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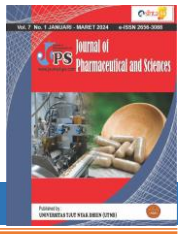

Global Cost Comparison of Hemodialysis and Peritoneal Dialysis in End-Stage Kidney Disease: A Systematic Review Across Country Income Levels

Perbandingan Biaya Global Hemodialisis dan Dialisis Peritonal Pada Penyakit Ginjal Tahap Akhir: Tinjauan Sistematis Berdasarkan Tingkat Pendapatan Negara

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Abstract

The increasing prevalence of end-stage renal disease poses an economic challenge to healthcare systems worldwide. Hemodialysis and peritoneal dialysis are currently the most commonly used renal replacement therapy modalities, but their costs vary across components and economic contexts. This systematic review aims to compare the costs of hemodialysis and peritoneal dialysis across countries, considering income levels and economic perspectives. A systematic literature search was conducted using EBSCO, ProQuest, PubMed, Scopus, and SpringerLink databases, with studies conducted between 2015 and 2025. Studies reporting cost analyses of hemodialysis and/or peritoneal dialysis were included. The selection process followed PRISMA guidelines, and the methodology was assessed using the CHEERS 2022 checklist. A total of 33 studies were included for discussion across low- to high-income levels. Economically, peritoneal dialysis was found to be more cost-effective than hemodialysis in most of these studies. The difference in cost structure is attributed to direct medical costs, which constitute the largest component of costs. Hemodialysis treatment is more expensive due to the costs of dialysis machines, service facilities, labor, and infrastructure, as well as lost productivity and indirect medical costs. Advantages of peritoneal dialysis include lower transportation costs, reduced productivity loss, and accessibility to low- and middle-income countries. Several studies have also shown that peritoneal dialysis yields quality-adjusted life years (QALYs) comparable to hemodialysis. This systematic review concludes that peritoneal dialysis can be cost-effective in most high-income countries. It should be considered a treatment modality of choice to improve efficiency, control long-term costs, and support health insurance management.

***Keywords*: Hemodialysis, Peritoneal Dialysis, Economic Evaluation.**

Abstrak

Meningkatnya prevalensi penyakit ginjal stadium akhir menimbulkan tantangan ekonomi bagi sistem perawatan kesehatan di seluruh dunia. Hemodialisis dan dialisis peritoneal saat ini merupakan modalitas terapi pengganti ginjal yang paling umum digunakan, tetapi biayanya bervariasi berdasarkan komponen dan konteks ekonomi. Tinjauan sistematis ini bertujuan untuk membandingkan biaya hemodialisis dan dialisis peritoneal di berbagai negara berdasarkan tingkat pendapatan dan perspektif ekonomi. Pencarian literatur sistematis dilakukan menggunakan basis data EBSCO, ProQuest, PubMed, Scopus, dan SpringerLink, dengan studi yang dilakukan pada tahun 2015–2025. Studi yang melaporkan analisis biaya hemodialisis dan/atau dialisis peritoneal disertakan. Proses seleksi menggunakan pedoman PRISMA dan metodologi dinilai berdasarkan CHEERS 2022. Sebanyak 33 studi disertakan untuk dibahas berdasarkan tingkat pendapatan dari rendah hingga tinggi. Secara ekonomi, dialisis peritoneal ditemukan lebih hemat biaya daripada hemodialisis dalam sebagian besar studi. Perbedaan dalam struktur biaya disebabkan oleh biaya medis langsung, yang merupakan komponen biaya terbesar. Pengobatan hemodialisis lebih mahal karena ketersediaan mesin dialisis, fasilitas layanan, tenaga kerja, dan biaya infrastruktur, serta hilangnya produktivitas akibat biaya medis tidak langsung. Keuntungan dialisis peritoneal meliputi biaya transportasi yang lebih rendah, pengurangan kehilangan produktivitas, dan aksesibilitas di negara-negara berpenghasilan rendah dan menengah. Beberapa penelitian juga menunjukkan bahwa dialisis peritoneal menghasilkan tahun hidup yang disesuaikan dengan kualitas (QALY) yang sebanding dengan

hemodialisis. Kesimpulan dari tinjauan sistematis ini adalah bahwa dialisis peritoneal dapat hemat biaya di sebagian besar negara berpenghasilan tinggi dan harus dipertimbangkan sebagai modalitas pengobatan pilihan untuk meningkatkan efisiensi, mengendalikan biaya jangka panjang dalam terapi ginjal, serta mendukung pengelolaan asuransi kesehatan.

Kata Kunci: Hemodialisis, Pertoneal Dialisis, Analisis Biaya.

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Introduction

Chronic kidney disease (CKD) is a global health issue and a leading cause of death. According to data from the World Health Organization (WHO), kidney disease is the ninth leading cause of death, and its prevalence has been rising steadily from 2000 to 2021 [1]**.** In recent decades, the impact of CKD has significantly increased, affecting the global population through morbidity and mortality [2]. Epidemiological analyses indicate that approximately 700-850 million people are affected by kidney dysfunction [3]. The prevalence of CKD continues to rise due to risk factors such as age, obesity, diabetes mellitus, hypertension, and cardiovascular disease. It is further driven by improvements in diagnostic capabilities and surveillance systems for detecting CKD [2], [3]. The economic burden, encompassing clinical and productivity costs, is associated with end-stage kidney disease (ESKD), a condition in which patients require renal replacement therapy as a long-term, lifelong supportive measure.

