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Economic trend in kidney transplantation costs in the world; insights from the ISN global kidney health atlas 2019-2023

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ABSTRACT

Introduction: Kidney transplantation is a critical treatment for end-stage kidney disease, but its costs vary widely across countries and over time.
Objectives: This study investigates changes in kidney transplantation costs between 2019 and 2023 using data from the International Society of Nephrology Global Kidney Health Atlas (ISN-GKHA).
Methods: This ecological study analyzed kidney transplantation costs reported globally for 2019 and 2023 using data from the ISN-GKHA. The study included countries with complete cost data for both years, excluding those with missing or inconsistent records. Data collection focused on extracting first-year and subsequent annual transplantation costs from the publicly available ISN database. The primary outcome was the change in transplantation costs over time, evaluated to identify trends and regional variations in expenses across the included countries.
Results: The trend from 2019 to 2023 in kidney transplantation costs varies by continent and globally. In Latin America, Brazil showed the highest increase, while Bolivia had the smallest. Oceania and Southeast Asia saw Australia with the largest increase and Indonesia with a decrease. Western Europe had the Netherlands with the greatest rise and Germany with a decrease. Saudi Arabia had the highest increase in the Middle East, while the West Bank and Gaza had the least. South Asia's Bangladesh showed a modest increase. In North America, the United States experienced the largest increase, whereas Canada had a decrease. North and East Asia saw Japan with the most notable increase and China with a decrease. Africa had Morocco with the highest increase and Egypt with the smallest. Eastern and Central Europe recorded the largest rise in Slovenia and the smallest in Serbia. Overall, the United States had the most significant increase, while Germany showed the greatest decrease.
Conclusion: The findings highlight significant regional disparities in kidney transplantation costs globally, emphasizing the necessity for targeted healthcare policies and ongoing monitoring to ensure cost-effective and equitable access to transplantation services worldwide.

Implication for health policy/practice/research/medical education:
These findings from this ecological study conclusively demonstrate pronounced global disparities in kidney transplantation costs, underscoring the critical importance of implementing region-specific health policies and continuous cost monitoring to promote affordability and equitable access to transplantation worldwide, ultimately improving patient outcomes and healthcare sustainability.

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Original

Introduction

Kidney failure represents a significant global health challenge, with chronic kidney disease (CKD) affecting over 850 million people worldwide and demonstrating a prevalence of 10.4% and 11.8% among men and women, respectively (1,2). The epidemiological burden of kidney dysfunction has been progressively increasing, with kidney disease ranking as the 16th leading cause of years of life lost globally (3). Recent analyses utilizing Global Burden of Disease Study data demonstrate that CKD prevalence continues to rise substantially, with projections indicating that CKD may become the fifth leading cause of death globally by 2040 (4). The global mortality patterns reveal significant regional variations, with end-stage renal disease (ESRD) incidence rates estimated at 150-200 per million population in developing countries, while the approximate prevalence of CKD reaches 800 per million population (4,5). Furthermore, the aging population and increasing prevalence of diabetes and hypertension, which serve as the most common underlying causes of ESRD, contribute to the expanding burden of kidney failure worldwide (4,6).

Kidney transplantation remains the gold standard treatment for eligible patients with end-stage kidney disease, demonstrating superior clinical outcomes compared to maintenance dialysis therapy (7). Contemporary survival data from the 2019-2023 period indicate excellent short- and long-term consequences, with one-year patient survival rates consistently exceeding 95% and five-year survival rates ranging from 85% to 90% across major transplant centers (8). The global transplant activity has shown remarkable resilience despite challenges posed by the COVID-19 pandemic, with kidney transplantation rates demonstrating recovery patterns by 2021-2022 (9). International registry data reveal that approximately two million people worldwide are being treated for ESRD and are candidates to receive kidney replacement therapy or kidney transplantation (10). Pre-emptive kidney transplantation, performed before initiation of maintenance dialysis, has emerged as the optimal treatment approach, demonstrating reduced all-cause mortality (adjusted HR: 0.78) and lower death-censored graft failure (HR: 0.81) compared to post-dialysis transplantation (11). The evolving landscape of donor utilization, including expanded criteria donors and donors after circulatory death, has contributed to addressing the critical organ shortage while maintaining acceptable outcomes (12).

