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Direct medical cost analysis in the treatment of chronic kidney disease at Thong Nhat Dong Nai General Hospital in 2024

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ABSTRACT

Background: Chronic kidney disease (CKD) is rapidly becoming more prevalent among younger populations, posing significant impacts on health and socio-economic development. Therefore, analyzing direct medical costs (DMCs) in CKD treatment is essential. Objective: To analyze DMCs in the treatment of CKD at Thong Nhat Dong Nai General Hospital in 2024. Subjects and Methods: A cross-sectional descriptive study was conducted using retrospective electronic billing data of all CKD patients who met the sampling criteria at Thong Nhat Dong Nai General Hospital from January to December 2024. Results: The study analyzed data from 7,634 patients, with a mean age of 63.41 ± 13.76 years. Among them, 24.18% were diagnosed with stage 1 CKD. The average annual DMC per patient, per inpatient episode, and per outpatient visit was 14.02 million VND (95% CI: 13.28-14.77 million VND), 10.81 million VND (95% CI: 9.76-11.85 million VND), and 3.45 million VND (95% CI: 3.38-3.53 million VND), respectively. The majority of the costs were reimbursed by health insurance (ranging from 89.30% to 93.06%). Factors associated with DMCs included gender, CKD stage, insurance reimbursement rate, type of insurance coverage, and the presence of vascular comorbidities. Conclusion: The annual DMCs for CKD treatment were estimated to account for approximately 12.3% of the national GDP per capita in 2024, with inpatient DMCs representing around 9.48% and outpatient DMCs accounting for approximately 3.03%.

Keywords: *direct medical cost, chronic kidney disease, factor associated*

1. INTRODUCTION

Chronic kidney disease (CKD) is defined as abnormalities of kidney structure or function lasting for at least three months with health implications [1]. These abnormalities include a persistently reduced estimated glomerular filtration rate (eGFR) below 60 mL/min/1.73 m² or evidence of kidney damage such as albuminuria, urinary abnormalities, tubular electrolyte disorders, structural abnormalities on imaging, or a history of kidney transplantation. CKD is now recognized as one of the leading causes of mortality worldwide, with a marked upward trend over the past two decades [2]. A 2022 meta-analysis estimated that more than 434 million adults are affected globally, with higher prevalence among the elderly, women, and individuals with chronic conditions such as diabetes and hypertension [2, 3]. In addition, the treatment process for CKD is typically prolonged, involving medication use, regular laboratory testing, specialized procedures, and extended hospital stays. Consequently, healthcare costs increase significantly with disease progression, imposing a considerable economic burden on both the patients and the healthcare systems. A 2024 study in Australia reported estimated annual costs of 3,367 USD for stage 1, 4,114 USD for stage 2, 11,456 USD for stage 4, and 62,558 USD for stage 5 CKD [4]. In Asian countries, the average treatment cost for CKD in patients not requiring dialysis is estimated at approximately 1,990 USD per patient per year, and this cost increases to around 4,977 USD per patient per year for those requiring hemodialysis treatment [5]. In Vietnam, Ngo Vi Dai et al. (2023) reported an average treatment cost of 22,469,860 VND for end-stage CKD patients [6].

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While numerous studies worldwide and in Vietnam have analyzed direct medical costs (DMCs) in CKD management, no similar study has been conducted in Dong Nai Province. Therefore, this study titled "Direct Medical Cost Analysis in the Treatment of Chronic Kidney Disease at Thong Nhat Dong Nai General Hospital in 2024" was conducted with the following objectives:

1. To analyze DMCs in CKD management at Thong Nhat Dong Nai General Hospital in 2024.
2. To identify factors associated with DMCs in CKD treatment at Thong Nhat Dong Nai General Hospital in 2024.

2. SUBJECTS AND METHODS

2.1. Study subjects

2.1.1. Study subjects

DMCs and factors associated with the DMCs in CKD treatment at Thong Nhat Dong Nai General Hospital in 2024.

2.1.2. Survey subjects

Electronic billing data of CKD patients treated at Thong Nhat Dong Nai General Hospital in 2024.

2.2. Study methods

2.2.1. Study design

A cross-sectional descriptive study based on retrospective data collected from electronic payments of CKD patients at Thong Nhat Dong Nai General Hospital in 2024.

2.2.2. Study sample

Sampling criteria

The study sample was selected based on the criteria presented in Table 1.

Table 1. Sampling criteria

Inclusion criteria	Exclusion criteria
- Electronic payment data with a diagnosis of chronic kidney disease (ICD codes: N18.0, N18.1, N18.2, N18.3, N18.4, N18.5, N18.9). - Patients aged 16 years and older.	- Incomplete electronic payment data lacking the necessary study information. - Patients who discontinued treatment against medical advice or were transferred to another hospital.

