



The Assessment on the Cost of Illness Among Patients with Chronic Kidney Disease in Stage 3 and 4 at H. Adam Malik Hospital, Medan

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ABSTRACT

Background: Chronic Kidney Disease (CKD) is a non-communicable disease that imposes a significant economic burden, both on patients and the healthcare system in Indonesia.

Objective: This study aims to describe the Cost of Illness (COI) based on actual hospital costs for patients with stage 3 and 4 CKD at RSUP H. Adam Malik Medan and to examine COI variations according to age, gender, and type of treatment. INA-CBGs tariffs are presented as contextual background only and are not directly compared with hospital costs.

Method: This study used a cross-sectional descriptive analytical quantitative design with total sampling. Data were retrospectively collected from medical records and hospital administrative and financial databases for patients with stage 3 and 4 CKD receiving inpatient or outpatient care at RSUP H. Adam Malik Medan from 2022 to 2025. The analysis focused on the Cost of Illness (COI), calculated from direct medical and direct non-medical costs, and examined according to age, gender, CKD stage, year of visit, and type of treatment. The analysis was conducted from the hospital provider's perspective, focusing on direct medical costs incurred by the hospital for CKD-related services.

Results: The study results show that patients with stage 3 and 4 CKD were predominantly male 121 (62.37%), adults aged 18-59 years 105 (54.12%), hospitalized 113 (58.25%), and service episodes recorded in 2024 110 (56.41%) from 2022 to 2025. Most CKD patients come from North Sumatra province (90.72%). The most common comorbidities varied by treatment type: diabetes mellitus without complications was the most frequent among outpatients (7.19%), while disorders of plasma-protein metabolism were most frequent among inpatients (10.21%). COI did not differ significantly by age or gender. A significant difference in COI was observed according to treatment type among patients with stage 3 CKD ($p = 0.021$), but not among those with stage 4 CKD ($p = 0.121$).

Conclusion: This study describes hospital-based COI for stage 3 and 4 CKD patients and underscores the need for future research that directly compares actual hospital costs with INA-CBGs tariffs to assess financing adequacy. The present analysis did not include such a direct comparison.

Keywords: BPJS Health; Cost of Illness; Indonesian Case-Based Groups; Chronic Kidney Disease

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INTRODUCTION

Chronic kidney disease (CKD) is defined as an abnormality of kidney structure or function that persists for at least three months and has implications for health. CKD progresses gradually and can lead to systemic complications, a decline in quality of life, kidney failure, and the need for long-term healthcare services (KDIGO CKD Work Group, 2024). State that stages G3 and G4 show a moderate to severe decrease in glomerular filtration rate, namely 30–59 mL/min/1.73 m² in G3 and 15–29 mL/min/1.73 m² in G4 (KDIGO CKD Work Group, 2024). In Indonesia, the prevalence of CKD has been estimated using national survey data. An analysis of *Riskesdas* 2018 reported a prevalence of 0.5% based on physician-diagnosed CKD, whereas another analysis of national survey data reported a prevalence of 0.38%. This difference may reflect variations in case definitions and ascertainment methods and suggests that national survey estimates may not capture all undiagnosed CKD cases, particularly in the early stages (Hustrini et al., 2022).

CKD imposes a substantial economic burden on patients, hospitals, and health financing systems (Madania et al., 2022). The burden includes direct medical costs related to consultations, laboratory examinations, medicines, medical procedures, hospitalization, management of comorbidities, and renal replacement therapy (Nisar et al., 2024; Sunariyanti et al., 2023).

In Indonesia's National Health Insurance system, INA-CBGs function as a bundled prospective payment mechanism for hospital services (Septia et al., 2026). Previous studies have reported discrepancies between actual hospital costs and INA-CBGs tariffs for CKD-related services, with the magnitude of these discrepancies influenced by treatment intensity, comorbidities, disease severity, and length of stay (Andayani et al., 2016; Sunariyanti et al., 2023). Therefore, evaluating the Cost of Illness (COI) among patients with stage 3 and 4 CKD is important because these stages may involve substantial medication use, medical procedures, and hospitalization. COI is an approach in health economics used to measure the cost burden of a disease from a specific perspective (Nisar et al., 2024). COI can include direct medical costs, direct non-medical costs, and indirect costs (Andriani et al., 2025). Research in Indonesia has largely focused on advanced stage CKD patients, particularly those undergoing hemodialysis or at stage 5 (Julio et al., 2026). Studies that specifically evaluate the COI of stage 3 and 4 CKD patients, particularly in tertiary referral hospitals, and the variation of COI based on treatment type, age, and gender in stage 3 and 4 CKD patients, are still limited. Few studies in Indonesia have specifically examined the Cost of Illness among patients with stage 3 and 4 CKD outside the hemodialysis or end-stage kidney disease population. Evidence regarding COI variation according to treatment type, age, and gender among patients with stage 3 and 4 CKD in tertiary referral hospitals also remains limited. Therefore, this study provides hospital-level evidence on the economic burden of stage 3 and 4 CKD based on actual hospital costs in a tertiary referral hospital setting in Indonesia.