The two most commonly used modalities worldwide today are hemodialysis and peritoneal dialysis. Hemodialysis is an extracorporeal blood filtration process performed using a dialysis machine at a dialysis center, typically several times a week [2], [3]. Hemodialysis can rapidly remove toxic substances from the blood but is highly dependent on hospital facilities, trained healthcare personnel, and the availability of dialysis machines [4]. The management of hemodialysis involves complex cost and resource components [3], [5]. Peritoneal dialysis (PD) is a form of dialysis that uses the peritoneal membrane as a natural semipermeable membrane. PD can be performed at home 4–5 times a day [3], [5]. The home-based nature of PD offers more flexible care and improves patient productivity compared with hemodialysis [5].

ESKD imposes a massive financial burden, both clinically and economically, as it is a lifelong condition. According to a report from the United States Renal Data System (USRDS), expenditures for ESKD patients are among the highest cost components. They will continue to be a significant financial burden on the national healthcare system [6]. Pharmacoeconomics is used to compare the most effective modalities in terms of clinical effects, productivity, and budgetary implications for the healthcare system. From the provider's perspective, hemodialysis requires substantial investment in equipment, infrastructure, and skilled medical staff. For PD, costs depend on dialysate, patient and family training, and vary across treatment modalities [6], [7]. From the societal perspective, there are costs associated with lost productivity among patients and their families, as well as long-term indirect non-medical impacts [6], [7].

The magnitude of cost components varies significantly across countries, influenced by the use of renal replacement therapy modalities, national income levels, cost reimbursement mechanisms, insurance coverage, and the capacity of each country's healthcare system. The increasing number of patients requiring renal replacement therapy poses a challenge for long-term budgets and national payment systems [6], [7]. In lower-middle-income countries such as Indonesia, from the perspective of both hospitals and the public, there is a

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significant cost difference between hemodialysis and CAPD. This highlights the policy relevance of expanding PD-first programs for home-based dialysis to improve the cost-efficiency of kidney disease management [8].

Several economic evaluation studies have been conducted, but few have comprehensively and systematically compared HD and PD across various countries, and the cost burden remains limited. Such analysis is crucial for informing sustainable dialysis cost policies in the world's diverse economies. The objectives of this systematic review are (1) to conduct a systematic literature search reporting on the costs of hemodialysis and PD; (2) to synthesize the literature search from various perspectives; and (3) to compare the costs of hemodialysis and PD based on a country's income level. The findings are expected to support policymakers in developing financing strategies for renal replacement therapy and in managing budgets in high-, middle-, and low-income countries.

Metods

Study Design

This study was conducted as a systematic review to compare costs incurred by patients with end-stage kidney disease undergoing hemodialysis and PD. This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. It included studies from 2015 to 2025 to identify the most relevant research from the past decade. The protocol for this systematic review has been registered in the International Prospective Register of Systematic Reviews (PROSPERO) (Registration ID: Pending).

Search Strategy

This systematic review aims to identify relevant scientific evidence regarding the costs of hemodialysis and peritoneal dialysis; therefore, the authors expanded the scope of the study to include five databases: SpringerLink, PubMed, ProQuest, Scopus, and EBSCO. The search strategy involved combining and matching Medical Subject Headings (MeSH) terms with keywords related to renal replacement therapy for end-stage kidney disease and its economic evaluation. The keywords used included "Renal Dialysis", "Kidney Failure, Chronic", "Continuous Renal Replacement Therapy", "Peritoneal Dialysis, Continuous Ambulatory", "Hemodialysis Units, Hospital", "Peritoneal Dialysis", and "Cost of Illness". The study search strategy was tailored to each database and supplemented by manual screening of included articles (snowballing). Included studies comprised those published in English or Indonesian, spanning the years 2015–2025, and deemed relevant. The study selection process was documented using a PRISMA flowchart.

Eligibility Criteria

Study eligibility was determined using the Population, Intervention, Comparator, and Outcome (PICO) framework, as shown in Table 1. Studies meeting the inclusion criteria included those explicitly focused on patients with end-stage kidney disease receiving renal replacement therapy via hemodialysis and/or peritoneal dialysis. Economic evaluations include cost analysis, budget impact analysis, and cost-effectiveness analysis, as well as studies reporting related costs, including direct medical costs, direct non-medical costs, and indirect costs. Studies were included from 2015 to 2025 to focus on the past decade and current healthcare pricing policies; studies written in English and Indonesian were selected to avoid translation errors. Excluded article categories include studies focusing on diseases other than ESKD, studies lacking dialysis modalities, studies without cost analysis, studies not available in full text, and non-empirical publications (reviews, books, editorials, reports, and others).

Data Analysis

The data analysis process was conducted after all eligible study articles were collected and identified. All references were managed using Zotero software to identify, select, and remove ineligible and duplicate articles. Titles, abstracts, and full texts were screened to ensure relevance and eligibility. The cost structures of each study article were analyzed and synthesized narratively to describe cost variations related to the intervention and various analytical perspectives, including those of service providers, payers, the public, the healthcare system, and patients.

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Data Extraction

The data extraction form used in this study is provided in a standardized tabular format for systematic data extraction across all included studies. The included information includes the author's name and year, country, sample size, dialysis modality, and analysis perspective (healthcare provider, payer, community, health system, and patient). Methodological quality assessment was performed using the Joanna Briggs Institute (JBI) critical appraisal tool based on the study design of each included article. In contrast, the reporting quality of economic evaluations was assessed using the CHEERS 2022 checklist, which comprises 28 items assessing the transparency and completeness of reporting. Cost data were converted to 2025 US dollars (USD) to facilitate comparisons across countries. Results from various studies are summarized in a table to highlight differences in cost structures between dialysis modalities and across countries with different income levels.