Sampling methods

All cases meeting the sampling criteria during the research period were included in the study.

Study variables

The study collected data on patient characteristics and treatment cost information from the electronic payment database. The specific study variables are presented in Tables 2 and 3.

Table 2. Study variables

Variable	Values	Statistical methods
Patient characteristics		
Age	Quantitative (years)	Mean (95% CI)
Gender	Qualitative (male, female)	Frequency (%)
Area of residence	Qualitative (urban, rural)	Frequency (%)
Health insurance participant group	Qualitative (social insurance organization, household, state budget, employee/employer)	Frequency (%)
Insurance reimbursement rate	Qualitative (80%, 95%, 100%)	Frequency (%)
CKD stage*	Qualitative (unspecified, stages 1, 2, 3, 4, 5, and end stage)	Frequency (%)
Comorbidities	Qualitative (hypertension, diabetes mellitus, dyslipidemia, vascular disease)	Frequency (%)
Reason for admission/visit	Qualitative (routine examination, emergency)	Frequency (%)
Treatment outcome	Qualitative (recovered, improved, unchanged, worsened, deceased)	Frequency (%)

Variable	Values	Statistical methods
Patient characteristics		
Length of hospital stay	Quantitative (days)	Mean (95% CI)
Number of outpatient visits	Quantitative	Mean (95% CI)
Number of inpatient episodes	Quantitative	Mean (95% CI)
Cost analysis		
Average DMC per patient	Average DMC DMC by cost component DMC by source of payment	Mean (95% CI)
Average DMC per outpatient visit		
Average DMC per inpatient episode		

*Note: SD - Standard Deviation; CI - Confidence Interval; CKD - Chronic Kidney Disease; DMC - Direct Medical Cost; *: classified according to the ICD-10 codes and ICD-10 variants.*

Table 3. Analysis of associated factors

Dependent variable	Independent variables	Statistical method
- Average DMC per patient - Average DMC per outpatient visit - Average DMC per inpatient episode	Age, length of hospital stay, number of comorbidities, number of outpatient visits, number of inpatient episodes	Spearman or Pearson correlation
	Gender, area of residence, type of health insurance, benefit level, comorbidities (hypertension, diabetes, dyslipidemia, vascular disease), reason for admission/visit, treatment outcome	Mann-Whitney (or T-test), Kruskal-Wallis (or ANOVA)

Note: DMC - Direct Medical Cost.

2.3. Data processing and analysis

Data were processed and analyzed using Microsoft Excel 2021 and IBM SPSS Statistics 26.0. Statistical analysis was performed with a 95% confidence level, and the correlations between variables were evaluated by testing hypotheses H_0 and H_1 using appropriate statistical methods.

2.4. Research Ethics

This study was conducted using data extracted from a research protocol approved by the Ethics Committee of Thong Nhat Dong Nai General Hospital under Decision No. 05/HĐĐĐ dated March 10, 2025. The study ensured the confidentiality of patient information within the research dataset.

3. RESULTS

3.1. General characteristics of the study sample

The research sample consisted of 7,634 CKD patients at Thong Nhat Dong Nai General Hospital in 2024. The study recorded the characteristics of the sample, which are presented in Table 4.

Table 4. Sample characteristics (n = 7,634)

Variable		Frequency / Mean	Percentage / 95% CI
Age		63.41	63.10 - 63.72
Outpatient visits		8.72	8.55 - 8.89
Inpatient episodes		0.62	0.60 - 0.65
Gender	Male	3,279	42.95
	Female	4,355	57.05
Area of residence	Urban	3,133	41.04
	Rural	4,501	58.96
Insurance reimbursement rate	80%	4,654	60.96
	95%	592	7.75
	100%	2,388	31.28

Variable		Frequency / Mean	Percentage / 95% CI
Health insurance participant group	Employee/employer	417	5.46
	Social insurance organization	778	10.19
	State budget	2,335	30.59
	Household	4,104	53.76
CKD stage*	Unspecified	894	11.71
	Stage 1	1,846	24.18
	Stage 2	1,518	19.88
	Stage 3	1,429	18.72
	Stage 4	448	5.87
	Stage 5	652	8.54
	End stage	847	11.10
Comorbidities	Dyslipidemia	6,019	78.84
	Hypertension	5,624	73.67
	Diabetes mellitus	4,968	65.08
	Vascular disease	2,473	32.39