The gap is important to study because stages 3 and 4 are strategic phases in the management of CKD. At this stage, controlling comorbidities, preventing complications, and optimizing therapy can help slow the progression of the disease and delay the need for renal replacement therapy. Conversely, delayed management can lead to increased service intensity, frequency of hospitalizations, medication use, and supporting examinations. Information regarding the COI of CKD patients at RSUP H. Adam Malik Medan, as a tertiary referral hospital in North Sumatra, can help the hospital evaluate resource utilization, support nephrology service planning, and provide input for the development of more efficient CKD management strategies. Based on this background, this study aims to describe the characteristics and comorbidity profiles of stage 3 and 4 CKD patients at RSUP H. Adam Malik Medan, and to analyze COI based on age, gender, and type of treatment during the period 2022 to 2025. The research questions are: what are the characteristics and comorbidity profiles of stage 3 and 4 CKD patients, and are there differences in COI based on age, gender, and type of treatment?

METHODS

Research Design and Sample

This research is an observational quantitative study with a cross-sectional design using retrospective data. The research was conducted at RSUP H. Adam Malik Medan, North Sumatra, which is a tertiary referral hospital and an educational hospital. The data analyzed comes from inpatient and outpatient services during the period from January 1, 2022, to December 31, 2025. This study aims to describe the characteristics of patients and the comorbidity profile of patients with stage 3 and 4 CKD, as well as to analyze the Cost of Illness (COI) and INA-CBGs claim rates. The target population of the study is all adult patients (aged 18 years and above) with stage 3 and 4 CKD who received BPJS Kesehatan services at RSUP H. Adam Malik Medan. The study sample consists of stage 3 and 4 CKD patients recorded in the Hospital Management Information System (SIMRS), medical records, hospital financial database during the study period, and who meet the inclusion and exclusion criteria of the research.

The primary sources of research data are patient medical records to collect diagnoses, CKD stages, comorbidities, age, gender, residence, year of visit, and type of service; the Hospital Management Information System (SIMRS) to gather information about services; diagnosis codes, ICD-10 codes, and INA-CBG codes, as well as the type of treatment and details of services received by patients; and the hospital's financial database and Unit responsible for access verification and cost data to determine the hospital's real costs. The data used are secondary administrative and clinical data. Patient identities are not recorded in the research worksheet. Each subject is assigned a research code to maintain data confidentiality.

The inclusion criteria for the study are patients aged >18 years, diagnosed with stage 3 or stage 4 CKD, receiving inpatient or outpatient services at RSUP H. Adam Malik Medan during the period 2022 to 2025, registered as JKN/BPJS Kesehatan participants, having diagnosis codes or claim codes corresponding to stage 3 or 4 CKD, possessing traceable medical record data and cost data, and having INA-CBGs claim rate information and actual hospital costs. Meanwhile, the exclusion criteria for this study are patients aged <18 years, patients with unverifiable diagnosis or CKD stage data, patients who are not JKN/BPJS Kesehatan participants, patients without actual cost data or INA-CBGs claim data, and patients with incomplete data on the main research variables.

The sampling technique used is total sampling. All patients who met the inclusion criteria and did not meet the exclusion criteria were included as research samples. Based on the initial search, there were 484 records of CKD patients. After selection based on the research criteria, 194 subjects were analyzed, consisting of 113 inpatients and 81 outpatients. Based on the initial search, there were 484 records of patients with CKD codes in the hospital database. After applying the inclusion and exclusion criteria, 194 subjects were included in the final analysis. The main reasons for exclusion were: age <18 years ($n = X$), CKD stage other than 3 or 4 ($n = X$), absence of cost data or INA-CBGs claim data ($n = X$), and incomplete data on key variables ($n = X$).

CKD staging was based on the clinical diagnosis recorded in the medical records and coded in the hospital information system. Staging was not recalculated using estimated glomerular filtration rate (eGFR) values because routine eGFR data were not consistently available for all patients across the study period. If a patient had service episodes in more than one calendar year, the CKD stage could differ between years according to the diagnosis recorded at each visit; in such cases, each episode was analyzed according to the stage documented for that year.

The main research variable is the COI of stage 3 and 4 CKD patients, and the characteristic variables include CKD stage, age, gender, type of treatment, year of visit, domicile, and comorbidities. Stage 3 and 4 CKD are determined based on clinical diagnosis and recorded in medical records. Age is grouped into 18-59 years and >60 years. Gender is categorized into male and female, type of treatment is categorized into inpatient and outpatient, and comorbidities are determined based on additional diagnoses recorded in the medical records and coded using ICD-10. Comorbidities are recorded based on the number of comorbidities per patient or the occurrence of comorbidity diagnoses, as one patient can have more than one comorbidity.

Measures and Data Analysis

COI is calculated for each patient or episode of service by summing all cost components that meet the research definition. Subsequently, the total COI is calculated overall and grouped by age, gender, and type of treatment, with the COI value presented in Indonesian rupiah. COI was calculated according to the corresponding service episode and calendar year. A single patient could have more than one service episode or referral recorded in different years. Therefore, the annual frequencies in Table 1 represent year-specific service episodes or visit records and may exceed the total number of unique patients. The overall sample size, however, was based on 194 unique patients.

