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Pragmatic literature reviews to populate a patient-level model and project the future economic burden of CKD in low-and middle-income countries

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INTRODUCTION

- Approximately 10% of individuals worldwide suffer from chronic kidney disease (CKD), a debilitating and progressive health condition[1].
- Inside CKD seeks to improve awareness of the clinical and economic burden of the condition and facilitate data-driven policy and guideline development across 36 high-, middle- and low-income countries and regions.
- Microsimulation models can measure both the current and future clinical and economic burden of CKD and related complications, such as cardiovascular diseases and kidney replacement therapies (KRT)[2].
- However, such individual level simulation models require the inclusion of multiple parameters, including demographic, epidemiological and economic data inputs.

AIM

- Conduct a literature review to collect data for parameterising country-specific, patient-level microsimulation models. These models aim to analyse the epidemiological and economic burden of CKD across four low-middle income countries (LMICs): Bolivia, Kenya, Sri Lanka, and Uzbekistan.
- Project the economic burden of CKD in Kenya and Uzbekistan.

METHOD

- Country-specific data for populating multiple modules in the microsimulation model were gathered through pragmatic literature reviews of national surveys or published literature.
- The microsimulation includes population, CKD/KRT, comorbidities, complications, and health economics modules (Fig. 1).
- Collected data encompassed country demographics, disease prevalence data for CKD, KRTs (kidney transplant, haemodialysis, and peritoneal dialysis), comorbidities (type 2 diabetes [T2D] and hypertension) and cardiovascular complications (myocardial infarction [MI], stroke, and heart failure [HF]).
- This poster focuses on the economic inputs, as the epidemiological parameters and model structure have been previously published[2,3] (WCN '24, forthcoming).
- For the health economics module, annual per-patient direct healthcare costs and disability weights associated with treating CKD, undergoing KRTs, and managing complications were collected and included.
- Costs were converted to USD, where appropriate, using currency conversion. If proxy data were used, the appropriate adjustments for purchasing power parity and currency conversions were conducted.
- When input data was not available, suitable proxy country data were chosen based on similarity in health spend, universal health coverage, and % private health coverage using data extracted from the World Bank [4].
- A project-specific matrix was developed to evaluate and score all data sourced from the review, and comprised of 10 dimensions: sample size, sample representativeness, study design, location type, data source specificity, measurement method, confounder measurement, confounder mitigation, data integrity and author consideration of limitations. Sources with higher scores were prioritised where available. Data is available upon request [5].
- Consultations with key nephrology experts from the respective countries were undertaken to validate the selected data sources, approve any proxy data used, and provide their expert opinions in the absence of any data.
- Data were modelled using an individual level microsimulation model according to the Inside CKD protocol [2].
- Projected results from 2024 to 2029 for Kenya and Uzbekistan are reported.

RESULTS

Chronic Kidney Disease Costs

- Country-specific annual CKD related healthcare costs were not available for all 4 countries across all 6 CKD stages (1, 2, 3a, 3b, 4 and 5). The use of proxy data was therefore required, with Bolivia using data from Mexico, Kenya and Sri Lanka from Thailand and India, and Uzbekistan from Russia. (Table 1)
- All costs presented were normalised to 2024 US$ values. Costs for CKD stages 1-2 assumed to be 0.
- Although the prevalence of CKD stage 5 was lowest across all stages, with a prevalence of <1% of the total population in the analysed countries, annual per-patient treatment costs were highest in this group. Estimated costs ranged from US$ 1,372.52 in Kenya to US$ 7,079.70 in Uzbekistan.