Table 1. Studi Criteria

Elements	Keywords	Inclusion	Exclusion
Population (P)	End-stage kidney disease	Studies involving patients diagnosed with end-stage kidney disease receiving kidney replacement therapy	Studies focusing on kidney diseases other than ESKD
Intervention (I)	Hemodialysis	Studies evaluating hemodialysis as a dialysis modality	Cost studies that do not involve hemodialysis
Comparator (C)	Peritoneal dialysis	Studies evaluating peritoneal dialysis, including CAPD or APD	Cost studies that do not involve peritoneal dialysis
Outcome (O)	Cost outcomes	Studies reporting cost analysis, including direct medical costs, indirect medical costs, direct non-medical costs, and intangible costs, cost-effectiveness, cost-utility, or budget impact of HD and/or PD	Studies that did not report cost data or economic outcomes related to HD or PD
Study Design	Economic evaluation	Original research reporting economic evaluations or cost analyses of HD and/or PD, comparing HD and PD	Non-empirical studies such as reviews, editorials, books, conference abstracts, reports, or studies without full-text availability

Result

Study Selection

The search results from the five databases yielded 5,484 studies for further identification. After removing 166 duplicate articles, 5,318 remained for further screening. 4,080 were excluded for failing to meet the specified study period. After systematic screening of titles, abstracts, and full-text availability, 33 studies met the criteria for full review; those that did not were excluded. The study selection flowchart and the reasons for exclusion are presented in Figure 1.

Characteristics of Included Studies

The review includes 33 studies from low-, middle-, and high-income settings. Cost evaluations of dialysis modalities in patients with end-stage or chronic kidney disease were included from various analytical perspectives, including those of payers, service providers, the public, the healthcare system, and patients. Study results reported cost components, including direct medical costs, direct non-medical costs, and indirect costs, over timeframes ranging from 1 year to several years. Several studies also reported costs adjusted for quality-adjusted life years (QALYs).

Cost Comparison by Country Income Level

High-Income Settings

High-income settings such as Germany and Spain show significant differences between the costs of hemodialysis and peritoneal dialysis. Hemodialysis incurs the highest costs due to high labor costs, service standards in healthcare facilities, provider infrastructure, and dialysis machines. In a study conducted in Hong Kong by Wong et al. (2019), the city was able to control ESKD costs by prioritizing the PD system as the

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primary modality. The study found that the total annual cost of PD was significantly lower and more controlled than that of hemodialysis [20]. A study by Shukri et al. (2022) in Germany found that the annual cost of PD was approximately USD 53,247, whereas hemodialysis was USD 54,712.13. This study did not show a significant cost difference. However, more studies have reported that PD is cheaper than hemodialysis. Given this significant cost difference, the study concluded that PD offers substantial cost savings [18]. Research in Germany also showed lower annual costs for PD than for hemodialysis without compromising clinical outcomes, as demonstrated by Barbado et al. (2025) [39].

Upper-Middle-Income Countries

Various studies from upper-middle-income countries indicate that the cost burden of PD is lower than that of hemodialysis. A study conducted by Liu et al. (2020) in China over the past decade found that the cost of PD was USD 4,814.97, while that of hemodialysis was USD 5,333.57, indicating that hemodialysis is more expensive than PD [14]. This is followed by other countries such as Thailand, Brazil, and South Africa, which are classified as upper-middle-income countries. A similar study by Hong et al. (2023), spanning 15 years, showed that the average annual cost of CAPD was only USD 12,769.26, while the average annual cost of hemodialysis was USD 20,966.90 [13].

