted life years (DALYs) (95% UI, 5.59–7.50 million), with an age-standardized DALY rate (ASDR) of 459 per 100,000 (95% UI, 393–534). Almost three-quarters of DALYs arose from premature death, underscoring the heavy mortality burden.

The prevalence of CKD was 128.0 million cases (95% UI, 118.5–138.7 million), representing 9.3% of India's population (**Supplementary Fig. 1**), with 2.24 million new cases diagnosed in 2021. Men accounted for the majority of deaths (59%), while women had slightly higher prevalence, reflecting more prolonged survival with CKD. The disease burden rose sharply with age: 84% of CKD deaths occurred in those ≥ 50 years, and nearly half in those ≥ 70 years (**Supplementary Fig. 2**).

By etiology, type 2 diabetes was the leading contributor, responsible for one-third of CKD deaths, followed by hypertension (19%), glomerulonephritis (14%), and type 1 diabetes (9%) (**Supplementary Fig. 3**). Together, diabetes and hypertension accounted for more than half of India’s CKD burden, highlighting the dominance of metabolic drivers.

Trends from 1990 to 2021

Between 1990 and 2021, CKD mortality in India tripled, rising from 58,500 to 175,600 deaths. The ASMR increased from 6.9 to 12.4 per 100,000, corresponding to an average annual percent change (AAPC) of + 1.9%. DALYs rose in parallel, with the ASDR nearly doubling (AAPC + 1.5%). Unlike communicable diseases such as tuberculosis and diarrheal illness, which declined, CKD showed persistent upward trends.

Joinpoint regression (Fig. 3) identified two inflection points in mortality trends (Fig. 3). From 1990–2000, mortality increased slowly (APC + 0.8% per year, 95% CI + 0.4 to + 1.3). Between 2000 and 2010, the slope steepened markedly (APC + 2.2%; 95% CI + 1.8 to + 2.6), coinciding with India's rapid rise in diabetes and hypertension prevalence. After 2010, the increase persisted but at a slower pace (APC + 0.6%; 95% CI + 0.2 to + 1.0). DALY patterns followed a similar trajectory, with an overall AAPC of + 1.5% (95% CI + 1.0 to + 1.9). These findings indicate that the CKD epidemic in India has unfolded in phases, with the sharpest escalation in the early 2000s.

Trends in etiology mirrored this transition. Diabetes-related CKD showed the steepest rise, while glomerulonephritis-related burden stabilized or declined. Hypertension-related CKD rose steadily, consolidating its position as the second leading cause.

Gender differences in burden

Marked sex disparities were evident (Fig. 4). In 2021, men experienced an ASMR of 14.1 per 100,000 (95% UI 12.0–16.5) compared with 10.9 per 100,000 in women (95% UI 9.2–12.8). The male ASDR was also higher (502 per 100,000; 95% UI 430–580) than the female rate (422 per 100,000; 95% UI 365–492). By contrast, women had slightly higher CKD prevalence, reflecting greater survival with the disease.

Trends show that the male disadvantage in mortality widened after 2000: between 2000 and 2010, APC was + 2.0% in men versus + 1.4% in women, and the gap persisted thereafter. By 2040, under the trend scenario, annual deaths are projected to exceed 320,000 in men versus 235,000 in women. The policy scenario narrows but does not eliminate this disparity. These findings highlight the need for gender-sensitive strategies in CKD prevention and care.

Projections to 2040

Looking forward, the CKD burden is projected to increase substantially under all scenarios (Table 1, **Fig. 2**).

Flat-rate scenario: If age-specific rates remain at 2021 levels, demographic change alone will drive annual deaths to 396,000 by 2040 (95% UI, 332,323–473,240), a 37% increase. DALYs are projected to reach 14.6 million (95% UI, 12.5–17.0 million), with prevalence approaching 160 million cases, or nearly 1 in 10 Indians.

Trend scenario: Continuing recent increases would push annual deaths to 556,000 by 2040 (95% UI, 464,507–670,733) and DALYs to 17.8 million (95% UI, 15.4–20.7 million), nearly doubling the 2021 burden. CKD would rank among the top five causes of death in India, surpassing traditional communicable killers and approaching ischemic heart disease and stroke.