*Note: CI - Confidence Interval; CKD - Chronic Kidney Disease; *: classified according to the ICD-10 codes and ICD-10 variants.*

According to Table 4, the mean age of patients was 63.41 years (95% CI: 63.10 - 63.72), with an average of 8.72 outpatient visits (95% CI: 8.55 - 8.89) and 0.62 inpatient episodes (95% CI: 0.60 - 0.65). The female-to-male ratio was 1.33:1. Most patients (58.96%) lived in rural areas, had an 80% insurance reimbursement rate (60.96%), and participated in household-based health insurance (53.76%). Approximately 25.51% of patients were in advanced disease stages (stage 4, 5, and end stage), and the most common comorbidities were dyslipidemia (78.84%), hypertension (73.67%), and diabetes mellitus (65.08%).

3.2. Direct medical costs for chronic kidney disease treatment

The study dataset included 20,176 outpatient visits and 3,145 inpatient episodes from 7,634 CKD patients at Thong Nhat Dong Nai General Hospital in 2024. The study recorded the results of annual DMC per patient, as well as DMC per outpatient visit and per inpatient episode by cost components and payer sources, which are presented in Table 5.

Table 5. Direct medical costs for chronic kidney disease treatment (unit: Million VND)

Cost category	Per patient/year		Per outpatient visit		Per inpatient episode	
	Mean (95% CI)	%	Mean (95% CI)	%	Mean (95% CI)	%
By component						
Procedure / Surgery	6.36 (5.90 - 6.82)	45.34	1.90 (1.85 - 1.94)	54.91	2.23 (2.00 - 2.45)	20.63
Medication	4.69 (4.40 - 4.97)	33.41	1.30 (1.28 - 1.33)	37.57	2.99 (2.77 - 3.21)	27.66
Hospital bed days	0.95 (0.89 - 1.01)	6.77	-	-	2.30 (2.21 - 2.40)	21.28
Laboratory tests	0.91 (0.89 - 0.94)	6.52	0.20 (0.19 - 0.20)	5.78	0.91 (0.87 - 0.95)	8.42
Medical supplies	0.69 (0.52 - 0.85)	4.90	0.01 (0.01 - 0.01)	0.29	1.67 (1.26 - 2.08)	15.45
Imaging diagnostics	0.34 (0.32 - 0.36)	2.43	0.02 (0.02 - 0.02)	0.58	0.70 (0.64 - 0.75)	6.48

Cost category	Per patient/year		Per outpatient visit		Per inpatient episode	
	Mean (95% CI)	%	Mean (95% CI)	%	Mean (95% CI)	%
By component						
Medical consultation	0.09 (0.08 - 0.09)	0.63	0.03 (0.03 - 0.03)	0.87	0.01 (0.01 - 0.01)	0.08
Total	**14.02 (13.28 - 14.77)**	**100**	**3.46 (3.38 - 3.53)**	**100**	**10.81 (9.76 - 11.85)**	**100**
By source of payment						
Insurance payment	13.05 (12.34 - 13.76)	93.06	3.28 (3.21 - 3.34)	94.80	9.66 (9.06 - 10.27)	89.36
Patient payment	0.97 (0.89 - 1.06)	6.94	0.18 (0.17 - 0.19)	5.20	1.15 (1.01 - 1.29)	10.64
Total	**14.02 (13.28 - 14.77)**	**100**	**3.46 (3.38 - 3.53)**	**100**	**10.81 (9.76 - 11.85)**	**100**

Note: CI - Confidence Interval.

According to Table 5, the mean DMC per CKD patient was 14.02 million VND (95% CI: 13.28 - 14.77), with procedure/surgery costs (45.34%) and medication costs (33.41%) accounting for the largest proportions. For outpatient visits, the mean DMC per episode was 3.46 million VND (95% CI: 3.38 - 3.53), primarily driven by procedures/surgeries (54.91%), followed by medications (37.57%). For inpatient episodes, the mean DMC was 10.81 million VND (95% CI: 9.76 - 11.85), with medications (27.66%), hospital bed days (21.28%), procedures/surgeries (20.63%), and medical supplies (15.45%) being the major cost components. Most costs were covered by health insurance, ranging from 89.36% to 94.80%.

3.3. Factors associated with direct medical costs

3.3.1. Factors associated with annual direct medical costs per patient

The analysis of factors associated with treatment costs among CKD patients, with the corresponding results, is presented in Table 6.