The economic dimensions of kidney transplantation present complex patterns that vary significantly across different healthcare systems and geographic regions. Economic evaluations consistently demonstrate that kidney transplantation represents the most cost-effective treatment modality for ESRD patients compared to long-term dialysis, with transplantation generating substantial financial savings that can offset the initial procedural costs (13,14). Healthcare financing analyses indicate that while kidney transplantation is initially perceived as highly expensive, the "gold standard" treatment for eligible ESRD patients provides significant economic advantages through reduced long-term healthcare resource utilization (15). Regional economic studies, such as those conducted in Sicily between 2017-2019, demonstrate that kidney transplant activity directly correlates with estimated healthcare savings, with declining transplant activity resulting in parallel reductions in financial benefits to healthcare systems (16). The cost-effectiveness profile varies considerably between healthcare systems, with studies from lower-middle-income countries like Cameroon showing that initial transplantation costs approximately 12 times the country's average income, though long-term survival with generic immunosuppression could make kidney transplantation economically viable for selected patients (14). These economic trends during 2019-2023 underscore the critical importance of systematic cost-utility analyses to guide healthcare policy decisions and resource allocation in the expanding field of kidney transplantation.

Objectives

The objective of this study is to analyze the economic trends in kidney transplantation costs globally between 2019 and 2023, using data from the International Society of Nephrology (ISN) Global Kidney Health Atlas (GKHA), to identify temporal changes and regional variations in first-year and annual transplantation costs in the later years across different countries in the world.

Materials and Methods

Study design

This ecological study employed a retrospective, cross-sectional design analyzing kidney transplantation cost data reported by countries globally for the years 2019 and 2023 as documented on the ISN website. The study compared first-year cost and annual transplantation costs in the later years between these two time points to assess trends and regional variations. Data collection involved extracting publicly available cost figures from the ISN database, and countries with incomplete or missing data for either year were excluded to ensure consistency.

Inclusion and exclusion criteria

The inclusion criteria for this study include countries that have reported complete kidney transplantation cost data for both 2019 and 2023, as available on the ISN website. Countries lacking complete or consistent cost data for either of these years were excluded from the analysis to ensure accuracy and comparability of the cost trends examined.

Data collection

Data for this study were collected retrospectively from the

ISN-GKHA database, which provides publicly available information on kidney transplantation costs reported by participating countries. The extraction process involved compiling the first-year and annual transplantation costs in the later years for 2019 and 2023. Only countries with complete data for both years were included to ensure data integrity and comparability. The study analyzed and compared the first-year transplantation costs and the annual costs incurred in subsequent years between 2019 and 2023 to evaluate cost trends and regional differences in kidney transplantation expenses (https://gkha.theisn.org/).

Outcome measurement

The primary outcome measured in this study was the change in kidney transplantation costs, specifically focusing on first-year post-transplantation expenses and the annual costs incurred in subsequent years. These cost metrics were analyzed to evaluate temporal trends and regional variability in transplantation expenses between 2019 and 2023 across participating countries.

Data analysis

Data analysis involved descriptive statistics to summarize first-year and annual transplantation costs by dollar ($) for the years 2019 and 2023 across included countries. Comparative analyses were conducted to assess differences in costs over time 2019 to 2023. Visualization methods such as tables and graphs were utilized to present regional and global cost comparisons effectively.