Policy scenario: Partial achievement of improved diabetes and hypertension control would reduce the 2040 toll to 473,000 deaths (95% UI, 394,831–570,123) and 15.5 million DALYs (95% UI, 13.5–17.9 million). Although absolute numbers still rise due to demographic momentum, the trajectory is substantially flatter than the trend scenario.

The contrast between flat and trend scenarios demonstrates the impact of recent accelerations in CKD, while the policy scenario highlights the potential for mitigation.

Avoidable burden under policy intervention

The gap between the trend and policy scenarios quantifies the scale of preventable CKD burden. By 2040, achieving policy targets could avert 83,500 deaths and 2.3 million DALYs annually, equivalent to nearly one in seven deaths and one in eight DALYs otherwise expected under the trend. The divergence becomes evident by 2030 and widens thereafter, underscoring both the urgency and the potential payoff of timely intervention.

Discussion

This study provides the most comprehensive assessment to date of the chronic kidney disease (CKD) burden in India, integrating Global Burden of Disease (GBD) 2021 data with forward-looking projections to 2040. We found that CKD caused more than 175,000 deaths and 6.5 million DALYs in 2021, and under current trends, mortality could exceed half a million annually by 2040. By framing flat, trend, and policy scenarios, our analysis quantifies the avoidable CKD burden if India strengthens control of metabolic risk factors and expands renal services.

Extending beyond global estimates

Although global and regional GBD analyses have previously demonstrated rising CKD burden,[16],[17],[18] few have provided India-specific projections, disaggregated by sex, age, and etiology, with explicit policy scenarios. Earlier reports documented CKD as one of the fastest rising global causes of death,[19] and highlighted India's disproportionately high prevalence.[20] However, these analyses stopped short of forecasting future trajectories in the Indian context. Our study fills this critical gap by demonstrating that, without intervention, CKD will climb into the top five causes of death in India by 2040, potentially outpacing several other noncommunicable diseases (NCDs) (**Supplementary Fig. 4**). Importantly, our policy scenario shows that nearly one in seven CKD deaths could be prevented through feasible health system measures.

Implications for policy and health systems

These findings carry significant implications for health policy, planning, and financing. India is already struggling to meet the demand for kidney replacement therapy (KRT). Although the Pradhan Mantri National Dialysis Programme expanded access to free dialysis in public facilities,[21] coverage remains patchy, with wide urban–rural disparities and continued reliance on out-of-pocket expenditure.[22] If trend projections materialize, dialysis and transplant needs will expand by more than 50% by 2040, overwhelming current capacity. Expanding RRT alone, however, is insufficient.

The majority of CKD deaths in India are attributable to diabetes and hypertension, consistent with global trends.[23] This reinforces the urgent need for integration of CKD prevention and detection into India's national NCD programs. Opportunistic CKD screening alongside hypertension and diabetes care could facilitate earlier detection, while tighter glycemic and blood pressure control would delay CKD progression. Our policy scenario highlights the payoff of such interventions, with more than 80,000 lives saved annually by 2040. This is aligned with India's commitments under the National Health Policy 2017 to reduce premature NCD mortality by 25% by 2025.[24] Our projections align with India's commitments under Sustainable Development Goal (SDG) 3.4, which calls for a one-third reduction in premature NCD mortality by 2030, and with efforts to expand universal health coverage (UHC). Integrating CKD prevention and management into NCD programs is therefore essential not only for nephrology but also for meeting broader national and global health targets.

Comparison with global and regional evidence

Globally, CKD is projected to continue rising and may become the fifth leading cause of death by 2040.[25] Our India-specific estimates align with this trajectory but reveal even steeper increases, reflecting India's rapid demographic and epidemiological transition. Similar to findings from China, where diabetes and hypertension now dominate CKD burden, [26]India is experiencing a sharp shift away from glomerulonephritis-related CKD towards metabolic causes. However, unlike high-income countries, where dialysis and transplantation buffer mortality, limited access to RRT in India amplifies premature deaths. Although our estimates are national, previous work from the India State-Level Disease Burden Initiative has shown wide heterogeneity in CKD outcomes across states, reflecting differences in diabetes prevalence, hypertension control, and access to renal services.[27] This underscores the need for state-specific planning rather than a uniform national strategy.