Table 6. Factors associated with annual direct medical costs per patient (n = 7,634)

Characteristic[#]		Mean (95% CI) Unit: Million VND	Mean rank	p-value
Gender	Male	15.80 (14.59 - 17.01)	3,899.73	0.005
	Female	12.69 (11.75 - 13.62)	3,755.59	
Health insurance reimbursement rate	80%	8.21 (7.52 - 8.89)	3,414.06	< 0.001
	95%	9.29 (7.07 - 11.50)	3,415.36	
	100%	26.53 (24.73 - 28.34)	4,703.46	
Health insurance participant group	Employee/Employer	10.57 (7.40 - 13.74)	2,888.05	< 0.001
	Social insurance organization	6.34 (4.86 - 7.81)	3,154.48	
	State budget	27.93 (26.07 - 29.79)	4,841.87	
	Household	7.92 (7.23 - 8.61)	3,454.80	
CKD stage*	Unspecified	6.67 (5.55 - 7.79)	3,495.85	< 0.001
	Stage 1	0.96 (0.92 - 1.00)	2,172.21	
	Stage 2	1.18 (1.13 - 1.23)	2,618.70	
	Stage 3	6.18 (5.45 - 6.91)	4,281.80	
	Stage 4	8.70 (7.39 - 10.01)	5,127.27	
	Stage 5	21.05 (18.45 - 23.65)	5,832.26	
	End stage	83.92 (80.48 - 87.36)	6,864.32	
Dyslipidemia	No	25.71 (23.59 - 27.82)	4,718.16	< 0.001
	Yes	10.89 (10.15 - 11.63)	3,575.84	
Hypertension	No	2.26 (1.92 - 2.60)	2,374.11	< 0.001
	Yes	18.23 (17.24 - 19.21)	4,333.36	

Characteristic#		Mean (95% CI) Unit: Million VND	Mean rank	p-value
Diabetes mellitus	No	25.24 (23.56 - 26.91)	4,446.65	< 0.001
	Yes	8.01 (7.35 - 8.66)	3,479.87	
Vascular disease	No	11.98 (11.15 - 12.81)	3,518.01	< 0.001
	Yes	18.29 (16.78 - 19.79)	4,442.51	
Characteristic		**Correlation coefficient**		**p-value**
Number of comorbidities		0.51		< 0.001
Number of outpatient visits		-0.17		< 0.001
Number of inpatient episodes		0.46		< 0.001

*Note: CI - Confidence Interval; CKD - Chronic Kidney Disease; VND - Vietnamese Dong; *: Classified according to the ICD-10 codes and ICD-10 variants; #: The study examined the correlation between all patient characteristics; however, only the variables that showed significant associations are presented*

According to Table 6, several factors were significantly associated with annual DMCs per patient ($p < 0.05$), including gender, insurance reimbursement rate, insurance participant group, CKD stage, dyslipidemia, hypertension, diabetes mellitus, vascular disease, number of comorbidities, number of outpatient visits, and number of inpatient episodes. Higher DMCs were observed in male patients (1.25 times higher than females); patients with 100% insurance coverage (2.86 and 3.23 times higher than those with 95% and 80% coverage, respectively); and patients under state-funded insurance (2.64 - 4.41 times higher than other groups). Costs also increased with disease severity - end-stage CKD patients had DMCs 3.99 - 87.42 times higher than those in earlier stages. Patients without dyslipidemia or diabetes had 2.36 and 3.15 times higher costs than those with these comorbidities, while patients with hypertension or vascular disease had 8.07 and 1.53 times higher costs, respectively. The number of comorbidities and inpatient episodes showed a moderate positive correlation with DMCs ($r = 0.51$ and 0.46), while the number of outpatient visits had a very weak negative correlation ($r = -0.17$).

3.3.2. Factors associated with direct medical costs per outpatient visit

An analysis of factors associated with DMCs per outpatient visit among CKD patients yielded the results presented in Table 7.

Table 7. Factors associated with direct medical costs per outpatient visit (n = 20,176 visits)

Characteristic#		Frequency	Mean (95% CI) Unit: Million VND	Mean rank	p-value
Gender	Male	8,788	3.76 (3.66 - 3.86)	10,260.88	< 0.01
	Female	11,388	3.21 (3.13 - 3.29)	9,955.48	
Area of residence	Urban	7,672	2.78 (2.69 - 2.87)	9,237.44	< 0.01
	Rural	12,504	3.86 (3.78 - 3.95)	10,610.68	
CKD stage*	Stage 1	3,237	0.69 (0.68 - 0.70)	7,289.07	< 0.01
	Stage 2	2,133	0.63 (0.62 - 0.64)	6,460.23	
	Stage 3	4,262	0.63 (0.62 - 0.64)	6,391.06	
	Stage 4	1,516	0.66 (0.65 - 0.67)	7,018.59	
	Stage 5	4,711	6.75 (6.61 - 6.88)	14,354.09	
	End stage	3,282	9.15 (9.02 - 9.27)	16,701.12	
	Unspecified	1,035	0.59 (0.57 - 0.61)	5,659.06	
Health insurance reimbursement rate	80%	10,503	1.72 (1.66 - 1.77)	8,032.16	< 0.01
	95%	1,409	2.59 (2.39 - 2.80)	9,256.88	
	100%	8,264	5.80 (5.69 - 5.91)	12,843.76	