Results

The first-year costs of kidney transplantation per patient vary significantly across different countries and regions worldwide, with notable changes between 2019 and 2023. In Latin America, countries like Argentina, Bolivia, Brazil, Colombia, Costa Rica, Mexico, and Morocco generally experienced increases in transplantation costs, with some countries showing substantial rises. Brazil had the most significant increase, while Bolivia had the smallest increase. Western Europe exhibited mixed trends, with countries such as Austria, Finland, France, Italy, Netherlands, Portugal, Slovenia, and Spain showing cost increases, while Belgium, Germany, and the United Kingdom reported decreases. The largest rise was found in the Netherlands, and a decrease was found in Germany. Eastern and Central Europe saw the highest rise in Slovenia, with Serbia having the least. The Middle East region, including Bahrain, Iran, Jordan, Saudi Arabia, and the West Bank and Gaza, predominantly saw rising costs. Saudi Arabia had the highest increase, and the West Bank and Gaza had the least. In the Oceania and Southeast Asia (OSEA) region, countries such as Australia, Malaysia, New Zealand, Singapore, Thailand, and others generally showed increasing trends, whereas Indonesia experienced a decrease. Australia showed the greatest increase, whereas Indonesia experienced a decrease. North and East Asian countries such as Japan and South Korea reported higher costs, but China showed a decline. Africa's countries, including Egypt, Nigeria, South Africa, Sudan, and Tunisia, mostly demonstrated rising costs. Africa witnessed the greatest increase in Morocco and the smallest in Egypt. North America showed contrasting patterns, with the United States observing the largest increase in costs, whereas Canada had a decrease. Globally, the United States had the most notable increase in transplantation costs, while Germany experienced the most significant decrease (Table 1 and Figure 1).

The annual costs of kidney transplantation per patient in the later years vary across countries and regions globally, with changes observed between 2019 and 2023. Oceania and Southeast Asia show generally moderate increases, as seen in countries like Australia, Indonesia, Malaysia, the Philippines, Singapore, New Zealand, and Thailand, which experienced notable cost rises, with Thailand having the largest cost increase. Western European countries, including Austria, Belgium, France, Italy, the Netherlands, Norway, Portugal, Spain, and the United Kingdom, exhibited mixed trends; most countries had increased costs except for Finland, Germany, and the United Kingdom, where costs decreased. In the Middle East, countries such as Bahrain, Jordan, Saudi Arabia, and the West Bank and Gaza reported increases, with the increases being more prominent in Jordan and Saudi Arabia; Jordan experienced the greatest increase. Eastern and Central Europe demonstrated consistent cost increases, with Hungary, Serbia, Slovenia, and Turkey all showing upward trends. Hungary had the highest increase. North America and the Caribbean, represented by Canada, experienced slight cost increases. Latin America had Mexico as the country reporting costs, showing a moderate increase. African countries, including Egypt, Morocco, South Africa, Sudan, and Tunisia, largely displayed rising costs, with Morocco and Sudan showing particularly substantial increases. The largest increase was observed in Morocco, showing a remarkably high rise. North and East Asian countries such as Japan, Korea, and Mongolia also reported increases, though these varied in magnitude, with Japan exhibiting the most notable increase. Globally, the Netherlands showed the most pronounced increase in annual costs, while Finland, Germany, and the United Kingdom noted decreases in costs over the given period (Table 2 and Figure 2).

Discussion

Our results showed that between 2019 and 2023, kidney transplantation costs per patient showed variable trends across regions worldwide: Brazil led Latin America in cost increases while Bolivia had the smallest rise; in Oceania and Southeast Asia, Australia's costs rose markedly, contrasting with a decline in Indonesia; Western Europe saw the largest increase in the Netherlands and a decrease

Table 1. First-year kidney transplantation costs per patient in different countries across the world in the years 2019 and 2023