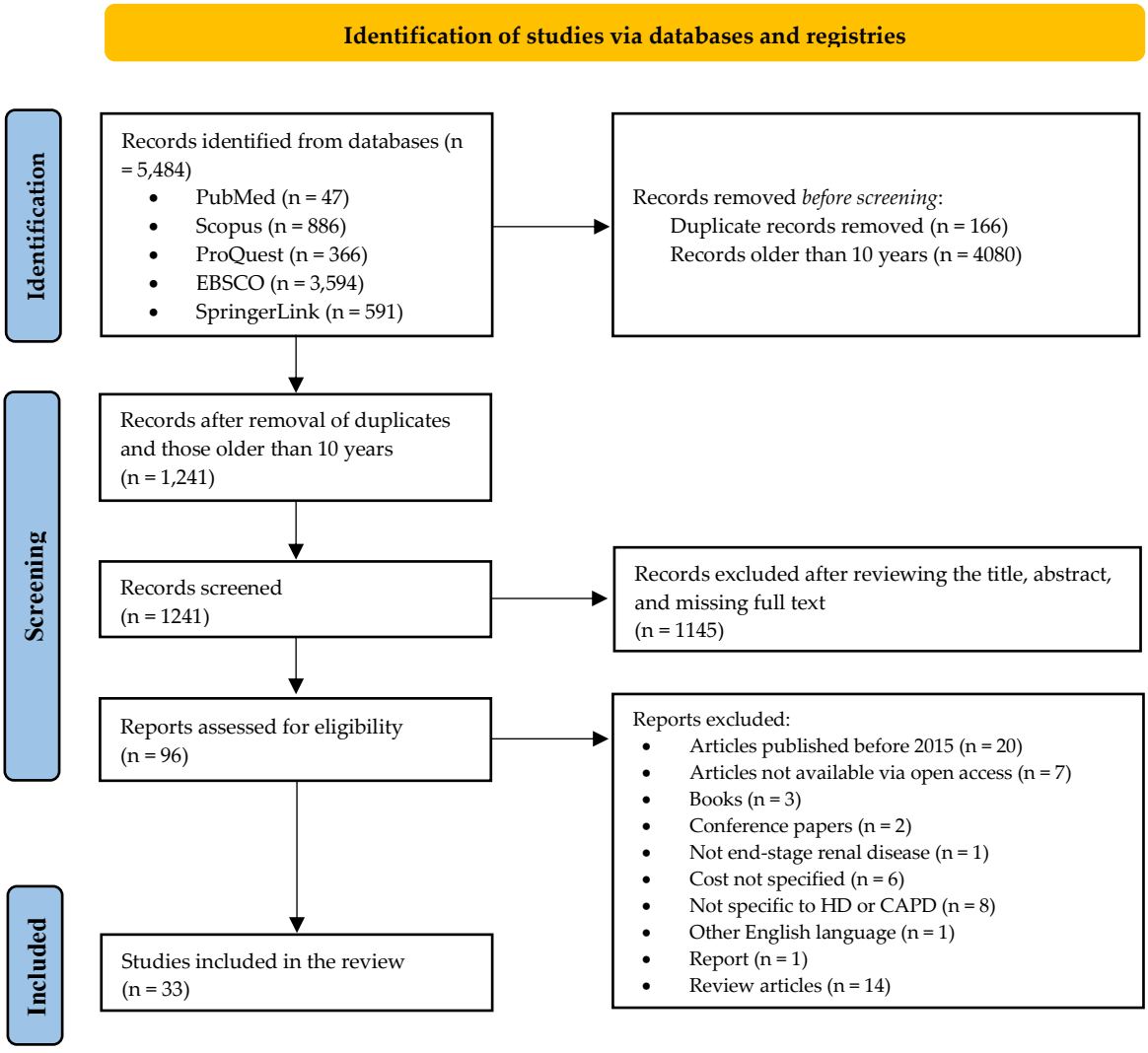

Figure 1. PRISMA diagram illustrating the study selection process for studies ultimately included in the analysis to evaluate the costs of renal replacement therapy modalities in patients with end-stage kidney disease undergoing hemodialysis and peritoneal dialysis

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Table 2. Data Extraction: Included Studies

No	Authors and Year	Country	Sample Size	Costing Method	Perspective	Result Cost
1	Schreider A. et al. (2022) [9]	Brazil	HD = 28,525 sessions (2013–2016), PD 264–372 patients (2013–2016)	Absorption Costing	Provider, Payer	The mean monthly cost was USD 186.28 per HD session for patients with hepatitis B; USD 46.99 for hepatitis C; USD 37.11 for seronegative patients; and USD 612.56 for PD.
2	Brabo et al. (2025)[10]	Brazil	198 HD patients = 99, PD = 99	Cost-Effectiveness Analyses	Payer	Cost per month of life in the first year: HD is USD641.27 ± 184.03, and PD is USD631.54 ± 140.64
3	Beaudry et al. (2018)[11]	Canada	425 patients. HD = 290, PD = 80, home HD = 45	Cost-Minimization Analysis	Payer	HD in facility: USD45,541.84; PD: USD27,417.02; HD at home: USD27,826.95
4	Wu H. et al (2020)[12]	Chinese	298 HD patients = 108, CAPD = 91 patients, KT = 99	Cost-Utility Analysis	Societal	Annual costs for HD were USD1657.13 ± 61.45; for PD were USD1502.08 ± 95.55; for KT were USD3089.42 ± 1726.59
5	Hong et al. (2023)[13]	Chinese	1,012 HD patients = 508, APD = 82, CAPD = 252, KT = 170	Cost-Effectiveness Analyses	Societal	Annual costs for APD were USD18,294.77; HD were USD20,966.90; CAPD were USD12,769.26; and KT were USD25,486.04
6	Liu et al. (2020)[14]	Chinese	2,295 HD and 3,713 PD	Cost-Effectiveness Analyses	Provider	Over the past 10 years, PD has totaled USD 4,814.97, and HD has totaled USD 5,333.57; HD has had a surplus of USD 518.59.
7	Ma et al. (2021)[15]	Chinese	190 CAPD patients	Medical Cost Evaluation	Provider	PD with conventional management is USD 33,329.92, and FCH three-level management is USD 27,027.12
8	Van der Tol et al. (2020)[16]	Europe	660,206 patients HD = 425,127; KT = 199,340; PD = 35,739	Comparative Reimbursement and Cost Analysis	Government, Payer	Annual costs for HD are USD 24,587.12; for PD, USD 24,443.94. The government spends USD 13,625,866,038 on HD and USD 1,039,260,969 on PD.
9	Baye et al. (2024)[17]	Ethiopia	HD = 128 patients (Public = 72, Private = 56)	Cost Analysis	Societal	The total annual cost is USD 7,739.17 ± 2,833.51. The private sector has higher costs than the public sector.
10	Shukri A. et al. (2022)[18]	Germany	872 patients, PD = 436 and HD = 436 and	Cost Analysis	Payer	Annual cost for HD is USD54,712.13, and for PD is USD53,247
11	Ntais C. et al. (2024)[19]	Greece	20 patients. PD= 7, HD = 9, OL-HDF = 4	Micro-Costing and the Bottom-Up Approach	Provider, Payer	Total annual costs PD are USD65,082.23; for HD are USD45,688.05; for OL-HDF are USD5,040.52
12	Wong et al (2019)[20]	Hong Kong	402 patients (hospital-based HD = 170; nocturnal home HD = 43; PD = 189)	Cost Analysis: A Micro-Costing Approach Approach	Providers, Societal	Annual provider costs: ICHD USD400,057 ± 62,822; PD USD118,467 ± 15,559; NHHD USD223,358 ± 18,055. Annual HD payer costs: USD 413,017 ± 73,501; PD: USD 151,520 ± 60,353; NHHD: USD 105,708 ± 23,853
13	Rajendran et al. (2024)[21]	India	HD = 81	Cost Analysis	Societal	Direct costs of USD5.6–32.67 per month in public and private facilities. Indirect costs of USD0.47–28. Costs significantly affect the quality of life