Data collection was conducted retrospectively with the following steps: the researcher obtained data access permission from RSUP H. Adam Malik Medan, the medical records unit, SIMRS, and the Unit responsible for access verification and cost data; the researcher identified patient records with stage 3 and 4 CKD diagnoses during the 2022 to 2025 period; clinical, demographic, service, real cost, and INA-CBGs claim data were extracted using a pre-prepared data collection sheet; diagnosis and comorbidity data were verified based on medical records and ICD-10 codes listed in the system; real cost data were matched with service episodes and INA-CBGs claim codes of the same patient; incomplete, duplicate, or inconsistent data between medical records and the financial database were excluded according to exclusion criteria; all data were anonymized before the analysis process; verified data were entered into Microsoft Excel and then imported into IBM SPSS Statistics. To improve data traceability, researchers maintained a data inspection list (patient resume) that includes the completeness status of diagnosis, stage, type of treatment, real costs, and claim rates for each subject.

INA-CBGs tariffs are recognized as the prospective payment mechanism used by the national health insurance system for hospital services. However, this study focused on describing actual hospital costs and their variation according to patient and service characteristics. Direct comparisons between actual hospital costs and INA-CBGs

tariffs were not performed in this analysis.

Data validity is maintained through source validation and cross-validation. Source validation is conducted using medical records, SIMRS, and the financial and INA-CBGs claim databases as official hospital data sources. Cross-validation is conducted by comparing the research code identity, diagnosis, CKD stage, type of treatment, actual costs, and claim rates for each episode of service. Descriptive analysis is used to present patient characteristics, distribution of CKD stages, types of treatment, year of service, domicile, and comorbidities. Categorical data is presented in the form of frequency and percentage. In this study, the Cost of Illness (COI) was defined as the average direct medical cost per patient per calendar year from the hospital provider's perspective. COI was calculated using direct medical costs recorded in the hospital's financial and administrative databases, including costs of consultations, medications, laboratory investigations, medical procedures, hospitalization, and other hospital-based services. Direct non-medical costs (such as transportation and accommodation) and indirect costs (such as productivity losses) were not included because these data were not available in the hospital databases. Therefore, COI results were presented as Average COI for each CKD stage, year, and treatment group. The Shapiro-Wilk test was used to assess the distribution of the COI data prior to inferential analysis. Because the primary outcome of the study was the average cost per patient per year, the descriptive presentation of COI was maintained as Average COI, while the distribution assessment was used to inform the selection of the appropriate inferential statistical test.

Initial data were collected, reviewed, and coded using Microsoft Excel 365. Statistical analysis was conducted using IBM SPSS Statistics 25. The stages of data processing include: checking the completeness and consistency of the data; variable coding; duplication checks; grouping categorical variables; calculating COI; data distribution tests; descriptive and analytical analysis; and compiling research result tables.

Six two-tailed Mann-Whitney U tests were conducted to compare COI by age, gender, and type of treatment, separately for CKD stage 3 and stage 4. Because these analyses were exploratory and hypothesis-generating, no adjustment for multiple comparisons was applied. Consequently, the risk of type I error is inflated, and any statistically significant finding should be interpreted cautiously as preliminary evidence rather than confirmatory proof. This limitation is acknowledged explicitly in the Limitations section.

This research uses secondary patient data derived from medical records and the hospital administration system. Before data collection was conducted, the researchers obtained approval from the Health Research Ethics Committee of the University of North Sumatra with ethical clearance number 852/KEPK/USU/2025. Access to the data was granted after obtaining written permission from RSUP H. Adam Malik Medan and the relevant units. The analyzed data does not include names, medical record numbers, complete addresses, phone numbers, or any other direct identifying information. Patient identities are replaced with research codes and can only be accessed by authorized researchers. All data is stored on protected media and used only for research purposes. Reporting of results is done in aggregate form so that subjects cannot be identified.

RESULTS

Patient Characteristics

All cost values presented in this study represent direct medical costs incurred by the hospital and are expressed as average COI per patient per calendar year. The analysis was conducted from the hospital provider's perspective. Direct non-medical costs and indirect costs were not included. The characteristics of stage 3 and 4 CKD patients at RSUP HAM are presented in Table 1.

Table 1. Characteristics of unique patients and distribution of service episodes among stage 3 and 4 CKD patients at RSUP HAM Medan.

Characteristic	Frequency of episodes	Percentage (%)
Gender:		
Male	121	62.37
Female	73	37.63
Age:		
18-59 years	105	54.12
>60 years	89	45.88
Year of visit:		
2022	9	4.62
2023	37	18.97
2024	110	56.41
2025	39	20.00
Type of Treatment:		
Inpatient	113	58.25
Outpatient	81	41.75

Characteristic	Frequency of episodes	Percentage (%)
Residence:		
North Sumatra Province	176	90.72
Outside North Sumatra Province	18	9.28

Note: Gender, age, and residence are presented for unique patients (n = 194). Year of visit and type of treatment are presented for service episodes (n = 195). One patient had service episodes recorded in more than one calendar year, resulting in a higher number of episodes than unique patients.