Country	Region	First-year costs ($)		
		2019	2023	Changes
Argentina	Latin America	21207	23499.64	+2,292.64
Australia	OSEA	34893.63	71270.43	+3,6376.8
Austria	Western Europe	67058.62	76551.59	+9,492.97
Bahrain	Middle East	18361.18	20330.61	+1,969.43
Bangladesh	South Asia	3285.38	4142.78	+857.4
Belgium	Western Europe	38450.73	35737.29	-2,713.44
Bolivia	Latin America	13783.79	15250.4	+1,466.61
Brazil	Latin America	7457.72	48844.66	+41,386.94
Canada	North America & Caribbean	82852.41	78392.65	-4,459.76
China	North & East Asia	25355.87	22301.86	-3,054.01
Colombia	Latin America	16890.435	20837.01	+3,946.57
Costa Rica	Latin America	21599.51	23934.42	2,334.91
Denmark	Western Europe	25836.08	27394.38	+1,558.3
Egypt	Africa	7482.44	8318.04	+835.6
Finland	Western Europe	36116.94	71626.88	+35,509.94
France	Western Europe	114219.6	126992.6	+12,773
Germany	Western Europe	101915.45	76629.21	-25,286.24
Hungary	Eastern & Central Europe	43044.78	47639.91	+4,595.13
Indonesia	OSEA	19743.325	14181.11	-5,562.215
Iran	Middle East	11128.84	17840.85	+6,712.01
Italy	Western Europe	71461.36	96430.45	+24,969.09
Japan	North & East Asia	43373.74	69899.54	+26,525.8
Jordan	Middle East	26838.89	29780.33	+2,941.44
Korea, Rep.	North & East Asia	50613.04	70228.05	+19,615.01
Malaysia	OSEA	20396.185	30132.6	+9,736.41
Mexico	Latin America	15913.24	18243.54	+2,330.3
Morocco	Africa	7357.3	91760.45	+84,403.15
Myanmar	OSEA	4301.65	4679.77	+378.12
Netherlands	Western Europe	71882.43	118595.1	+46,712.67
New Zealand	OSEA	38641.61	42876.59	+4,234.98
Nigeria	Africa	21459.67	38045.73	+16,586.06
Norway	Western Europe	33413.71	41108.32	+7,694.61
Philippines	OSEA	7821.19	8508.67	+687.48
Portugal	Western Europe	105183.15	116952.3	+11,769.15
Saudi Arabia	Middle East	113935.2	156050.4	+42,115.195
Serbia	Eastern & Central Europe	16384.72	17768.23	+1,383.51
Singapore	OSEA	43900.76	71620.7	+27,719.94
Slovenia	Eastern & Central Europe	109180.14	140066.29	+30,886.15
South Africa	Africa	23826.77	27618.54	+3,791.77
Spain	Western Europe	45486.68	64821.89	+19,335.21
Sudan	Africa	15679.89	18269.14	+2,589.25
Thailand	OSEA	8603.31	31553.57	+22,950.26
Tunisia	Africa	17870.08	20713.91	+2,843.83
Turkey	Eastern & Central Europe	30961.73	34324.29	+3,362.56
United Kingdom	Western Europe	27971.05	14011.84	-13,959.21
United States	North America & Caribbean	35324.76	451697.9	+416,373.14
Vietnam	OSEA	4575.39	4977.57	+402.18
West Bank and Gaza	Middle East	17464.95	18185.4	+720.45

OSEA: Oceania and Southeast Asia.