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14	Gupta et al. (2021)[22]	India	192 patients. HD = 115 and PD = 77	Cost-Effectiveness Analyses	Societal	The average annual cost for PD patients was USD 26,306,603.7, and for HD patients was USD 26,740,566.4
15	Putri et al. (2022)[23]	Indonesia	110 patients with 92 HD and 28 CAPD	Cost-Effectiveness Analyses	Societal	Total costs were USD95,504 and USD96,908 for CAPD and HD, respectively
16	Afiatin et al. (2017)[24]	Indonesia	104 with 52 patients each for PD and HD	Cost-Effectiveness Analyses	Societal, Provider	From the societal perspective, the cost is USD 125.93; the PD-first policy costs USD 51,600, and the HD-first policy costs USD 54,474.07. From the provider's perspective, the cost is USD 74.07; the PD-first policy costs USD 49,933.33, and the HD-first policy costs USD 49,807.41
17	Omranikhoo et al. (2025)[25]	Iran	HD = 657	Bottom-Up and Human Capital Approaches	Societal	The average cost per patient is USD 169,016; the economic burden of hemodialysis in 2022 was USD 13,849,321 and USD 977,677,441, respectively.
18	Moradpour, et al. (2020)[26]	Iran	214 patients. PD = 56; HD = 158	Cost-Effectiveness Analysis	Societal	The annual cost of hemodialysis is USD13,477, peritoneal dialysis is USD12,865, and a transplant is USD16,450.
19	Yousefi et al. (2024)[27]	Iran	760 samples. HD = 331, KT = 324, and PD = 105	Cost-Effectiveness Analyses	Provider	Average cost over 10 years is USD1,133,879.49–1,184,826.49 with an incremental value of 0.054 per QALY for HD.
20	Kim et al. (2019)[28]	Korea	HD and PD patients were 45,007 and 10,109	Budget Impact Analysis	Payer	The average annual medical costs for all patients were USD 20,143 for HD and USD 14,801 for PD. Total dialysis medical costs amounted to USD1,056,213,941 in 2018 (HD: USD906,584,200; PD: USD149,629,741)
21	Aoun et al. (2022)[29]	Lebanon	160 patients. 40 HD, 102 non-dialysis, 10 KT, 8 PD	Cost of Illness	Societal, third-party payer	Annual costs from a societal perspective: CKD-ND USD2,988.44; KT USD7,145.54; PD USD28,595.70; HD USD2,718.15. From a third-party payer perspective: CKD-ND USD1,975.90; KT USD6,055.11; PD USD26,033; HD USD23,379.86
22	Kumar Surendra et al. (2018)[30]	Malaysia	141 patients with PD = 64 and HD = 77	Mixed Step-Down and Activity-Based Costing	Payer	The cost per patient per year for HD is USD 9,253.62 and for PD is USD 8,738.61.
23	Surendra et al. (2019)[31]	Malaysia	HD = 77 patients and PD = 64 patients	Cost-Effectiveness Analyses	Ministry of Health (MOH)	Mean cost per patient per year, USD9,253.72 for HD and $8,738.60 for CAPD
24	Agada-Amade et al. (2024)[32]	Nigeria	230 HD patients	Contingent Valuation Method, Willingness to Pay (WTP)	Patient	From the patient's perspective, they are willing to pay USD 25,999.06 per year for hemodialysis, with an altruistic contribution of USD 1,539.89
25	Behlul & Artac Ozdal (2022)[33]	Northern Cyprus	358 ESRD HD = 285, PD = 29, KT = 44	Cost Burden	Provider	PCR USD63.88/patient and CT USD2.88/patient. RRT HD USD75.53; PD USD36.75; KT USD8.67
26	Moreno Velásquez et al. (2019)[34]	Panama	2,075 patients with public HD = 1,746, PD = 265, and private HD = 64	A Budget Impact Analysis	Payer	Total annual costs for HD are USD 62 million, and for PD are USD 7.9 million. Total public and private sector costs are USD 70.3 million per year. Annual costs due to CKD are USD 25,501,808.40

