Economic burden of Chronic Kidney Disease (CKD) in Type 2 Diabetes (T2D), considering the costs of hospitalization due to heart failure (HF) in Colombia.

Poster Session: Poster Session 3
Poster Code: EE232

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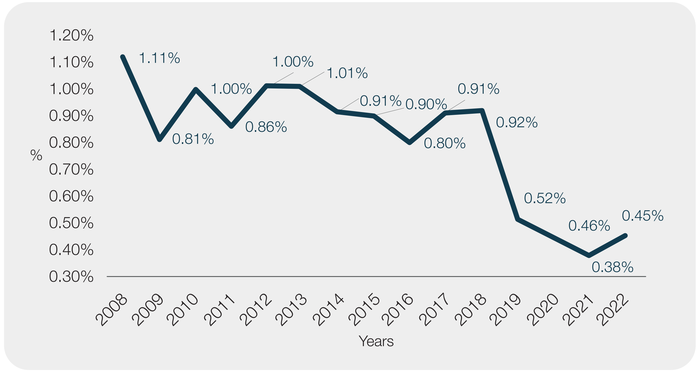
Introduction

Approximately 25% to 40% of individuals with type 1 or type 2 diabetes will experience Chronic Kidney Disease (CKD) at some stage in their disease [1]. Over the past decade, the incidence of CKD in patients with Type 2 Diabetes (T2D) has doubled, mainly due to the rise in type 2 diabetes cases, with diabetic kidney disease (DKD) accounting for 45% of new end-stage renal disease cases in the United States. Hypertension and glomerular diseases follow as the second and third leading causes, respectively [1, 2].

In Colombia, the High-Cost Account estimates that more than 1.99 million people have diabetes [3]. CKD is the most prevalent microvascular complication among patients with Type 2 Diabetes (T2D), affecting up to 40% of these individuals [4]. Using Vital Statistics from DANE with a different approach than that of the High-Cost Account and focusing only on deceased individuals with an associated diagnosis (direct cause of CKD), it was determined that, out of the total deaths from natural causes in 2022 (236,000 people in total), 0.45% (1,145 people) had CKD as the direct cause of death (3)

Figure 1. Proportion of CKD Deaths to Natural Deaths



Diabetes mellitus can cause kidney damage (diabetic nephropathy), which in turn can contribute to the development of cardiovascular disease, including heart failure. Factors such as hypertension, dyslipidemia, and inflammation play a crucial role in this process [5-7]

The hazard ratios for heart failure and hospitalization according to levels of albuminuria/creatinine ratio (ACR) and estimated glomerular filtration rate (eGFR) were taken from the international guidelines KDIGO 2024 [8,9]

The percentage of patients with diabetic kidney disease who have a significantly higher risk of developing heart failure may vary according to studies and the specific population analyzed. However, it is estimated that between 25% and 50% of patients with chronic kidney disease (CKD) related to diabetes mellitus will develop heart failure at some point in their disease (5-7)

Figure 2. HR for cardiovascular event according to ACR and eGFR

Heart faliure				
Age <65	ACR, mg/g			
eGFRcr-cys	<10	10-29	30-299	+300
105+	0.90	1.2	1.7	3.7
90-104	ref	1.3	1.4	2.5
60-89	1.2	1.6	1.9	3.0
45-59	1.5	2.2	3.0	4.1
30-44	2.5	2.9	4.1	5.7
<30	5.3	4.8	6.5	7.7

Hospitalization				
Age <65	ACR, mg/g			
eGFRcr-cys	<10	10-29	30-299	+300
105+	1.00	1.1	1.1	1.6
90-104	ref	1.1	1.3	1.4
60-89	1.1	1.2	1.3	1.6
45-59	1.3	1.4	1.5	1.7
30-44	1.5	1.5	4.1	2.1
<30	1.8	2.0	2.1	3.0

Objective

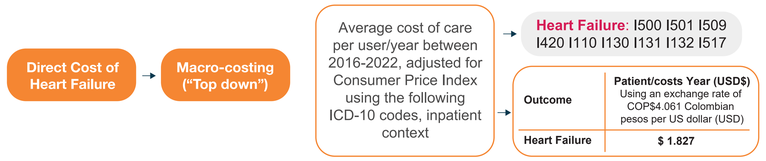
To estimate the economic burden of Chronic Kidney Disease (CKD) in Type 2 Diabetes (T2D), considering the standard of care and the costs of hospitalization due to heart failure (HF) in Colombia.

Methods & Results

The cost analysis presented here was carried out from a social perspective, primarily focusing on Colombia's Health System by utilizing a macro-costing strategy and a top-down approach (10). Direct costs of CKD and T2D were estimated using the Gestion de la Demanda from the SISPRO database (11).

Initially, the Codigo Unico de Procedimiento (CUP) codes were identified, which, except for dialysis care and kidney transplantation, accounted for a significant portion of the healthcare costs associated with ICD-10 codes N17-N19. In the next step, for the ICD-10 codes linked to ESRD (E102, E112, E142, N06X, N083, R80X), the average cost of the selected procedures was calculated, along with the costs of medications and supplies for beneficiaries of the contributory regime who had received at least one healthcare service. For the advanced stage involving replacement therapy, the previously calculated average value was added to the estimated average cost of dialysis for the treated beneficiaries, based on the same data.