Gender analysis

Sex differences in CKD burden are an important and underappreciated finding of this study. We observed consistently higher mortality and DALY rates in men, despite women experiencing slightly higher prevalence. This divergence likely reflects differences in exposure to risk factors, access to care, and biological susceptibility. Prior studies have also shown that men are more likely to progress rapidly to kidney failure and have poorer survival on dialysis.[28] In India, cultural and socioeconomic factors may exacerbate this disparity, as men are more likely to access dialysis or transplantation, whereas women may be underdiagnosed or underreferred.[29] Projections suggest that without intervention, male–female mortality gaps will persist or widen through 2040. Addressing these inequities will require gender-sensitive strategies, including equitable screening, referral, and access to renal replacement therapy.

Strengths and limitations

A significant strength of this study is its reliance on standardized GBD data, allowing comparability across time, causes, and regions. Our projections incorporate both demographic momentum and recent epidemiological trends, and by contrasting flat, trend, and policy scenarios, we provide actionable estimates for policymakers. Nonetheless, limitations must be acknowledged. First, GBD estimates rely on modeled inputs in the absence of comprehensive national surveillance, which may introduce uncertainty.[30] Second, projections assume continuation of recent trends or uniform policy implementation, whereas real-world dynamics may differ by state or socioeconomic group. Third, we did not model explicit state-level trajectories, though state-level variation in CKD burden has been documented.[31] Despite these caveats, our findings robustly highlight the urgency of acting now to mitigate CKD's rise.

Conclusions

Chronic kidney disease is already a significant cause of premature death and disability in India, and without intervention, it will rise into the top five causes of death by 2040, with annual mortality exceeding half a million. By combining GBD estimates with forward-looking scenarios, this study provides the first India-specific projections of CKD burden. Importantly, our analysis shows that a substantial share of this burden is preventable: effective control of diabetes and hypertension, integration of CKD detection into national NCD programs, and expansion of affordable renal replacement therapy could avert more than 80,000 deaths and 2 million DALYs annually by 2040. Persistent gender disparities, with men facing higher mortality despite women carrying a greater prevalence, highlight the need for gender-sensitive and equitable approaches. These results make a compelling case for

embedding CKD prevention and care within India's health system reforms and prioritizing CKD in national and regional NCD policy agendas.

Declarations

Conflict of interest:

None

Ethics approval:

Not required

Funding:

None

Author Contribution

All authors have equal contributions to the work

Acknowledgments:

None

Data Availability

Data is available as open source for training and research purposes

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Tables

Table 1
Policy scenarios and projection

metric	scenario	year	rate_mid	rate_lo	rate_hi	count_mid	count_lo	count_hi
Mortality	Flat	2030	12.4	10.4	14.9	380781	319723	455298
		2040	12.4	10.4	14.9	395787	332323	473240
	Trend	2030	14.6	12.3	17.6	447826	375622	537934
		2040	17.5	14.6	21.1	556375	464507	670733
	Policy	2030	13.9	11.7	16.7	425435	356841	511037
		2040	14.9	12.4	17.9	472919	394831	570123
	Averted_vs_Trend	2030				22391	18781	26897
		2040				83456	69676	100610
DALYs	Flat	2030	458.9	393.2	533.9	14044996	12034046	16339388
		2040	458.9	393.2	533.9	14598480	12508283	16983290
	Trend	2030	510.9	437.7	594.4	15635868	13394561	18193045
		2040	575.5	491.8	670.3	18306961	15644370	21322883
	Policy	2030	485.3	415.8	564.7	14854074	12724833	17283393
		2040	489.2	418	569.7	15560916	13297714	18124450
	Averted_vs_Trend	2030				781793	669728	909652
		2040				2746044	2346656	3198432