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27	Villanueva et al. (2025)[35]	Philippines	The study population included non-diabetic and diabetic patients with CKD	Cost of Illness	Societal	Annual costs per patient: HD (acute) USD 10,357.32 and (chronic) USD 9,852.03; PD (acute) USD 8,697 and (chronic) USD 7,054.51; KT (acute) USD 34,587.15 and (chronic) USD 8,158.19
28	Nemzoff et al. (2024)[36]	Rwanda	Patients aged >15 years	Cost-Effectiveness Analysis	Payer	Total annual cost is USD 1,771 for PD and USD 1,999 for HD. PD is preferred
29	Thsehla et al. (2025)[37]	South Africa	Adult patient population aged >40 years	Cost-Effectiveness Analysis	Societal	The 5-year costs of PD use are USD 42,730.84, and HD use is USD 66,542.44. Budget impact for PD is USD 975,609,756.1 and for HD is USD 1,409,214,092
30	Makhele et al. (2019)[38]	South Africa	46 patients, HD = 32 and PD = 14	Micro-Costing and Cost Analysis	Healthcare, Provider	Annual cost HD = USD31,993.12 and PD = USD25,282.00 per patient
31	Barbado et al. (2025)[39]	Spain	27,281 patients. PD = 3,141 and HD = 24,140, with 6,052 new dialysis patients (HD = 4,879 and PD = 1,173)	Budget Impact	Payer, Societal	PD USD 121,863,253.4 and HD USD 1,219,148,618. Alternative scenario: total cost USD 1,328,089,665; PD USD 144,476,859.5; and HD USD 1,183,612,805.
32	Tang et al. (2019)[40]	Taiwan	554 total patients. HD = 308 patients and PD = 246 patients	Cost Analysis	Societal	Total cost per patient-month: USD668.73 for HD and USD561.2 for PD
33	Assanatham et al. (2022)[41]	Thailand	660 patients, PD = 293, HD = 367	Cost-Utility Analysis	Government, Societal	Total annual costs are USD 39,802–96,355 for PD (societal) and USD 37,837–90,204 for government. For HD, they are USD 73,311–166,600 (societal) and USD 58,243–132,084 (government)

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Lower-Middle-Income Countries

Significant cost differences between PD and hemodialysis are also evident in lower- and middle-income countries such as India and Indonesia. In a study by Rajendra et al (2024), the direct medical costs of one month of hemodialysis in India significantly impacted patients' quality of life [21]. Meanwhile, a study by Gupta et al. (2021) found that the absolute cost of PD therapy was lower than that of hemodialysis in the long term. [22]. In Indonesia, a study by Putri et al. (2022) found that the absolute costs of PD were lower when accounting for indirect costs to patients and families, such as lost productivity and transportation costs; for CAPD, the total cost was approximately USD 95,504, while hemodialysis cost USD 96,908 [23]. A similar study was also conducted by Afiatin et al (2017), which emphasized that the policy of selecting PD as a renal replacement therapy modality could result in cost savings from a social perspective of approximately USD51,600 versus USD54,474.07; this finding can be used to inform strategies for the national JKN system [24].

Findings from Low-Income Countries

Low-income countries face a financial burden in providing renal replacement therapy for their citizens, given limited facilities, resources, and financial capacity. The limited availability of hemodialysis facilities and the fact that patients bear the cost of dialysis are realities that must be addressed. In Ethiopia, the annual cost of hemodialysis reaches USD 7,739.17 [17]. A study focusing on Rwanda showed a similar pattern: expanding the use of PD can help healthcare systems achieve cost savings, but there was no significant difference between hemodialysis and PD [36]. Patterns from low-income countries suggest that PD can generate savings, particularly through improved access to services and reduced financial burden, but does not significantly reduce costs compared to hemodialysis.

Discussion

This systematic review presents evidence from 33 studies evaluating hemodialysis and PD across various perspectives and economic contexts in countries with varying income levels. Overall, more studies evaluate PD as a less expensive renal replacement modality than hemodialysis in most regions of the world. PD was lower because it offers advantages in reducing high hospital operational costs, avoiding costs dependent on service-provider infrastructure, particularly the availability of dialysis machines at hemodialysis sites, and because PD is performed at home, which can reduce non-medical and indirect costs such as lost patient productivity. Further cross-country cost comparisons indicate that dialysis modality costs are influenced by the availability of health financing, national income, health financing mechanisms, service availability, and modality utilization patterns [15]. Of the 33 studies included in this systematic review, 24 reported cost savings for PD from both direct and indirect cost perspectives. These savings were generally reflected in lower annual costs due to the absence of dialysis facilities at the provider's location, fewer routine visits to the health center, greater treatment flexibility, and reduced productivity loss. Six studies reported hemodialysis as less expensive than PD, and three studies reported no significant difference between the two modalities. Most studies have reported that hemodialysis imposes a significant financial burden due to the extensive use of dialysis machines, high treatment-related hospitalization rates, high per-session costs, and the need for specialized facilities and staffing [28]. These findings are consistent with those reported in this systematic review and indicate that direct medical costs dominate the modality's total costs. However, total expenditures vary widely and are country-specific. The distribution of study significance is shown in the bar chart below, which groups studies by country income level.

According to the World Bank's income classification, a cost analysis of dialysis provides a structured framework for understanding how economic capacity shapes dialysis costs. Grouping countries by income level within renal replacement therapy modalities reveals fairly consistent patterns; in this context, PD can be a significantly cost-saving modality choice for long-term treatment across all economic categories, although the underlying factors driving cost savings differ by context [36]. This stratification can provide insights into sustainable financing policies and modality selection, and selecting PD as the primary option may be crucial for the sustainability of therapy.

The economic burden of dialysis is one of the greatest financial pressures on the sustainability of healthcare systems, as demonstrated by the 33 studies included in this systematic review. From various perspectives, payers, service providers, patients, and the public across countries with different income levels,

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PD is consistently lower cost than hemodialysis when calculated on a total annual cost basis. The magnitude and primary drivers of cost differences between these treatment modalities vary significantly across economic contexts. In high-income settings such as South Korea and Canada, this economic trend is clearly evident: PD is associated with lower annual costs and favorable budgetary implications for both public and private insurance [11], [28].