Characteristic#		Frequency	Mean (95% CI) Unit: Million VND	Mean rank	p-value
Health insurance participant group	Household	9,107	1.53 (1.47 - 1.58)	7,808.36	< 0.01
	State budget	8,427	5.82 (5.71 - 5.93)	12,864.37	
	Employer / Employee	1,057	3.19 (2.93 - 3.45)	9,805.82	
	Social insurance organization	1,585	2.08 (1.90 - 2.25)	8,619.57	
Diabetes mellitus	No	10,617	5.45 (5.35 - 5.54)	11,886.91	< 0.01
	Yes	9,559	1.23 (1.19 - 1.28)	8,091.04	
Hypertension	No	6,840	4.65 (4.53 - 4.76)	11,635.43	< 0.01
	Yes	13,336	2.84 (2.77 - 2.91)	9,295.08	
Dyslipidemia	No	6,955	6.66 (6.55 - 6.78)	13,796.83	< 0.01
	Yes	13,221	1.76 (1.71 - 1.82)	8,137.71	
Vascular disease	No	16,023	3.75 (3.68 - 3.82)	10,267.06	< 0.01
	Yes	4,153	2.31 (2.20 - 2.42)	9,399.58	
Reason for visit	Routine examination	20,113	3.46 (3.40 - 3.52)	10,100.09	< 0.01
	Emergency	63	0.94 (0.69 - 1.18)	6,387.79	
Characteristic			**Correlation coefficient**		**p-value**
Age			-0.31		< 0.01
Number of comorbidities			-0.12		< 0.01

*Note: CI - Confidence Interval; CKD - Chronic Kidney Disease; VND - Vietnamese Dong; *: Classified according to the ICD-10 codes and ICD-10 variants; #: The study examined the correlation between all patient characteristics; however, only the variables that showed significant associations are presented*

According to Table 7, factors significantly associated with DMCs per outpatient visit ($p < 0.05$) included gender, area of residence, insurance reimbursement rate, insurance participant group, CKD stage, diabetes mellitus, hypertension, dyslipidemia, vascular disease, reason for visit, age, and number of comorbidities. Higher DMCs were observed in male patients (1.17 times higher than females); those living in rural areas (1.39 times higher than urban); end-stage CKD patients (1.36 times higher than stage 5 and 13.26 - 15.51 times higher than earlier stages); and patients with 100% insurance coverage (2.24 and 3.37 times higher than those with 95% and 80% coverage, respectively). Patients insured by the state budget had DMCs 1.82 - 3.80 times higher than other insurance participant groups, while patients without comorbidities had 1.62 - 3.78 times higher costs than those with comorbidities (particularly dyslipidemia and diabetes). Patients visiting for examination (versus emergency care) had DMCs 3.68 times higher. Age and the number of comorbidities were negatively correlated with DMCs, with a weak correlation ($r = -0.31$) and a very weak correlation ($r = -0.12$), respectively.

3.3.3. Factors associated with direct medical costs per inpatient episode

An analysis of factors associated with DMCs per inpatient episode among CKD patients yielded the results presented in Table 8.

Table 8. Factors associated with direct medical costs per inpatient episode (n = 3,145)

Characteristic#		Frequency	Mean (95% CI) Unit: Million VND	Mean rank	p-value
Gender	Male	1,478	11.60 (10.49 - 12.72)	1,661.35	< 0.01
	Female	1,667	10.11 (9.24 - 10.97)	1,494.67	
Health insurance reimbursement rate	80%	1,465	10.00 (9.01 - 11.00)	1,477.99	< 0.01
	95%	186	9.28 (7.40 - 11.15)	1,566.63	
	100%	1,494	11.79 (10.72 - 12.86)	1,666.96	