Table 1 Presents characteristics of 194 unique patients and the distribution of 195 service episodes. Among unique patients, 121 (62.37%) were male and 73 (37.63%) were female. The age group of 18–59 years comprised 105 patients (54.12%), while patients aged >60 years numbered 89 (45.88%). Most patients resided in North Sumatra Province (176 patients, 90.72%). The distribution of service episodes by year showed that the highest number was recorded in 2024, with 110 episodes (56.41%), followed by 2025 with 39 episodes (20.00%), 2023 with 37 episodes (18.97%), and 2022 with 9 episodes (4.62%). Because one patient had service episodes recorded in more than one calendar year, the total number of episodes (195) exceeded the number of unique patients (194). Most patients come from North Sumatra Province, with 176 patients (90.72%), while 18 patients (9.28%) come from outside North Sumatra Province. The number of service episodes in 2022 was relatively small (n = 9) compared with subsequent years. This may reflect changes in coding practices, data availability, or service patterns during the early post-pandemic period.

Comorbidity Profile

The comorbidity profile of stage 3 and 4 CKD patients is presented based on the type of service. One patient can have more than one comorbidity, so the number of comorbidity diagnoses does not always equal the number of study patients. The comorbidity profile of inpatients with stage 3 and 4 CKD at RSUP HAM is presented in Table 2.

Table 2. Comorbidity Profile of Inpatients with Stage 3 and 4 CKD from 2022 to 2025 at RSUP HAM Medan

Disease Group	Name of Comorbidity	Amount	Percentage (%)
Metabolic and Endocrine	Disorders of plasma-protein metabolism	29	10.21
	Type 2 diabetes mellitus without complications	20	7.04
	Hyperlipidaemia, unspecified	3	1.06
	Disorders of calcium metabolism	2	0.70
Hematology	Anaemia in other chronic diseases classified elsewhere	19	6.69
	Anaemia, unspecified	11	3.87
	Acute posthaemorrhagic anaemia	6	2.11
	Anaemia in neoplastic disease	5	1.76
	Coagulation defect, unspecified	4	1.41
	Thrombocytopenia, unspecified	3	1.06
	Agranulocytosis	1	0.35

Table 2 presents the selected top-N comorbidities recorded among inpatients with stage 3 and 4 CKD. The percentages were calculated using 284 recorded inpatient comorbidity diagnoses as the denominator. Therefore, the frequencies shown in the table do not sum to the denominator because only selected comorbidities are presented. The most frequently recorded comorbidity was disorders of plasma-protein metabolism, with 29 diagnoses (10.21%), followed by Type 2 diabetes mellitus without complications, with 20 diagnoses (7.04%), and anaemia in other chronic diseases classified elsewhere, with 19 diagnoses (6.69%). Percentages are based on 284 recorded inpatient comorbidity diagnoses. This table presents selected top-N comorbidities and does not include all recorded diagnoses. Therefore, the sum of the Amount column does not represent the total number of inpatient comorbidity diagnoses. Because one patient may have more than one comorbidity, the number of recorded diagnoses is not equivalent to the number of unique patients. As for the outpatient patients with stage 3 and 4 CKD at RSUP HAM, they are presented in Table 3.

Table 3. Comorbidity Profile of Outpatient Stage 3 and 4 CKD Patients from 2022 to 2025 at RSUP HAM Medan

Disease Group	Name of Comorbidity	Amount	Percentage (%)
Metabolic and Endocrine	Type 2 diabetes mellitus without complications	10	7.19
	Type 2 diabetes mellitus with other specified complications	2	1.44
	Disorders of plasma-protein metabolism NEC	1	0.72
Kidney and Urology	Calculus of kidney	8	5.76
	Other and unspecified hydronephrosis	7	5.04
	Nephrotic syndrome, unspecified	4	2.88
	Congenital single renal cyst	3	2.16
	Proliferatif Glomerulonefritis Primer	3	2.16
Hematology	Anaemia in other chronic diseases classified elsewhere	7	5.04
	Thrombocytopenia, unspecified	2	1.44
	Haemolytic-uraemic syndrome	1	0.72

Table 3 presents the selected top-N comorbidities recorded among outpatients with stage 3 and 4 CKD. The percentages were calculated using 139 recorded outpatient comorbidity diagnoses as the denominator. The frequency of Type 2 diabetes mellitus with other specified complications was 2 diagnoses (1.44%). The frequencies shown in the table do not sum to 139 because the table presents only selected comorbidities rather than the complete list of recorded diagnoses. The most frequently recorded comorbidity was Type 2 diabetes mellitus without complications, with 10 diagnoses (7.19%), followed by calculus of kidney, with 8 diagnoses (5.76%).

Cost of Illness (COI)

COI is calculated based on the total actual hospital costs for each patient or episode of care. This study aims to examine whether there are differences in COI based on age, gender, and type of treatment.

Cost of Illness Based on Age

COI was expressed as the average cost incurred per patient per year and is presented as Average COI in the following tables. The COI of outpatient patients with stage 3 and 4 CKD based on age is presented in Table 4.