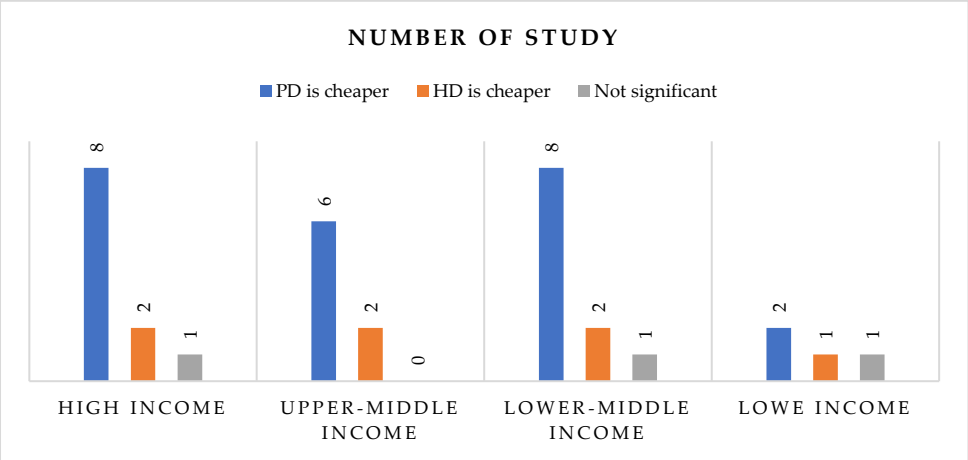

Figure 2. Bar chart of the distribution of cost significance studies based on country income level

Findings from low-income countries (LICs) indicate that hemodialysis imposes a heavy burden due to infrastructure limitations and reliance on healthcare centers, which incur extremely high costs. In countries such as Ethiopia and Rwanda, the relatively high cost of hemodialysis relative to household income often limits patients' access to healthcare centers and treatment. Some evidence suggests that PD offers more low-cost care in LICs, particularly by reducing non-medical direct costs such as transportation to treatment centers and indirect costs such as lost productivity due to missed work, as well as substantially reducing direct medical costs [17]. In Rwanda, a risk-based analysis indicates that using PD could yield significant cost savings for the healthcare system and improve access to dialysis services [36]. These findings also suggest that PD has the potential to reduce costs, serving as an incentive to improve accessibility and alleviate the financial burden.

Lower-middle-income countries (LMICs) show that the differences between hemodialysis and PD remain substantial, as seen in India and Indonesia, which report on these differences from various analytical perspectives. A study in India showed that direct medical and non-medical costs associated with hemodialysis, a kidney replacement therapy, are substantial and affect patients' quality of life [21]. Long-term analyses comparing hemodialysis and PD indicate that PD can be lower-cost, consistent with findings in low-income countries [22]. In Indonesia, although PD is more commonly associated with CAPD, compared with hemodialysis, CAPD demonstrates significant economic efficiency in terms of lost productivity and transportation costs to the hospital [23]. Several studies also support PD as the modality strategy from a social perspective, a trend that is becoming increasingly strong due to economic priorities and the JKN health insurance scheme [13], [14], [24].

China, Brazil, South Africa, and Thailand are upper-middle-income countries (UMICs) that demonstrate similar cost-benefit patterns favoring PD over hemodialysis. Several modeling studies also indicate that PD incurs lower costs over a 10- to 15-year period without worse clinical outcomes than hemodialysis in China [13], [14]. Government and societal cost-effectiveness analyses from Thailand show that hemodialysis is more expensive than PD, particularly when indirect costs are included [10], [41]. Countries such as South Africa and Brazil demonstrate that PD can yield substantial savings at both the patient and national levels. Several studies also support these findings by highlighting the scalability of each dialysis modality in sustaining the economy within rapidly developing healthcare systems [18], [20], [39].

In high-income settings, hemodialysis remains a more expensive modality than PD, as seen in countries such as Germany, Hong Kong, Canada, and Spain. High labor costs, advanced technology, extensive provider infrastructure, and significant resource requirements drive the high cost structure. Despite the availability of sufficient resources, various studies indicate that the annual cost of PD is lower, with clinical outcomes comparable to hemodialysis [18], [20], [39]. In Hong Kong, a "PD-first" policy has been implemented, providing a notable example of how dialysis-related expenditures can be managed in a resource-rich

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environment. Findings from these studies indicate that the financial viability of PD remains relevant across all income levels and various resource settings.

From a cost perspective, the included studies consistently categorized costs into four main components: direct medical costs, direct non-medical costs, indirect costs, and intangible costs. Direct medical costs, including medications, disposable medical supplies, dialysis sessions, hospital stays, and healthcare provider and physician fees, constitute the largest share of total costs for hemodialysis [15]. Direct non-medical costs, such as caregiver expenses, accommodation, and transportation, have a significant impact in low-income countries where hemodialysis services require patients to travel to dialysis centers [23]. Indirect costs, such as lost productivity from treatment, caregiving time, and income, are acutely felt by hemodialysis patients because of the need to visit facilities and the frequency and duration of services [26]. Intangible costs, such as reduced quality of life, psychological stress, and physical pain, are often not explicitly quantified. However, some studies incorporate these impacts into the assessment of long-term dialysis use in terms of quality-adjusted life years (QALYs). Various studies also report utility measures indicating that PD achieves comparable QALY outcomes. In contrast, some studies show higher QALYs for PD than for hemodialysis, while others show lower QALYs, reinforcing the economic appeal of long-term PD evaluation [27].