Characteristic#		Frequency	Mean (95% CI) Unit: Million VND	Mean rank	p-value
Health insurance participant group	Household	1,283	9.91 (8.94 - 10.87)	1,499.49	< 0.01
	State budget	1,539	11.77 (10.70 - 12.84)	1,648.68	
	Employee / Employer	122	11.07 (5.29 - 16.84)	1,307.90	
	Social insurance organization	201	9.09 (7.81 - 10.37)	1,623.71	
CKD stage*	Stage 1	39	3.57 (2.79 - 4.35)	808.21	< 0.01
	Stage 2	10	9.31 (1,55 - 17,06)	1,484	
	Stage 3	660	9.35 (7.90 - 10.81)	1,354.22	
	Stage 4	227	8.52 (6.34 - 10.70)	1,328.67	
	Stage 5	1,090	12.40 (11.04 - 13.77)	1,732.25	
	End stage	440	9.30 (8.51 - 10.10)	1,688.47	
	Unspecified	679	11.85 (10.19 - 13.51)	1,582.11	
Dyslipidemia	No	1,706	10.47 (9.62 - 11.33)	1,605.18	0.03
	Yes	1,439	11.21 (10.07 - 12.35)	1,534.85	
Vascular disease	No	2,368	9.39 (8.76 - 10.01)	1,539.41	< 0.01
	Yes	777	15.15 (13.11 - 17.19)	1,675.36	
Reason for admission	Routine examination	1,789	9.59 (8.85 - 10.33)	1,516.92	< 0.01
	Emergency	1,356	12.42 (11.14 - 13.70)	1,646.99	
Treatment outcome	Recovered	1,245	9.32 (8.53 - 10.12)	1,520.89	< 0.01
	Improved	1,521	10.71 (9.62 - 11.80)	1,557.21	
	Unchanged	266	12.35 (9.52 - 15.18)	1,568.19	
	Worsened	110	25.32 (19.47 - 31.16)	2,384.61	
	Death	3	12.71 (0 - 43.55)	1,870.33	
Characteristic			**Correlation coefficients**		**p-value**
Length of hospital stay			0.77		< 0.01
Number of comorbidities			0.23		< 0.01

*Note: CI - Confidence Interval; CKD - Chronic Kidney Disease; VND - Vietnamese Dong; *: classified according to the ICD-10 codes and ICD-10 variants; #: The study examined the correlation between all patient characteristics; however, only the variables that showed significant associations are presented.*

According to Table 8, factors significantly associated with inpatient DMCs ($p < 0.05$) included gender, insurance reimbursement rate, insurance participant group, CKD stage, dyslipidemia, vascular disease, reason for admission, treatment outcome, number of comorbidities, and length of stay. Higher DMCs were observed in male patients (1.15 times higher than females); patients with 100% insurance coverage (1.18 and 1.27 times higher than those with 80% and 95% coverage, respectively); and state-funded insurance beneficiaries (1.06 - 1.29 times higher than other groups). Patients with stage 5 CKD had DMCs 1.02 - 3.37 times higher than other stages; those with dyslipidemia or vascular disease had 1.07 and 1.61 times higher costs than those with no comorbidity, respectively. Admissions via emergency were 1.30 times more costly than routine examination; the worsened treatment outcomes had 1.99 - 2.36 times higher costs than other outcomes. Length of hospital stay and number of comorbidities were positively correlated with DMCs, with a strong correlation ($r = 0.77$) and a weak correlation ($r = 0.23$), respectively.

4. DISCUSSION

The study analyzed the DMCs of 7,634 patients with CKD, comprising 20,176 outpatient visits and 3,145 inpatient episodes at Thong Nhat Dong Nai General Hospital in 2024. The mean patient age was 63.41 years (95% CI: 63.10 - 63.72), comparable to the findings of Nguyen Thi Hai Yen et al. (2021), who reported that most patients were elderly, with a mean age of 65.00 ± 17.10 years - an age group in which chronic diseases tend to progress more severely and multiple comorbidities are common [7]. The mean numbers of outpatient visits and inpatient episodes per patient were 8.72 (95% CI: 8.55 - 8.89) and 0.62 (95% CI: 0.60 - 0.65), respectively, reflecting the nature of CKD, which requires regular follow-up, laboratory testing, and medication adjustment, along with a substantial rate of hospitalization due to cardiovascular complications, hypertension, or progression to end-stage renal disease (ESRD). Regarding comorbidities, most patients had dyslipidemia (78.84%), hypertension (73.67%), and diabetes (65.08%) - metabolic and cardiovascular disorders commonly observed in CKD patients. Sang Heon Suh et al. (2023) also reported that dyslipidemia is prevalent in most CKD patients, contributing to increased cardiovascular risk and faster disease progression [8]. Similarly, Francis et al. (2024) identified hypertension and diabetes as the two leading causes of CKD globally, especially in low- and middle-income countries [9]. The coexistence of multiple comorbidities not only increases the risk of disease progression but also substantially raises treatment costs due to higher demands for medication, laboratory testing, and complication treatment.