Table 4. Average COI in Outpatient CKD Stage 3 and 4 Patients from 2022 to 2025 at RSUP HAM Based on Age

Visit	Stage 3				P Value
	Average COI (IDR)	Population of Patients	Average COI (IDR)	Population of Patients	
2022	381,600.00	1	601,508.33	5	0.564
2023	881,463.64	3	721,417.65	10	
2024	856,051.22	17	816,170.00	9	
2025	740,480.00	3	853,133.33	2	
Visit	Stage 4				P Value
	Average COI (IDR)	Population of Patients	Average COI (IDR)	Population of Patients	
2022		0		0	1.000
2023		0		0	
2024	516,787.50	7	457,854.55	9	
2025	877,071.43	11	1,057,750.00	4	

Using the Mann-Whitney test

Table 4 shows that the COI for outpatient CKD patients is highest in the age group > 60 years with stage 4 amounting to IDR 1,057,750.00 in 2025. Meanwhile, the COI for outpatient CKD patients is lowest in the 18-59 years age group with stage 3 amounting to IDR 381,600.00 in 2022. Based on the two-tailed Mann-Whitney U test, there was no statistically significant difference in COI according to age among outpatients with stage 3 CKD ($p = 0.564$) or stage 4 CKD ($p = 1.000$). No outpatient service episodes for stage 4 CKD were recorded in 2022 and 2023 in the hospital database. This may indicate that most stage 4 CKD patients during this period were managed as inpatients or that outpatient coding for stage 4 CKD was not consistently implemented in those years. The COI for inpatient CKD patients in stages 3 and 4 during the 2022 to 2025 period at RSUP HAM is presented in Table 5.

Table 5. Average COI in Inpatient CKD Stage 3 and 4 Patients from 2022 to 2025 at RSUP HAM Based on Age

Visit	Stage 3				P Value
	18-59 years Average COI (IDR)	Population of Patients	>60 years Average COI (IDR)	Population of Patients	
2022	26,328,400.00	1		0	0.439
2023		0	32,126,513.64	9	
2024	26,676,693.75	14	30,497,495.74	9	
2025	4,521,000.00	2	14,834,855.56	3	
Visit	Stage 4				P Value
	18-59 years Average COI (IDR)	Population of Patients	>60 years Average COI (IDR)	Population of Patients	
2022	150,119,900.00	1	11,588,000.00	1	0.248
2023	34,004,736.84	10	38,187,585.71	5	
2024	28,980,889.55	24	28,826,298.51	21	
2025	23,106,510.53	11	15,269,462.50	3	

Using the Mann-Whitney test

Table 5 shows that the highest mean COI for hospitalized CKD patients was observed in the age group 18–59 years with stage 4 in 2022, amounting to IDR 150,119,900.00 (n = 1). The lowest mean COI among inpatients was observed in the age group 18–59 years with stage 3 CKD in 2025, amounting to IDR 4,521,000.00 (n = 2). Among inpatients with stage 4 CKD, the lowest mean COI was observed in the age group >60 years in 2022, amounting to IDR 11,588,000.00 (n = 1). The Mann–Whitney U test showed no statistically significant difference in COI according to age among inpatients with stage 3 CKD (p = 0.439) or stage 4 CKD (p = 0.248). These extreme values are based on single observations and should be interpreted with caution.

Cost of Illness Based on Gender

The COI of inpatient patients with stage 3 and 4 CKD according to gender is presented in Table 6.

Table 6. Average COI in Inpatient CKD Stage 3 and 4 Patients from 2022 to 2025 at RSUP HAM Based on Gender

Visit	Stage 3				P Value
	Male Average COI (IDR)	Population of Patients	Female Average COI (IDR)	Population of Patients	
2022		0	26,328,400.00	1	0.127
2023	32,126,513.64	7	18,227,372.73	2	
2024	26,676,693.75	14	29,057,219.64	9	
2025	29,737,184.62	3	11,299,500.00	2	
Visit	Stage 4				P Value
	Male Average COI (IDR)	Population of Patients	Female Average COI (IDR)	Population of Patients	
2022	150,119,900.00	1	11,588,000.00	1	0.248
2023	31,281,436.36	10	34,921,136.36	5	
2024	28,659,379.41	23	27,192,027.42	22	
2025	26,389,146.67	9	23,106,510.53	5	

Using the Mann-Whitney test

Table 6 shows that the gender in COI for hospitalized stage 3 and 4 CKD patients with the highest overall COI is in the male group with stage 4, amounting to IDR 150,119,900.00. Meanwhile, the lowest COI is in the female group with stage 3, amounting to IDR 11,299,500.00. The Mann–Whitney U test showed no statistically significant difference in COI according to gender among inpatients with stage 3 CKD (p = 0.127) or stage 4 CKD (p = 0.248). The COI of outpatient patients with stage 3 and 4 CKD according to gender is presented in Table 7.

Table 7. Average COI in Outpatient CKD Stage 3 and 4 Patients from 2022 to 2025 at RSUP HAM Based on Gender

Visit	Stage 3				P Value
	Male Average COI (IDR)	Population of Patients	Female Average COI (IDR)	Population of Patients	
2022	645,490.00	3	621,500.00	3	0.564
2023	748,046.67	8	748,846.67	5	
2024	816,170.00	21	1,154,777.27	5	
2025	830,350.00	4	381,000.00	1	

Visit	Stage 4				P Value
	Male Average COI (IDR)	Population of Patients	Female Average COI (IDR)	Population of Patients	
2022		0		0	1.000
2023		0		0	
2024	468,771.43	8	525,800.00	8	
2025	977,486.67	11	966,171.43	4	

Using the Mann-Whitney test

Table 7 shows that, among outpatients, the highest mean COI was observed in female patients with stage 3 CKD in 2024, amounting to IDR 1,154,777.27. The lowest mean COI was observed in female patients with stage 3 CKD in 2025, amounting to IDR 381,000.00. This lowest value was based on only one patient and should therefore be interpreted as a descriptive estimate. The Mann-Whitney U test showed no statistically significant difference in COI according to gender among outpatients with stage 3 CKD ($p = 0.564$) or stage 4 CKD ($p = 1.000$).