Kidney Replacement Therapy Costs

- KRT costs were available across all therapies (peritoneal dialysis, haemodialysis, transplant), and transplant maintenance only for Bolivia. Kenya required the use of proxy data from the Philippines and the UK, Sri Lanka from the Philippines, and Uzbekistan from Russia, depending on the therapy. (Table 1)
- Costs of therapies were included based on the midpoint if a range was sourced. Specific costs for each therapy varied substantially between countries.
- For peritoneal dialysis, costs ranged from US$ 2,180.72 in Uzbekistan to US$ 8,243.38 in Sri Lanka. Haemodialysis presented a similar trend, with Uzbekistan showing the lowest cost at US$ 1,115.72, compared to the highest of US$ 9,444.46 observed in Sri Lanka.
- Kidney transplants costs were, however, the highest in Uzbekistan (Russia proxy) at US$ 55,015.74, compared to the lowest of US$ 3,058.05 in Kenya. Transplant maintenance costs were lowest in Bolivia at US$ 6,000, and highest in Sri Lanka (Philippines proxy) at US$ 8,668.25. (Fig. 3)

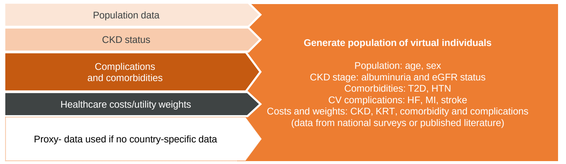
Complication Costs

- Country-specific annual complication costs were available only for Bolivia. All 3 other countries required the use of proxy data, with Kenya and Sri Lanka using data from India and the Philippines, and Uzbekistan from Russia. (Table 1).
- Estimated annual costs for myocardial infarction ranged from US$ 745.84 in Kenya (Philippines proxy) to US$ 1,816.40 in Bolivia. Similarly, costs for heart failure varied, with the lowest being US$ 539.62 in Uzbekistan (Russia proxy) and the highest at US$ 1,816.40 in Bolivia. Stroke-related costs were also varied, ranging from US$ 957.63 in Uzbekistan (Russia proxy) to US$ 2,477.98 in Bolivia.
- Annual costs were highest in Bolivia, across all three complications considered: myocardial infarction, heart failure, and stroke.

Microsimulation modelling results – Kenya and Uzbekistan

- Between 2024 and 2029, CKD prevalence was projected to increase from 5.1M to 5.6M in Kenya (9.0% population prevalence), and from 2.2M to 2.7M in Uzbekistan (7.0% population prevalence).
- KRT accounted for <4% of all CKD cases in both countries.
- CKD costs (pre-KRT) were projected to reach $18.3M and $146.1M in Kenya and Uzbekistan respectively (Fig. 4).
- CKD costs (including KRT) were projected to reach $47.8M in Kenya, and $219.0M in Uzbekistan, of which $29.5M and $72.9M were for KRTs respectively (Fig. 5).
- KRT costs were projected to account for 61.8% of total CKD spend in Kenya, and 33.5% of total CKD spend in Uzbekistan (Fig. 5), representing an increase in KRT costs from 2024 of 9.1% and 41.2%, respectively.
- From 2024 to 2029, the proportion of healthcare expenditure spent on CKD and KRT was projected to increase from 1.08% to 1.10% in Kenya, and from 3.16% to 4.80% in Uzbekistan.

Fig. 1 – Country-Specific Data Inputs Collected



CKD: chronic kidney disease; CV: cardiovascular; eGFR: estimated glomerular filtration rate; T2D: type 2 diabetes, HTN: hypertension; HF: heart failure: MI: myocardial infarction, KRT: kidney replacement therapies.

Fig. 2 – Annual CKD Costs by Stage

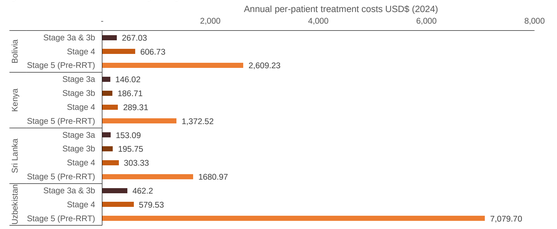


Fig. 3 – Annual KRT Costs (First Year of Treatment)