Figures

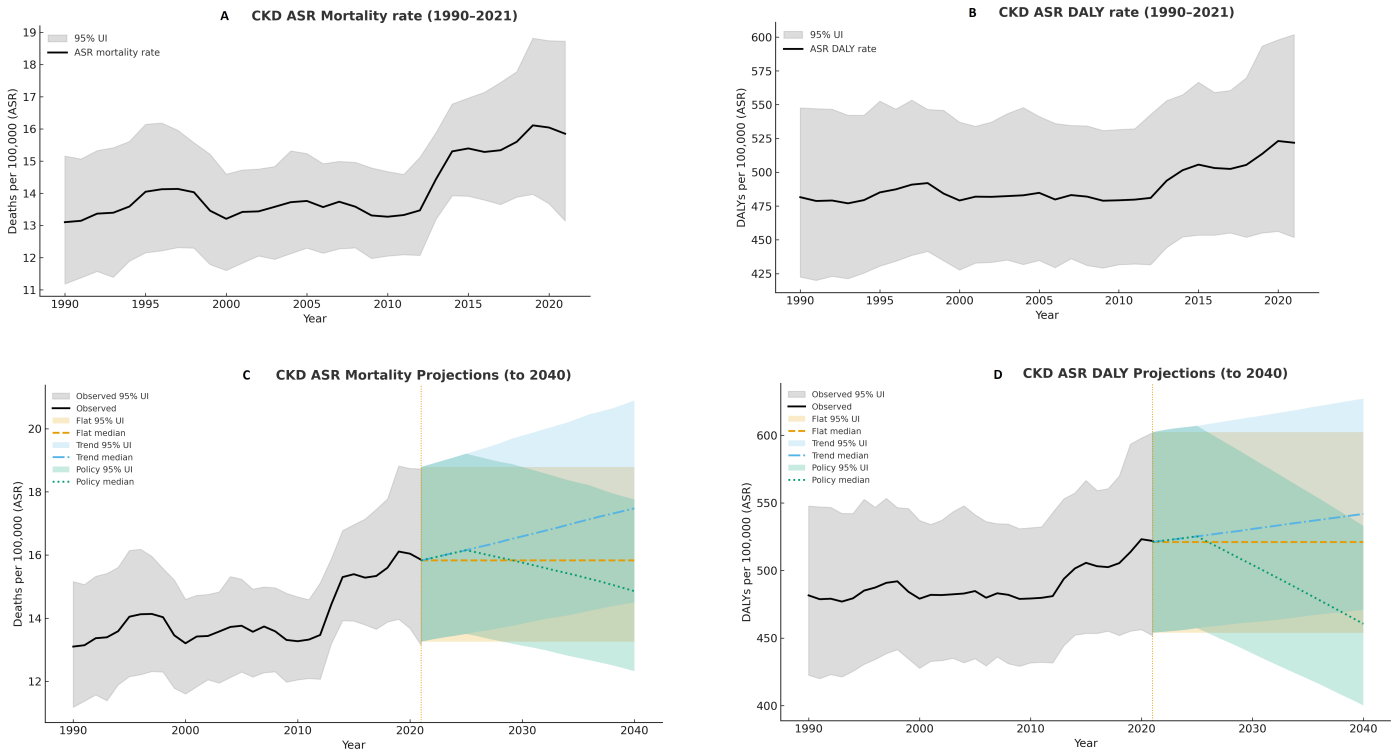


Figure 1

Historical trends in CKD mortality and DALYs in India, 1990–2021.

Age-standardized mortality rates (ASMR, left) and age-standardized DALY rates (ASDR, right) for CKD are shown from 1990 to 2021. Both mortality and DALYs increased steadily over the three decades, with ASMR rising from 6.9 to 12.4 per 100,000 and ASDR from 250 to 459 per 100,000. Shaded areas represent 95% uncertainty intervals.