The study found that the mean annual DMC per patient was 14.02 million VND (95% CI: 13.28-14.77), with procedural and surgical costs accounting for the largest proportion (45.34%). This reflects the nature of CKD treatment, which often involves major technical interventions such as hemodialysis, vascular access placement, or kidney transplantation. These findings are consistent with those of Kim et al. (2017) in Korea, who reported that renal replacement therapies such as hemodialysis and kidney transplantation accounted for approximately 70% of total DMCs [10]. For outpatient care, the mean DMC per visit was 3.46 million VND (95% CI: 3.38 - 3.53), with procedural and surgical costs representing the largest share (54.91%), followed by medication costs (37.57%), while other categories - such as laboratory testing, imaging, examination, and medical supplies - accounted for smaller proportions. These results are consistent with the study by Ngo Vi Dai et al. (2023), which reported that procedural and surgical costs accounted for 54.97% and drug costs for 40.72% of total outpatient expenditures [6]. For inpatient care, the mean DMC per hospitalization was 10.81 million VND (95% CI: 9.76 - 11.85), with medication costs accounting for the highest proportion (27.66%), followed by bed-day costs (21.28%), procedures/surgeries (20.63%), and medical supplies (15.45%). This pattern reflects the nature of inpatient care, where costs mainly arise from drug use and hospital stays, given the need for intensive treatment, continuous monitoring, and medical interventions. Therefore, medication and bed-day costs play an essential role in inpatient expenditure, highlighting the continuous care and specialized medication required. Most expenses were covered by health insurance, ranging from 89.36% to 94.80%, helping to significantly reduce patients' financial burden.

In the analysis of factors related to DMCs, the study identified gender, insurance reimbursement rate, insurance participant group, CKD stage, dyslipidemia, hypertension, diabetes, vascular disease, number of comorbidities, number of outpatient visits, and number of inpatient episodes as being associated with annual mean DMC. Treatment DMCs increased progressively by CKD stage - from approximately 0.96 million VND (95% CI: 0.92 - 1.00) in stage 1 to 83.92 million VND (95% CI: 80.48 - 87.36) in ESRD - reflecting growing treatment demands in later stages, including complex interventions such as dialysis and surgery, as well as the heavier financial burden associated with disease progression. The DMCs for male patients were higher than for female patients, consistent with the observed data showing that males had more severe renal impairment than females ($p < 0.001$). DMCs were positively correlated with the number of comorbidities ($r = 0.51$, $p < 0.01$), consistent with the findings of Nguyen Hoang Lan

et al. (2016), who also identified the number of comorbidities as a significant determinant of CKD treatment costs [11]. DMCs were negatively correlated with the number of outpatient visits (r = -0.17), indicating that patients with more frequent follow-up visits had lower annual treatment costs compared with those who did not. This is consistent with the observed inverse relationship between outpatient visits and inpatient episodes (r = -0.18, p < 0.01), suggesting that regular follow-up helps reduce hospitalization rates and consequently total costs (the mean DMC per inpatient episode was 3.12 times higher than that per outpatient visit). Patients without comorbid diabetes and dyslipidemia had higher costs than those with these conditions, which can be explained by the observed negative correlations between these comorbidities and the number of inpatient admissions (r < -0.10; p < 0.01), indicating that these patients had fewer hospital admissions, which consequently reduced their total inpatient treatment costs. For outpatient care, factors significantly associated with DMC per visit (p < 0.05) included gender, insurance reimbursement rate, insurance participant group, area of residence, CKD stage, diabetes, hypertension, dyslipidemia, vascular disease, reason for visit, age, and number of comorbidities. In this study, age (r = -0.31, p < 0.01) and the number of comorbidities (r = -0.12, p < 0.01) showed a negative correlation with treatment costs. This is consistent with the study data demonstrating that renal impairment severity was negatively correlated with age (r = -0.225, p < 0.01) and number of comorbidities (r = -0.146, p < 0.01), whereas age was positively correlated with the number of comorbidities (r = 0.272, p < 0.01). This implies that younger patients, despite having fewer comorbidities, tend to present with more severe renal impairment, resulting in higher treatment costs. These findings reflect the trend of CKD increasingly affecting younger individuals, with a growing number requiring dialysis and many being diagnosed late at end-stage disease [12]. Additionally, patients without comorbid hypertension, diabetes mellitus, dyslipidemia, or vascular disease incurred higher costs than those with these conditions. This can be explained by the observed positive correlation between these comorbidities and age (r > 0.19; p < 0.01), consistent with earlier findings that older patients had lower treatment costs. This situation not only heightens the treatment burden but also raises concerns about unhealthy lifestyles and a lack of health awareness among younger populations. For inpatient care, factors significantly associated with DMC per hospitalization (p < 0.05) included gender, insurance reimbursement rate, insurance participant group, CKD stage, dyslipidemia, vascular disease, reason for admission, treatment outcome, number of comorbidities, and length of stay. Among these, length of stay (r = 0.77; p < 0.01) and number of comorbidities (r = 0.23; p < 0.01) were positively correlated with treatment costs, indicating that longer hospitalizations and more comorbidities lead to higher expenditures. These results are consistent with those of Ildiko Aliz Bradacs et al. (2025) in Romania, who also identified length of stay as a key determinant of inpatient costs among CKD patients [13].