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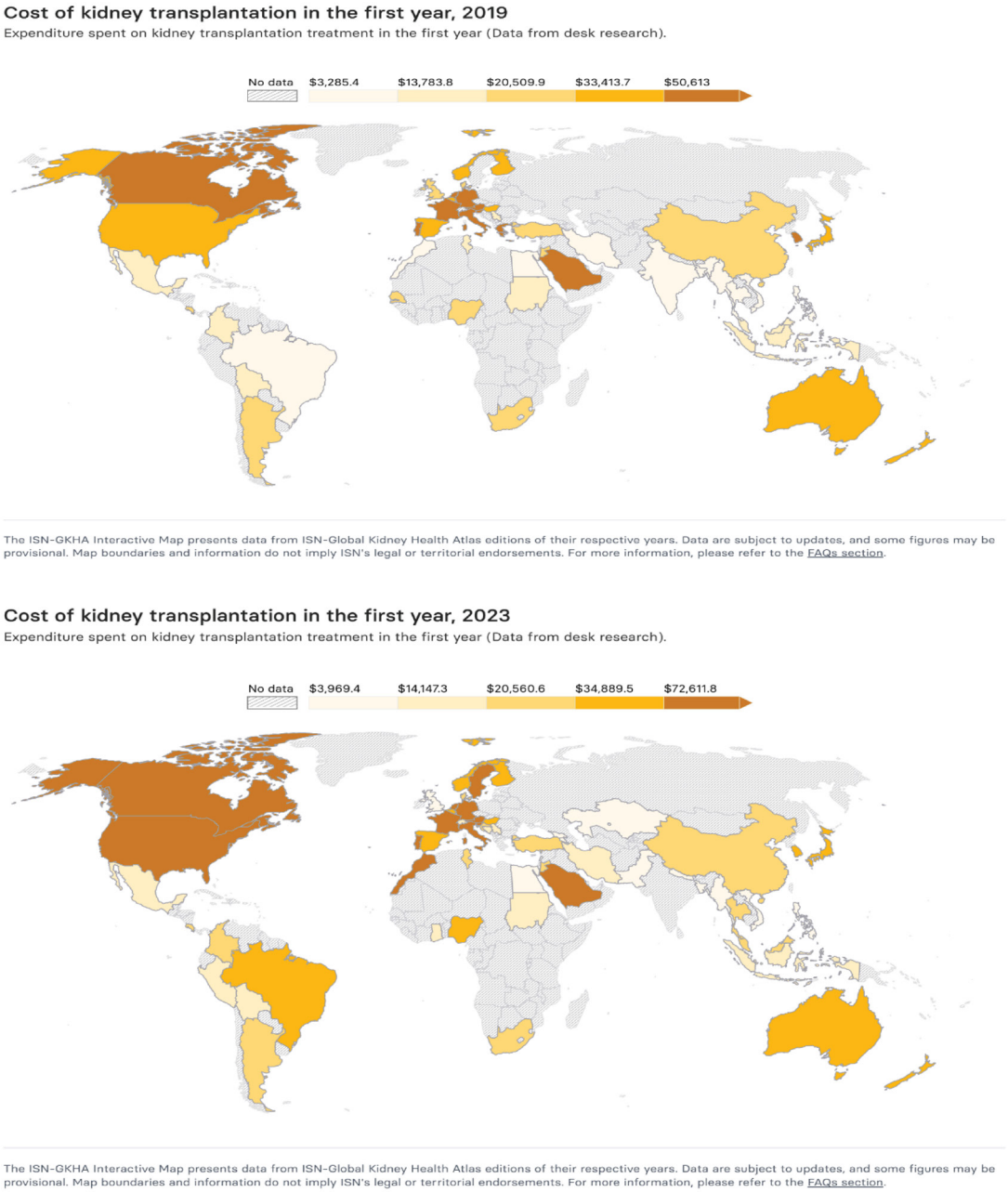

Figure 1. The geographic distribution of first-year kidney transplantation costs in different countries across the world in the years 2019 and 2023. Reprinted with permission from International Society of Nephrology, Belgium (Copyright 2025). Available at: https://gkha.theisn.org/. These 2019 and 2023 data are based on the ISN-Global Kidney Health Atlas Map, produced by the International Society of Nephrology (ISN).

in Germany; Saudi Arabia exhibited the highest costs increase in the Middle East, while the West Bank and Gaza had minimal change; Bangladesh in South Asia showed a modest increase; North America's United States experienced a significant rise contrasted by a decrease in Canada; in North and East Asia, Japan's costs increased most notably while China's decreased; Africa had the highest cost growth in Morocco and the smallest in Egypt; and within Eastern and Central Europe, Slovenia recorded the largest rise, and Serbia the smallest. Overall, the United States had the greatest global increase, while Germany recorded the largest decrease in kidney transplantation costs. Our findings reveal significant regional variability in kidney transplantation cost trends between 2019 and 2023, which aligns with the established literature demonstrating geographic disparities in healthcare economics for kidney replacement therapy. Previous systematic reviews have consistently identified kidney transplantation as the most cost-effective kidney replacement therapy modality globally, with all included studies indicating that kidney transplantation held either a dominant position over hemodialysis and peritoneal dialysis or demonstrated an incremental cost-effectiveness ratio well below accepted willingness-to-pay

Table 2. Annual cost of kidney transplantation per patient in the later years, in different countries across the world, 2019 and 2023