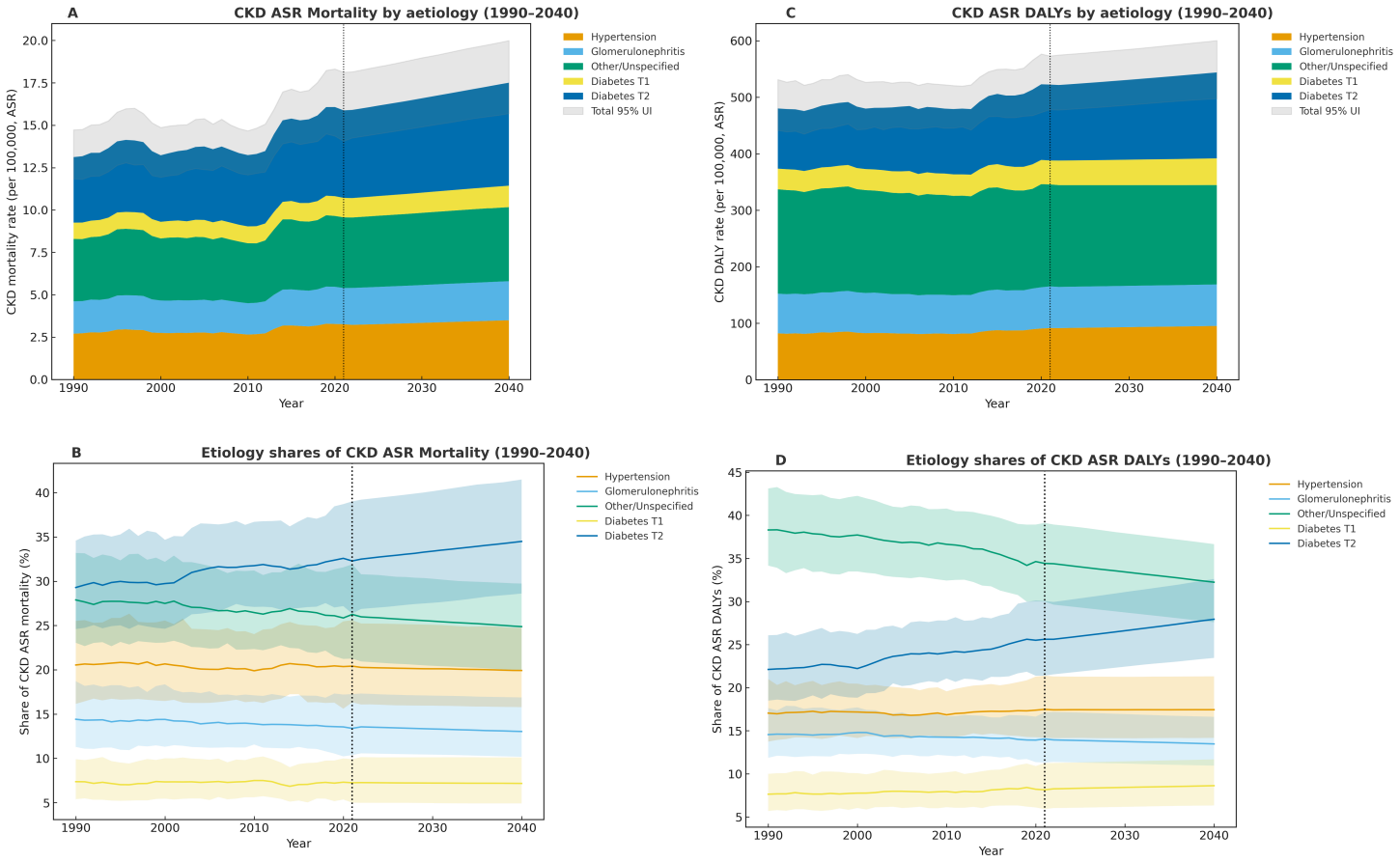


Figure 2

Projected CKD deaths and DALYs in India under flat, trend, and policy scenarios, 2022–2040.

Annual CKD deaths (left) and DALYs (right) are projected to 2040. Flat-rate projections show 396,000 deaths and 14.6 million DALYs by 2040, while trend projections reach 556,000 deaths and 17.8 million DALYs. Policy intervention could reduce the 2040 burden to 473,000 deaths and 15.5 million DALYs. Shaded bands indicate 95% uncertainty intervals.