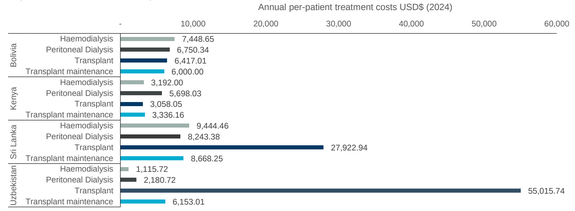


Table 1 – Economic Input Data (US$ 2024) & Availability by Country

	Country			
Condition	Bolivia	Kenya	Sri Lanka	Uzbekistan
Chronic Kidney Disease (CKD)				
CKD Stage 1	Assumed 0	Assumed 0	Assumed 0	Assumed 0
CKD Stage 2	Assumed 0	Assumed 0	Assumed 0	Assumed 0
CKD Stage 3a	267.03 (Mexico Proxy)	146.02 (Thailand Proxy)	153.09 (Thailand Proxy)	462.20 (Russia Proxy)
CKD Stage 3b	Not Identified	186.71 (Thailand Proxy)	195.75 (Thailand Proxy)	
CKD Stage 4	606.73 (Mexico Proxy)	289.31 (Thailand Proxy)	303.33 (Thailand Proxy)	579.53 (Russia Proxy)
CKD Stage 5 (pre-KRT)	2609.23 (Mexico Proxy)	1372.52 (India Proxy)	1680.97 (India Proxy)	7079.70 (Russia Proxy)
Kidney Replacement Therapies (KRTs)				
Peritoneal Dialysis	6750.34	5698.03 (Philippines Proxy)	8243.38	2180.72
Haemodialysis	7448.65	3192.00	9444.46	1115.72
Transplant	6417.01	3058.05	27922.94 (Philippines Proxy)	55015.74 (Russia Proxy)
Transplant maintenance	6000.00	3336.16 (UK Proxy)	8668.25 (Philippines Proxy)	6153.01 (Russia Proxy)
Complications				
Myocardial infarction	1816.40	745.84 (Philippines Proxy)	765.87 (Philippines Proxy)	1669.75 (Russia Proxy)
Heart failure	1816.40	1698.88 (India Proxy)	1381.61 (India Proxy)	539.62 (Russia Proxy)
Stroke	2477.98	1460.89 (Philippines Proxy)	1500.13 (Philippines Proxy)	957.63 (Russia Proxy)

Fig. 4 – Projected annual costs of CKD by stage in 2029

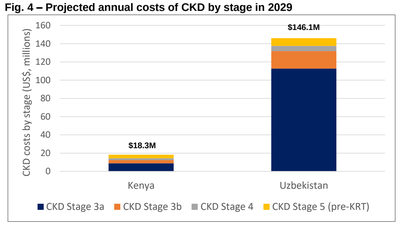
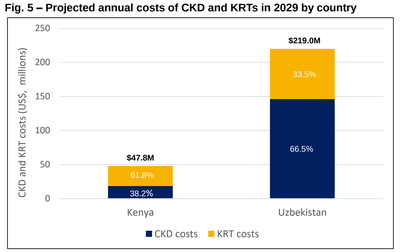
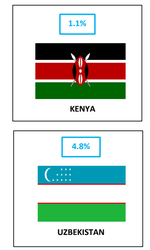


Fig. 5 – Projected annual costs of CKD and KRTs in 2029 by country



Projected proportion of national healthcare expenditure spent on CKD and KRT in 2029



CONCLUSIONS

- Availability of country-specific cost data was limited for these low-income countries and collection of modelling inputs required the use of proxies.
- CKD costs data showed substantially higher healthcare costs associated with stage 5 CKD, especially in Bolivia and Uzbekistan.
- Projections highlighted that despite accounting for <1% of the total diagnosed burden of CKD, KRTs contribute disproportionately to the economic burden.
- Microsimulation modelling can help estimate the economic benefits resulting from reductions in the burden of CKD, CKD comorbidity and complications, that could be achieved through national policies such as earlier diagnosis and treatment to slow disease progression in LMIC countries.

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4. World Bank indictors, Open data 2021. Available from: https://data.worldbank.org/indicator [Accessed 2 May 2024]
5. Data is available upon request

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