Country	Region	Annual costs in the later years ($)		
		2019	2023	Changes
Australia	OSEA	10268.9	10286.7	+17.8
Austria	Western Europe	19827.75	22634.61	+2,806.86
Bahrain	Middle East	7344.75	8132.55	+787.8
Belgium	Western Europe	8948.5	9920.34	+971.84
Canada	North America & Caribbean	22168.25	22366.24	+197.99
Egypt	Africa	5126.86	5699.4	+572.54
Finland	Western Europe	14696.87	14479.73	-217.14
France	Western Europe	26660.32	29533.17	+2,872.85
Germany	Western Europe	20704.09	19923.6	-780.49
Hungary	Eastern & Central Europe	56843.61	62911.79	+6,068.18
Indonesia	OSEA	2956.41	3216.28	+259.87
Italy	Western Europe	13968.78	14091.18	+122.4
Japan	North & East Asia	22885.98	25456.33	+2,570.35
Jordan	Middle East	14058.47	15599.22	+1,540.75
Korea, Rep.	North & East Asia	35765.1	36508.42	+743.32
Malaysia	OSEA	5384.885	6465.96	+1,081.075
Mexico	Latin America	4293.58	4922.32	+628.74
Mongolia	North & East Asia	5391.79	5993.99	+602.2
Morocco	Africa	1499.57	18705.01	+17,205.44
Netherlands	Western Europe	14376.49	41254.11	+26,877.62
New Zealand	OSEA	19116.96	21212.11	+2,095.15
Norway	Western Europe	22708.35	25241.95	+2,533.6
Philippines	OSEA	5605.18	6097.88	+492.7
Portugal	Western Europe	11133.3	12379.04	+1,245.74
Saudi Arabia	Middle East	15271.77	16663.28	+1,391.51
Serbia	Eastern & Central Europe	14020.82	15204.72	+1,183.9
Singapore	OSEA	16478.84	17995.96	+1,517.12
Slovenia	Eastern & Central Europe	14124.49	15782.12	+1,657.63
South Africa	Africa	17870.08	20713.91	+2,843.83
Spain	Western Europe	9561.92	10630.23	+1,068.31
Sudan	Africa	10879.14	13126.32	+2,247.18
Thailand	OSEA	5735.54	14594.83	+8,859.29
Tunisia	Africa	8339.37	9666.49	+1,327.12
Turkey	Eastern & Central Europe	13272.53	14713.98	+1,441.45
United Kingdom	Western Europe	5226.34	4546.99	-679.35
West Bank and Gaza	Middle East	3176.03	3307.05	+131.02

OSEA: Oceania and Southeast Asia.

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thresholds (17,18). However, our results show that despite this established cost-effectiveness, actual transplantation costs have exhibited divergent trends across regions. The observed cost increases in high-income countries like the United States and Australia are consistent with broader healthcare inflation patterns documented in developed economies, where transplant drug pricing is substantially higher than in other countries (19,20). Conversely, the cost decreases observed in Germany and China align with findings from European studies suggesting that generic immunosuppressant adoption and healthcare system reforms have contributed to cost containment. The mixed regional patterns we observed reflect the complex interplay between healthcare system structures, economic development levels, and policy frameworks that previous literature has identified as key determinants of kidney replacement therapy costs (21).

The heterogeneous cost trends we identified across regions reflect fundamental differences in healthcare system organization, economic capacity, and policy priorities that have profound implications for global kidney transplantation accessibility. While countries like the United States experienced the largest cost increases, this paradoxically occurs alongside evidence that kidney