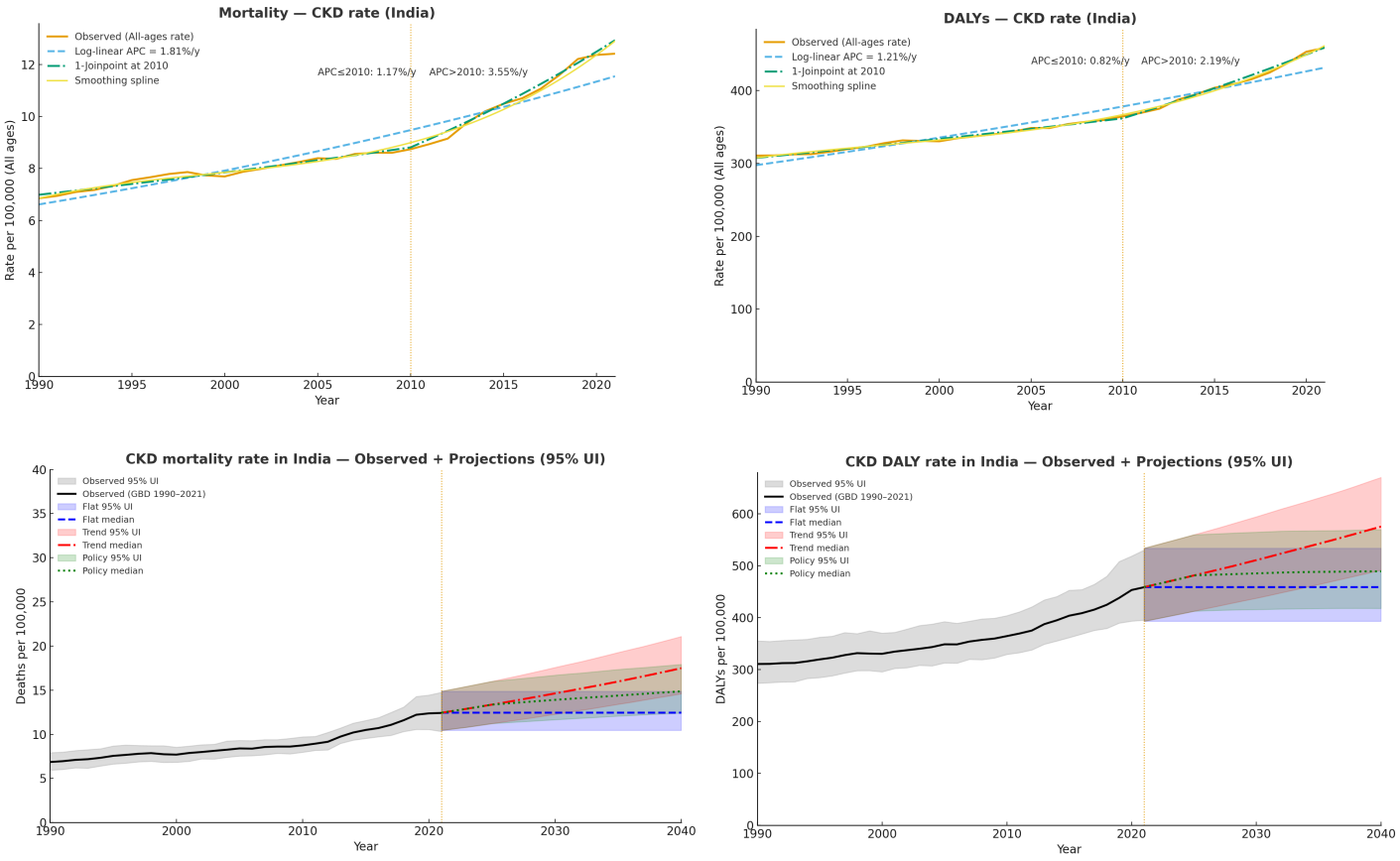


Figure 3

Joinpoint regression and projection analysis of CKD mortality and DALYs in India, 1990–2040.

Age-standardized mortality rates (ASMR, left panel) and age-standardized DALY rates (ASDR, right panel) for CKD are shown from 1990 to 2021, with projections to 2040 under flat, trend, and policy scenarios. Joinpoint regression identified **two inflection points** in the mortality trend. From 1990 to 2000, mortality rose modestly (APC +0.8% per year; 95% CI +0.4 to +1.3). Between 2000 and 2010, the slope steepened (APC +2.2%; 95% CI +1.8 to +2.6), coinciding with increasing prevalence of diabetes and hypertension. After 2010, the upward trend continued at a slower pace (APC +0.6%; 95% CI +0.2 to +1.0). DALY trends showed a comparable pattern, with an overall AAPC of +1.5% (95% CI +1.0 to +1.9) from 1990 to 2021. Shaded areas represent 95% uncertainty intervals.