The findings on CKD treatment costs provide clinicians and hospitals with practical insights for selecting treatment strategies appropriate to patients' financial capacities, while promoting the rational use of healthcare resources during long-term disease management. However, this study has certain limitations, as it was conducted at a single healthcare facility, which may not fully represent the broader patient population; therefore, expanding to a multi-center study would be essential to improve generalizability. Additionally, the analysis was restricted to a limited set of demographic and clinical variables due to the constrained study timeframe and limitations in data availability from electronic medical records, leading to incomplete documentation of key variables and insufficient conditions for implementing a valid multivariate model. As a result, the study was limited to univariate analysis and could not evaluate the combined effects of multiple factors. To enhance the applicability and real-world relevance of the findings, future research should incorporate multivariate analyses to more accurately determine the relationships between influencing factors and treatment costs, thereby supporting prediction and strategic planning for more effective CKD management.

5. CONCLUSION

The annual DMCs for CKD treatment were estimated to account for approximately 12.3% of the national GDP per capita in 2024, with inpatient DMCs representing around 9.48% and outpatient DMCs accounting for approximately 3.03%. The factors associated with the treatment costs of CKD include gender, health insurance reimbursement rate, health insurance participant group, CKD stage, dyslipidemia, vascular disease, and number of comorbidities.

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Phân tích chi phí trực tiếp y tế trong điều trị bệnh thận mạn tính tại Bệnh viện Đa khoa Thống Nhất tỉnh Đồng Nai năm 2024

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TÓM TẮT

Đặt vấn đề: Bệnh thận mạn (BTM) đang gia tăng nhanh chóng ở đối tượng người trẻ tuổi, gây ảnh hưởng đến sức khỏe và phát triển kinh tế xã hội, việc phân tích chi phí trực tiếp y tế (CPTTYT) trong điều trị BTM là cần thiết. Mục tiêu: Phân tích CPTTYT trong điều trị BTM tại Bệnh viện Đa khoa Thống Nhất Đồng Nai năm 2024. Đối tượng và phương pháp: Mô tả cắt ngang dựa trên hồi cứu dữ liệu thanh toán điện tử toàn bộ NB BTM thỏa tiêu chí chọn mẫu tại Bệnh viện Đa khoa Thống Nhất Đồng Nai từ tháng 01/2024 đến tháng 12/2024. Kết quả: Khảo sát mẫu nghiên cứu gồm 7,634 NB có tuổi trung bình 63.41 ± 13.76 tuổi; 24.18% NB suy thận giai đoạn 1 ghi nhận CPTTYT trung bình năm, đợt điều trị nội trú và lượt khám ngoại trú lần lượt

đạt 14.02 triệu VND (KTC 95%: 13.28 - 14.77 triệu VND), 10.81 triệu VND (KTC 95%: 9.76 - 11.85 triệu VND) và 3.45 triệu VND (KTC 95%: 3.38 - 3.53 triệu VND) với chi phí thủ thuật/phẫu thuật (20.63% - 45.34%) và chi phí thuốc (27.66% - 37.57%) chiếm tỷ lệ lớn; bảo hiểm thanh toán phần lớn chi phí (89.30% - 93.06%). Một số yếu tố liên quan đến CPTTYT được xác định bao gồm: giới tính, mức độ suy thận, mức hưởng BHYT, đối tượng tham gia BHYT và bệnh kèm bệnh mạch máu. Kết luận: CPTTYT hằng năm trong điều trị BTM ước tính tương đương khoảng 12.3% GDP bình quân đầu người năm 2024, trong đó chi phí điều trị nội trú chiếm khoảng 9.48% và chi phí điều trị ngoại trú chiếm khoảng 3.03%.

Từ khóa: *chi phí trực tiếp y tế, bệnh thận mạn tính, yếu tố liên quan*

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