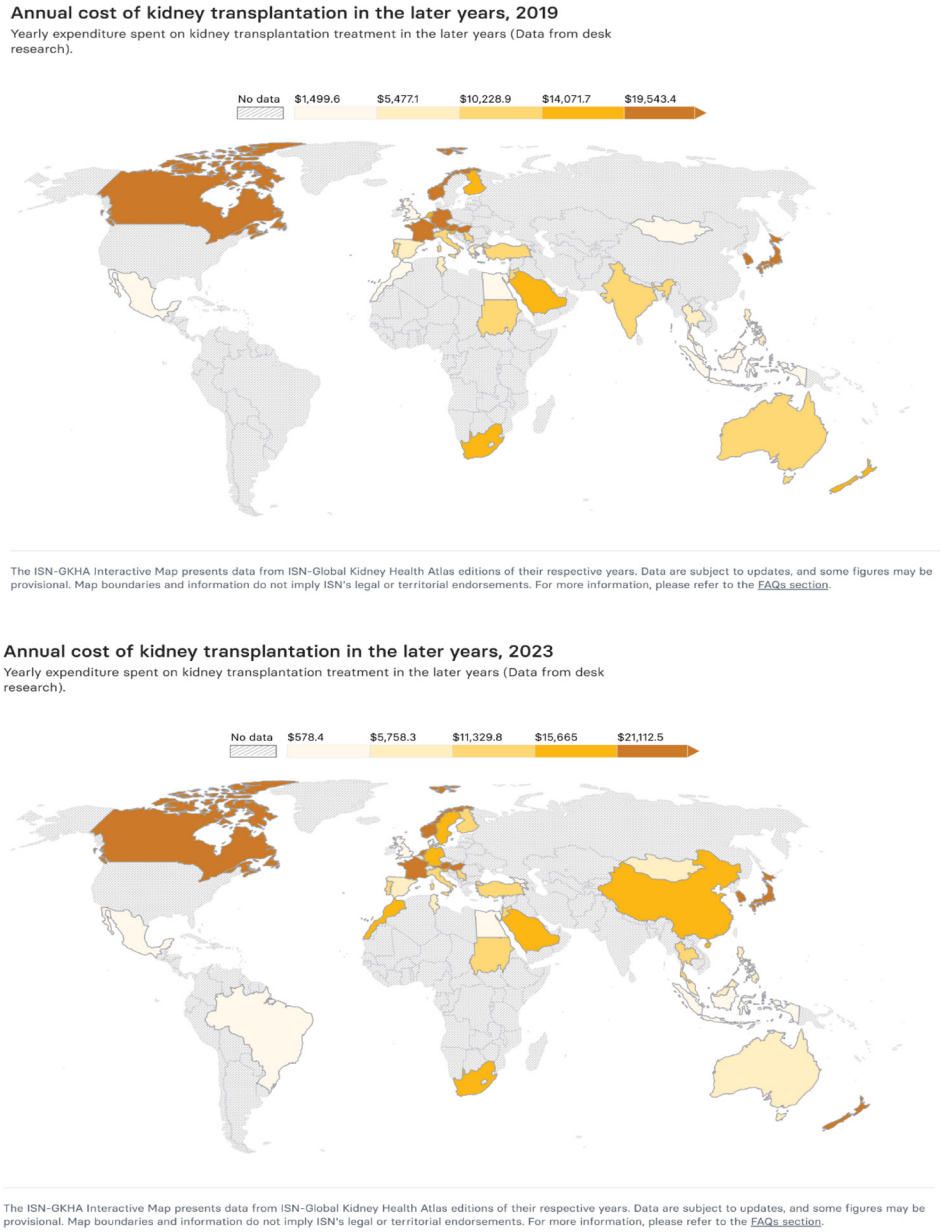

Figure 2. Geographic distribution of annual costs during the later years of kidney transplantation across various countries in 2019 and 2023. Reprinted with permission from International Society of Nephrology, Belgium (Copyright 2025). Available at: https://gkha.theisn.org/. These 2019 and 2023 data are based on the ISN-Global Kidney Health Atlas Map, produced by the International Society of Nephrology (ISN).

transplantation generates substantial long-term cost savings compared to dialysis, with estimated annual cost reductions ranging from $26 million to $363 million in Medicare savings through generic drug adoption alone (20). The cost reductions observed in countries like Germany and China suggest successful implementation of cost-containment strategies, including increased utilization of generic immunosuppressants, which have demonstrated comparable clinical outcomes while reducing annual treatment costs by approximately €2,000 per person (21). However, the global picture remains concerning, as access to kidney transplantation decreased from 30 to 29 per million population between 2019 and 2023, despite increased public funding proportions globally (22). This disconnect between funding availability and access suggests that cost factors alone do not determine transplantation rates, with infrastructure limitations, organ shortage, and healthcare system capacity playing equally critical roles. The regional variations we observed also highlight the urgent need for tailored healthcare economic policies that consider local economic contexts while maintaining focus on the established cost-effectiveness advantage of transplantation over long-term dialysis treatment.