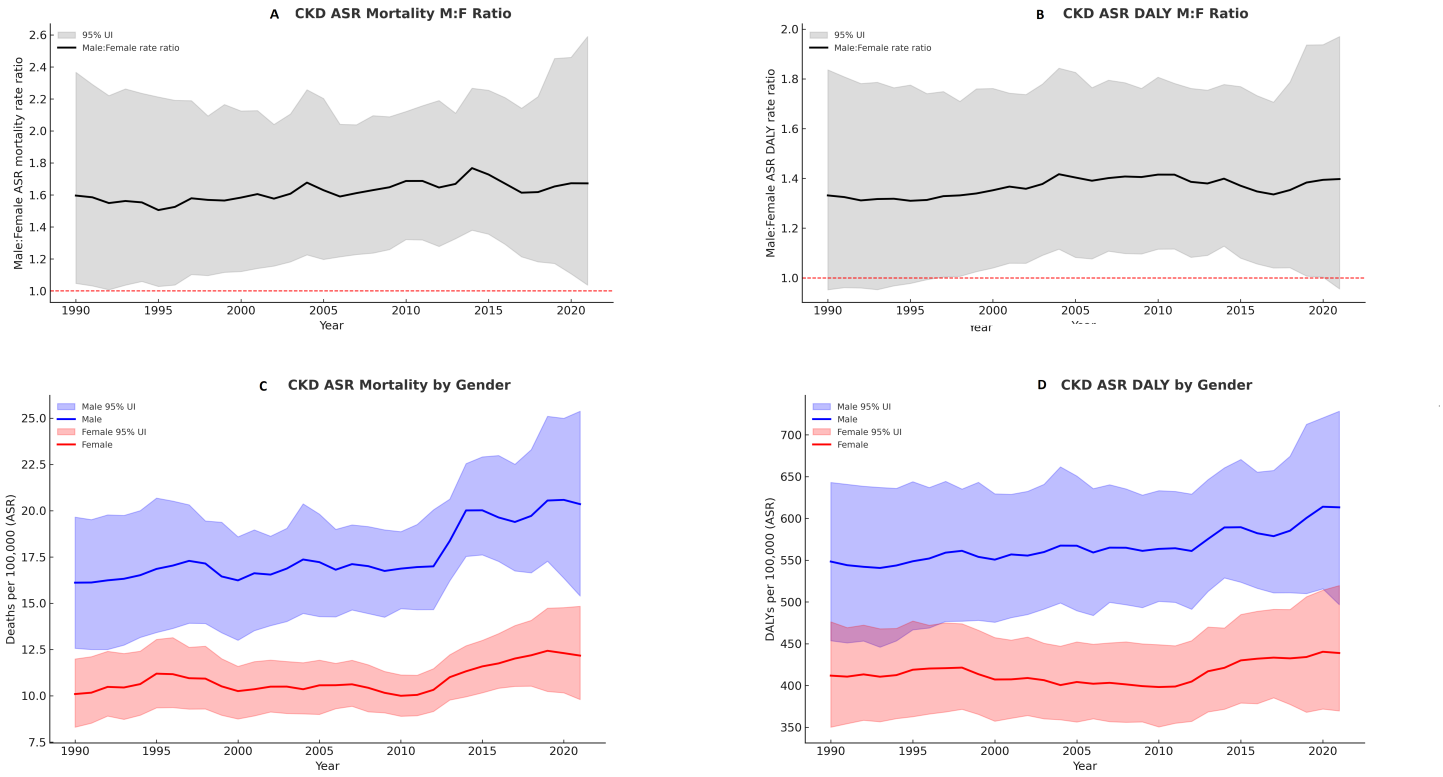


Figure 4

Sex-specific CKD burden in India, 2021 and projections to 2040.

ASMR and ASDR are presented for men and women in 2021, along with projections under flat, trend, and policy scenarios. Mortality was higher in men (14.1 per 100,000) than in women (10.9 per 100,000), while prevalence was slightly higher in women. By 2040, male deaths are projected to exceed 320,000 under the trend scenario, compared with 235,000 in women.

Supplementary Files

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- Supple.docx