Most studies report that PD is more costly than hemodialysis, but some report the opposite, suggesting that hemodialysis is more cost-effective than PD, with lower absolute costs. This difference is likely influenced by the economic evaluation approach, clinical outcomes, and outcomes demonstrating good cost-effectiveness in the context of the country's health [36]. In addition, Ntais et al. (2024) reported higher PD costs among pediatric ESRD patients in Greece [19]. Higher PD costs in the pediatric population may be influenced by specialized care needs, smaller patient volumes, additional monitoring requirements, and differences in reimbursement systems compared with the adult population. These findings suggest that dialysis modalities can vary depending on the characteristics of the patient population, the financing system, and the economic evaluation method used.

Although numerous studies demonstrate lower overall costs for peritoneal dialysis (PD), these findings should not be interpreted as universal support for a strict "PD-first" policy. Several studies report comparable quality-adjusted life years (QALYs) between PD and hemodialysis (HD), suggesting that lower costs do not always correspond to superior clinical effectiveness. Therefore, PD may be considered a preferred modality under certain healthcare and economic conditions, particularly in low- and middle-income countries where healthcare resources and dialysis infrastructure are limited. Furthermore, healthcare financing and reimbursement systems should be designed to avoid disadvantages in PD use. However, cost should not be considered the sole determinant in dialysis modality selection. Clinical conditions, patient suitability, comorbidities, prior abdominal surgery, obesity, lifestyle preferences, and shared physician-patient decision-making remain important considerations in selecting a renal replacement therapy modality.

Table 3. Cost Sub-Group Analysis Based on Perspective, Time Horizon, and Costing Method

Category	Classification	Number of Studies	PD Dominant	Hemodialysis Dominant	No Significant
Economic Perspective	Payer vs Provider	19	15	2	2
	Societal vs Patient	15	12	2	1
	Government/Health System vs Third-party Payer	5	4	1	0
Time Horizon	≤1 year	18	14	2	2
	>1 year	15	13	1	1
Costing Methods	Micro-costing	6	5	1	0
	Gross-costing	27	22	2	3

This systematic review has important advantages, particularly for low-income countries. First, the study includes a wide range of countries and income levels to account for varying economic conditions worldwide. Second, the use of various economic evaluation methods, including cost-effectiveness, cost-utility, and cost-benefit analyses, enhances the reliability and relevance of the findings for health policy. Third, the cohort- and Markov-based studies in this review provide strong long-term evidence for the use of renal replacement therapy modalities. Finally, the consistency of studies comparing the cost savings of PD versus hemodialysis strengthens the reliability of health policy decision-making. Nevertheless, several limitations should be acknowledged. First, substantial heterogeneity in study design, costing methods, analytical

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perspectives, time horizons, and currency valuations limits direct quantitative comparisons between studies. To address this within-study heterogeneity, we conducted additional subgroup analyses based on perspective, time horizon, and costing method.

Subgroup analyses showed that the economic benefits of peritoneal dialysis (PD) remained consistent across analytical perspectives, time periods, and costing methods. Among studies using a payer/provider perspective, most reported lower reimbursement and operational costs for PD compared with hemodialysis (HD). Studies using a societal perspective consistently showed that PD reduced indirect costs, particularly transportation costs and lost productivity. Longer time periods (>1 year) showed greater cumulative cost savings for PD, while shorter-term studies also supported PD, albeit with smaller differences. Furthermore, both micro-costing and gross-costing approaches generally reported lower total costs for PD, although some studies found no substantial economic difference between the two modalities. These findings reinforce the conclusion that PD is a cost-effective renal replacement therapy modality across healthcare settings.

Second, the limited number of studies from low-income countries necessitates cautious interpretation of findings in these settings. Third, the exclusion of indirect costs in some studies may lead to an underestimation of the true economic burden of HD. Finally, variation in QALY measurement and reporting reduces the comparability of cost-utility outcomes across countries.

Conclusion

This systematic review concludes that peritoneal dialysis is a renal replacement therapy modality with lower costs compared to hemodialysis. Income disparities across countries consistently indicate that peritoneal dialysis is significantly more cost-effective. Cost structures depend on economic variations, national healthcare systems, payment mechanisms, and healthcare organizations. Peritoneal dialysis offers advantages, including lower medical costs and relatively manageable indirect costs, due to its flexibility. The benefits include reduced medical costs, reduced indirect costs, and reduced dependence on healthcare infrastructure and resources. These economic benefits are particularly evident when the societal/social perspective is considered. The results of this review suggest that peritoneal dialysis (PD) should be considered as an economically viable renal replacement therapy option, particularly in low- and middle-income countries with limited healthcare resources. However, the choice of dialysis modality should not be based solely on economic considerations. Clinical suitability, patient preferences, healthcare infrastructure, and shared decision-making remain critical factors in determining the most appropriate therapy for patients with end-stage renal disease (ESRD).

Conflict of Interest

The authors have not received any financial support or incentives from any party with a direct interest in this study.

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Ethical Consideration

No

Supporting Information

The complete search strategy is available in the Supplementary File 1
The CHEERS assessment process can be seen in Supplementary File 2
JBI's assessment process for assessing potential bias can be seen in Supplementary File 3

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