Figure 3. Heart Failure costs event estimation



For a cohort of 1,000 patients, simulations are conducted that begin in normoalbuminuria and end when the entire cohort is in the absorbing state (Death – Cycle 60), estimating the costs per patient and for the entire cohort [12]
All patients start in normoalbuminuria and at the age of 40.
Life expectancy is 77.23 years (DANE, 2023).

Figure 4. Transition stages of CKD and T2D

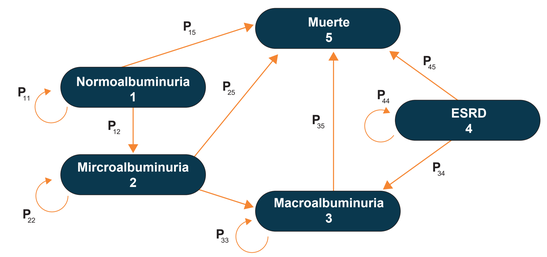


Figure 5. Standard Treatment Transition Matrix

Start	Normo	Micro	Macro	ESRD	Death
Normo	1-0.056-p (age)	0.056	0	0	p(age)
Micro	0	1-0.056-p(age)	0.094	0	p(age)
Macro	0	0	1-0.056-p(age)	0.056	p(age)
ESRD	0	0	0	0.87	0.13
Death	0	0	0	0	1

The cost of heart failure was applied to all stages, weighted by the probabilities of hospitalization for the current standard treatment as follows:

Cumulative Survival Placebo
$S_{t=24}$ = 82,66%

Cumulative Probability of Hospitalization for Heart Failure
$F_{t=24}$ = 17,34%

Source: Calculated from FIDELITY study (13)

$$Prob_n = 1 - \frac{S(t)\ HRhosp_n * HRfalla_n}{S(t)\ HRfalla}$$

Table 1. Hazard Ratio HR Heart Failure by stage of eGFR and ACR

Stage	HR Heart Failure
Microalbuminuria (HR1)	3,0
Macroalbuminuria (HR2)	4,1
ESRD (HR3)	7,7

Source: KDIGO, 2024 (9)

Stage	Probability of Heart Failure Hospitalization
Microalbuminuria (HR1)	24,84%
Macroalbuminuria (HR2)	42,10%
ESRD (HR3)	94,67%

Source: KDIGO, 2024 (9)

Using an exchange rate of COP$4.061 Colombian pesos per US dollar (USD), the summary of the annual direct costs in Colombian pesos at 2024 prices, calculated based on the methodologies previously explained, is presented. These values were used to conduct the simulation with the Markov chain in each of the considered stages

Table 2. Patient costs/year ERD + HF outcomes with current treatment.

Description		Normo-albuminuria	Micro-albuminuria	Macro-albuminuria	ESRD
Direct Medical Costs	Direct costs (Renal care)	$0	$113	$113	$6.300
	Heart Failure hospitalization evento cost	$0	$1.987	$2.735	$4.405
Out-of-pocket expenses	Medical and no Medical costs	$0	$33	$452	$3.174
Total Direct costs		$0	$2.133	$3.300	$13.879

The sources of information used to assess to the costs assumed by the household, also known as "out-of-pocket expenses" in this study were the Multipurpose Survey for Bogotá (EMB) (14) conducted by DANE in 2017, and the National Time Use Survey (ENUT), conducted by DANE during the period 2020-2021 (15).

The disability-adjusted life years (DALY) weights or years lost due to premature death considered for each stage of the disease according to the WHO estimation for the disease [16]. The value of productivity loss obtained at each stage is the result of multiplying the respective weight by the average annual labor income value estimated in USD $ 4.951 (GEIH-DANE, 2024).

$$Lose\ of\ productivity_{stage\ n} = Average\ annual\ labor\ income\ value * DALY_{stage\ n}$$

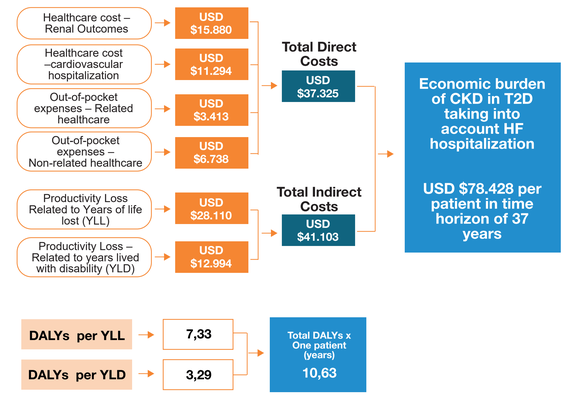
Table 3. Indirect cost by Markov Stage

Description	Normo-albuminuria	Micro-albuminuria	Macro-albuminuria	ESRD	Death
Disability-Adjusted Life Years (DALYs)	-	0,104	0,104	0,571	1,000
Productivity Loss (average annual salary)	$0	$526	$526	$2.888	$5.059

Using an exchange rate of COP$4.061 Colombian pesos per US dollar (USD)

The total economic burden of CKD and T2D disease, including renal outcomes and HF hospitalization events in 2024 US dollars per patient in time horizon of 37 years were:

Figure 4. Economic burden of CKD and T2D taking into account cardiovascular events



Conclusions

The economic burden of CKD and T2D associated with hospitalization due to HF in Colombia is approximately USD$78.428 per patient in time horizon of 37 years.

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