Cost of Illness Based on Type of Treatment

The COI of stage 3 and 4 CKD patients according to treatment type is presented in Table 8.

Table 8. Average COI of stage 3 and 4 CKD patients from 2022 to 2025 at RSUP HAM Based on type of treatment

Visit	Stage 3				P Value
	Inpatient Care Average COI (IDR)	Population of Patients	Outpatient Care Average COI (IDR)	Population of Patients	
2022	26,328,400.00	1	601,508.33	6	0.021
2023	32,126,513.64	9	721,417.65	13	
2024	26,676,693.75	23	840,500.00	26	
2025	29,737,184.62	5	740,480.00	5	

Visit	Stage 4				P Value
	Inpatient Care Average COI (IDR)	Population of Patients	Outpatient Care Average COI (IDR)	Population of Patients	
2022	80,853,950.00	2		0	0.121
2023	33,942,452.17	15		0	
2024	28,659,379.41	45	516,787.50	16	
2025	21,427,856.24	14	977,486.67	15	

Using the Mann-Whitney test

Table 8 shows that the COI in stage 3 and 4 CKD patients in the inpatient group is higher than in the outpatient group. The mean COI in the inpatient group was substantially higher than in the outpatient group, with ratios ranging from approximately 24 to 56 times across years and CKD stages where both types of service were available. For example, in stage 4 CKD, the inpatient-outpatient COI ratio was approximately 55 times in 2024 and 24 times in 2025. The Mann-Whitney U test showed a statistically significant difference in COI according to treatment type among patients with stage 3 CKD ($p = 0.021$). In contrast, no statistically significant difference was observed among patients with stage 4 CKD ($p = 0.121$).

P-values were obtained using the two-tailed Mann-Whitney U test on pooled observations from 2022–2025, separately for CKD stage 3 and stage 4. No separate hypothesis test was performed for each calendar year. Several age-, gender-, stage-, and treatment-specific cells contained fewer than five observations, including cells

with zero observations. The corresponding means should therefore be interpreted as descriptive estimates only and not as stable population estimates. Particular caution is required when interpreting very high or low mean COI values derived from one or two observations

DISCUSSION

It is important to note that the COI estimates in this study reflect direct medical costs from the hospital provider's perspective only. Costs borne by patients and families, such as transportation, accommodation, and lost productivity, were not captured because the data sources were limited to hospital administrative and financial records. Therefore, the total societal burden of stage 3 and 4 CKD is likely higher than the estimates presented here. Future studies adopting a societal perspective are needed to provide a more comprehensive picture of the economic burden of CKD.

This study shows that stage 3 and 4 CKD patients at RSUP H. Adam Malik Medan have diverse characteristics and different cost burdens according to the context of care. Among the 194 unique patients, the majority were male (62.37%) and aged 18–59 years (54.12%). In terms of service episodes, 110 out of 195 episodes (56.41%) were recorded in 2024. Most patients also came from North Sumatra Province (90.72%). Male patients constituted the larger proportion of patients included in this study. However, the demographic distribution cannot be directly interpreted as a causal factor for the high COI because the research analysis shows that neither gender nor age provides a statistically significant difference in COI.

The comorbidity profile shows a different pattern between inpatients and outpatients. In hospitalized patients, the most frequently recorded comorbidity was disorders of plasma-protein metabolism with 29 cases (10.21%), followed by type 2 diabetes mellitus without complications with 20 cases (7.04%) and anemia in chronic disease with 19 cases (6.69%). Meanwhile, in outpatient patients, the most common comorbidity was type 2 diabetes mellitus without complications with 10 cases (7.19%), kidney calculus with 8 cases (5.76%), and anemia in chronic disease and hydronephrosis each with 7 cases (5.04%). Because one patient can have more than one comorbidity, the distribution reflects the frequency of comorbidity diagnoses rather than the exclusive prevalence in each patient. The finding of diabetes mellitus and anemia as relatively common comorbidities is relevant to the management of CKD because these accompanying conditions can increase the complexity of monitoring and service needs (Nisar et al., 2024). Diabetes mellitus is one of the conditions closely related to CKD and requires integrated management of risk factors and complications (Sunariyanti et al., 2023; Nisar et al., 2024). Similarly, anemia is a common complication found in CKD and is one of the aspects that need to be considered in patient management (Hidayat et al., 2025). The comorbidity tables present selected top-N diagnoses rather than the complete distribution of all recorded comorbidities. Percentages were calculated using 284 recorded inpatient comorbidity diagnoses and 139 recorded outpatient comorbidity diagnoses as the respective denominators. Consequently, the sum of the frequencies displayed in Tables 2 and 3 is lower than the total number of diagnoses used for percentage calculations. In addition, because one patient could have more than one comorbidity, the frequency of recorded diagnoses does not correspond directly to the number of unique patients. The most common comorbidity patterns remained disorders of plasma-protein metabolism among inpatients and Type 2 diabetes mellitus without complications among outpatients.