Overall, the observed regional variations in kidney transplantation cost trends between 2019 and 2023 underscore the complex and multifactorial nature of healthcare economics in organ transplantation, with

significant implications for global health equity and resource allocation. While kidney transplantation remains the most cost-effective kidney replacement therapy modality according to systematic evidence (17), the divergent cost trajectories across regions, from substantial increases in the United States to notable decreases in Germany, reflect disparate healthcare system responses to economic pressures, policy interventions, and infrastructure constraints. These findings emphasize the critical need for evidence-based healthcare economic policies that balance cost containment with maintenance of transplantation access, particularly given the documented long-term cost savings and superior clinical outcomes associated with transplantation compared to dialysis. Future research should focus on identifying specific policy interventions and healthcare system characteristics that enable cost-effective transplantation delivery, with particular attention to low- and middle-income countries where access remains severely limited despite the established economic advantages of transplantation over alternative kidney replacement therapies.

Limitations of the study

Being an ecological and retrospective analysis, it relies on aggregated country-level data, which may mask within-country variations and individual patient factors influencing transplantation costs. The analysis depends solely on publicly available data from the ISN Global Kidney Health Atlas, which may be subject to reporting biases, incomplete data, or inconsistencies across countries and years. Additionally, variations in healthcare systems, currency fluctuations, and differences in cost calculation methods were not adjusted for, potentially affecting the comparability of findings. Finally, the study does not account for clinical outcomes or quality of transplantation services, limiting its ability to assess cost-effectiveness comprehensively.

Conclusion

In conclusion, the analysis of kidney transplantation costs from 2019 to 2023 reveals significant regional variations, highlighting disparities in healthcare economics across continents. While some countries have experienced substantial increases in transplantation costs, others have seen decreases or more modest changes, reflecting diverse healthcare infrastructures, economic conditions, and policy environments. These findings underscore the need for tailored strategies to manage kidney transplantation expenses effectively while ensuring equitable access to life-saving treatments globally. Continued monitoring and policy interventions are essential to address these cost disparities and optimize kidney care delivery worldwide.

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Authors' contribution

Conceptualization: Rasoul Jafari Arismani, Ali Emadzadeh, and Maede Safari.
Data curation: Rasoul Jafari Arismani, Zahra Eydizadeh, and Maede Safari.
Formal analysis: Motahareh Sabaghi Qala Nou and Zahra Eydizadeh.
Investigation: Sina Salem Ahim, Kamran Safa, and Maryam Miri.
Methodology: Sara Ghaseminejad Kermani and Motahareh Sabaghi Qala Nou.
Project management: Maede Safari.
Supervision: All authors.
Validation: Maryam Miri and Sara Ghaseminejad Kermani.
Visualization: Sina Salem Ahim and Kamran Safa.
Writing–original draft: All authors.
Writing–review and editing: All authors.

Conflicts of interest

There are no competing interests.

Ethical issues

This study has been compiled based on data from the ISN-GKHA website (https://gkha.theisn.org/). Ethical considerations related to data extraction were formally addressed through email communications with ISN officials to ensure compliance with established ethical standards. Also, the study protocol was registered on the Research Registry (unique identifying number [UIN]: researchregistry11535) website. Besides, the authors have observed ethical issues (including plagiarism, data fabrication, and double publication).

Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of generative artificial intelligence (AI) and AI-assisted technologies in the writing process

During the preparation of this work, the authors utilized AI (Perplexity.ai and Grammarly.com) to refine grammar points and language style in writing. Subsequently, the authors thoroughly reviewed and edited the content as necessary, assuming full responsibility for the publication's content.

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