Based on age, there is a variation in COI values among age groups, stages, and years of visit, but this descriptive variation is not accompanied by evidence of statistically significant differences. In outpatients, the highest COI was found in the age group >60 years with CKD stage 4 in 2025, which was IDR 1,057,750.00, while the lowest value was found in the age group 18–59 years with CKD stage 3 in 2022, which was IDR 381,600.00. In inpatients, the highest value was found in the age group 18–59 years with CKD stage 4 in 2022, which was IDR 150,119,900.00. The Mann–Whitney test results show that there is no significant difference in COI based on age in the analyzed patient groups.

The absence of significant differences based on age indicates that age cannot yet be used as the main differentiator of COI magnitude in this research population. A high COI value in certain age groups within one year does not automatically indicate a consistent pattern throughout the study period. The characteristics of service episodes, the number of patients in each group, the stage of the disease, and resource utilization variables can influence these differences (Sunariyanti et al., 2023). Therefore, no statistical evidence was found to indicate that age causes differences in COI, nor is it concluded that age is entirely unrelated to CKD costs. Consequently, the interpretation of the research results is more accurate.

Variations in treatment costs according to service setting and hospital characteristics have been reported for chronic kidney disease care in Indonesia (Andayani et al., 2016; Sunariyanti et al., 2023). The present study extends this observation to stage 3 and 4 CKD in a tertiary referral hospital. The results of this study indicate that significant variations in CKD costs can be caused by the characteristics of the service system and resource utilization. Therefore, the results of this study, which do not show differences in COI based on age, suggest that variations in CKD costs are not always primarily determined by patient demographics.

The outpatient COI varied by gender and CKD stage. The highest outpatient COI was observed among female patients with stage 3 CKD in 2024, amounting to IDR 1,154,777.27. Meanwhile, the lowest value was observed among female patients with stage 3 CKD in 2025, amounting to IDR 381,000.00. This lowest value was based on only one patient and should therefore be interpreted as a descriptive estimate.

The difference between the COI values of males and females in a particular year or stage should be viewed with caution because the number of subjects in some strata is relatively small. For example, in stage 4 of 2022, there were only two inpatients, one male and one female. This condition causes the average value in that group to be very sensitive to the characteristics of each service episode. Therefore, extreme COI values in one group are not sufficient to indicate a general pattern of cost differences based on gender. The statistical results of the study actually show that the evidence of COI differences based on gender is not significant in the research population. The findings regarding the type of treatment are one of the most important results in this study. In stage 3 CKD, the average inpatient COI was consistently higher than the outpatient COI throughout the entire observation period. In 2022, for example, the average COI for inpatient care was IDR 26,328,400.00 compared to IDR 601,508.33 for outpatient care. The same pattern is also observed in 2023, 2024, and 2025. The Mann-Whitney test showed a significant difference in COI based on the type of treatment in stage 3 CKD patients ($p = 0.021$).

In stage 4 CKD, the inpatient COI was also descriptively higher compared to the outpatient COI in the years when both types of services were available. In 2024, for example, the average COI for inpatient care was IDR 28,659,379.41, while for outpatient care it was IDR 516,787.50. In 2025, the average COI for inpatient care was IDR 21,427,856.24 compared to IDR 977,486.67 for outpatient care. However, the Mann-Whitney test yielded $p = 0.121$, indicating that there is no statistically significant difference based on the type of treatment for stage 4 patients. Therefore, the research results do not support the conclusion that the type of treatment always results in differences in COI across all stages of CKD. Statistical evidence of such differences was only found in stage 3.

The magnitude of the descriptive difference in COI between inpatient and outpatient care can be understood in the context of resource utilization. Inpatient episodes generally include more service components during a single episode of care compared to outpatient visits. However, this study does not analyze the contribution of each cost component inferentially, so the specific mechanism causing the higher inpatient COI cannot be directly determined from the study results. Previous Indonesian studies have shown that CKD-related costs comprise multiple components, including hemodialysis, procedures, laboratory investigations, medicines, hospitalization, and supporting services. The relative contribution of each component may vary according to disease severity, treatment type, comorbidities, and hospital characteristics (Andayani et al., 2016; Sunariyanti et al., 2023).

The results of this study are also relevant to the research by Neti and Dominata (2021) on the cost analysis of inpatient CKD therapy in Indonesia. The research highlights that within the JKN system, the actual hospital costs can differ from the INA-CBGs rates and that the cost components of CKD services contribute differently to the total cost. These differences are important because this research focuses on stage 3 and 4 CKD patients, not just end-stage patients or hemodialysis patients. Therefore, the results of this study provide an overview of costs during the CKD phase before it reaches the end stage, such as the need for kidney replacement therapy.

Theoretically, the findings of this study indicate that COI in stage 3 and 4 CKD should be understood as the result of the interaction between disease characteristics and hospital services. Age and gender do not show significant differences in COI, whereas the type of treatment shows significant differences in stage 3. Thus, the research results indicate that the episode of care can be a more informative aspect in understanding cost variations compared to certain demographic characteristics. This interpretation remains contextual because the research was conducted at a single tertiary referral hospital and used retrospective data over four years.

From a managerial perspective, the findings regarding the high COI of inpatient care descriptively provide important information for hospitals in resource planning and monitoring the cost of CKD services. Hospital managers can use COI information based on the stage and type of treatment as initial data to identify service episodes with relatively high cost burdens. However, the research results are not sufficient to determine which service components need to be reduced or changed. Further evaluation needs to break down the costs of medication, laboratory tests, radiology, medical procedures, length of stay, medical supplies, and other service components so that efficiency strategies can be directed toward the truly dominant cost sources.

The findings also have implications for the Indonesian National Health Insurance (JKN) financing system, particularly the INA-CBGs payment mechanism. However, this study primarily evaluated the Cost of Illness based on actual hospital costs and did not perform a detailed analysis of the difference between actual costs and INA-CBGs tariffs across individual service components. Therefore, the findings should not be interpreted as evidence that INA-CBGs tariffs are generally sufficient or insufficient to cover CKD services. Further research is needed to directly compare actual hospital costs with INA-CBGs reimbursement by CKD stage, type of treatment, and major cost components to identify potential differences in financing adequacy.

Overall, this study shows that the COI of stage 3 and 4 CKD patients at RSUP H. Adam Malik Medan varies according to stage, year, age, gender, and type of treatment. However, these variations do not always indicate

statistical differences. Age and gender do not show significant differences in COI, whereas the type of treatment shows significant differences in stage 3 patients but not in stage 4. These findings highlight the importance of considering services when evaluating the economic burden of CKD. From a managerial perspective, these results can serve as an initial basis for hospitals to monitor resource utilization based on stage and type of service, while from a financing perspective, further analysis of the alignment between actual costs and INA-CBGs rates is needed to produce more specific and evidence-based financing recommendations.

CONCLUSION AND IMPLICATIONS

This study shows that patients with stage 3 and 4 CKD at RSUP H. Adam Malik Medan during the period 2022–2025 were predominantly male, aged 18–59 years. The comorbidity profile varied by type of service. Among inpatients, disorders of plasma-protein metabolism were the most frequently recorded comorbidity, followed by type 2 diabetes mellitus without complications and anaemia in chronic diseases. Among outpatients, type 2 diabetes mellitus without complications was the most common comorbidity, followed by calculus of kidney and anaemia in chronic diseases. This study shows that the COI of patients with stage 3 and 4 CKD varied descriptively across CKD stage, year of visit, age group, gender, and type of treatment. However, statistical analysis showed no significant differences in COI according to age or gender. A significant difference in COI according to type of treatment was observed among patients with stage 3 CKD ($p = 0.021$), whereas no significant difference was observed among patients with stage 4 CKD ($p = 0.121$). The results of this study theoretically indicate that understanding the economic burden of CKD in stages 3 and 4 should be conducted in the context of service, not just based on patient demographics. From a health financing perspective, the research results support the need for further evaluation of the alignment between actual hospital costs and INA-CBG tariffs at each stage and type of service. From a health financing perspective, the results support the need for further evaluation of the alignment between actual hospital costs and INA-CBGs tariffs at each stage and type of service. Managerially, the variation in COI, particularly the difference in costs between inpatient and outpatient services at stage 3, can serve as initial information for hospitals in monitoring resource utilization and planning CKD services. This evaluation can help produce more evidence-based financial planning and resource management, while acknowledging that direct comparisons between hospital costs and INA-CBGs tariffs were not performed in this study.

LIMITATIONS AND FUTURE RESEARCH

This study has several limitations. First, it used retrospective secondary data from a single tertiary hospital, which may limit the generalizability of the findings to other healthcare facilities. Second, the COI analysis focused on age, gender, and treatment type and did not examine the independent effects of clinical factors, comorbidities, length of stay, disease severity, or individual cost components. Third, several subgroup cells contained very few observations, including cells with one or two patients or no patients; therefore, the corresponding mean COI values should be interpreted as descriptive estimates rather than stable population estimates. Extreme mean values derived from such small cells are particularly sensitive to outliers and should not be overinterpreted. Fourth, six two-tailed Mann–Whitney U tests were performed to compare COI according to age, gender, and treatment type, separately for CKD stage 3 and stage 4. Because these analyses were exploratory and hypothesis-generating, no adjustment for multiple comparisons was applied. The statistically significant finding for treatment type in stage 3 should therefore be interpreted cautiously, acknowledging the increased risk of type I error. It is also worth noting that some Mann–Whitney U tests conducted in different subgroup comparisons (for example, age versus gender among outpatients) yielded identical two-tailed p-values. Because the Mann–Whitney U test is based on the rank distribution of observations rather than on mean differences, identical p-values can occur when the rank patterns and group sizes are sufficiently similar, even if the mean COI values differ across comparisons. All statistical outputs were rechecked to confirm that these p-values correspond to the correct subgroup analyses. Future studies should use a multicenter design with larger sample sizes and more comprehensive cost analyses, including clinical severity scores and detailed cost components. Longitudinal designs are recommended to evaluate changes in COI as CKD progresses and to identify the factors driving cost variations over time. Fifth, the unit of analysis for the Mann–Whitney U tests was the year-specific average COI per patient (four observations per group), not the individual patient or service episode. This limits the statistical power of the comparisons and means that the findings reflect differences in aggregated annual averages rather than in the distribution of costs at the patient level.

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