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Global trends in kidney failure incidence over a 5-year period of 2019–2023; an ecological analysis of the International Society of Nephrology data

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ABSTRACT

Introduction: Kidney failure, a critical global health issue, has shown varying trends in incidence across different regions over the past five years.

Objectives: This ecological analysis examines data from the International Society of Nephrology (ISN) to identify the trend pattern of kidney failure incidence between 2019 and 2023 across the world.

Methods: This ecological study was conducted to evaluate kidney failure incidence across 78 countries over a five-year period (2019–2023) using data from the ISN Global Kidney Health Atlas (GKHA). Data were sourced from the ISN-GKHA website and included information for 78 countries across 10 global regions. The analysis involved extracting datasets from 2019 and 2023 to calculate changes in kidney failure incidence, identifying regional and global trends.

Results: The results indicated that high-income countries exhibited varying trends in kidney failure incidence. For instance, Taiwan, Korea, and Chile experienced significant increases, whereas the Czech Republic and Panama recorded decreases. In middle-income countries, the patterns were mixed; Indonesia, Mexico, and Tunisia show marked rises, while Ecuador and El Salvador reported notable declines. Meanwhile, countries like Bahrain, Egypt, Georgia, Iran, and South Africa demonstrated stable rates, potentially reflecting steady healthcare systems or reliable data collection practices.

Conclusion: The incidence of kidney failure across countries revealed diverse trends influenced by income levels and healthcare systems. High-income countries demonstrated variability, with significant increases in Taiwan, Korea, and Chile, contrasted by declines in the Czech Republic and Panama. Middle-income nations exhibited mixed patterns, as Indonesia, Mexico, and Tunisia reported rising rates, while Ecuador and El Salvador experienced declines. The stability observed in countries such as Bahrain, Egypt, Georgia, Iran, and South Africa suggests consistent healthcare infrastructure or effective data collection practices.

Registration: This study has been compiled based on data from the ISN-GKHA website, and its protocol was registered on the research registry (UIN: researchregistry11142) website (https://gkha.theisn.org/).

Original

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Implication for health policy/practice/research/medical education:
In this ecological study, we observed that kidney failure incidence trends varied significantly across countries, influenced by economic status and healthcare infrastructure. Among high-income nations, trends were inconsistent, with marked increases in Taiwan, Korea, and Chile, while notable declines were seen in the Czech Republic and Panama. Middle-income countries displayed mixed patterns; for instance, Indonesia, Mexico, and Tunisia reported rising rates, whereas Ecuador and El Salvador experienced reductions. Stability in incidence rates in Bahrain, Egypt, Georgia, Iran, and South Africa suggests robust healthcare systems or reliable data collection mechanisms. These findings highlight the complex interplay between socioeconomic factors and healthcare capacity in shaping kidney failure trends globally.

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Introduction

Chronic kidney disease (CKD) is characterized by kidney damage or an estimated glomerular filtration rate (eGFR) less than 60 mL/min/1.73 m^2, persisting for at least three months, irrespective of the cause (1-3). Kidney failure imposes a substantial and escalating global health burden, with its prevalence and associated impacts experiencing a sharp upward trajectory over the past two decades (4). CKD represents a profound global health challenge characterized by steadily increasing incidence and substantial disease burden across diverse populations. According to comprehensive analyses of the Global Burden of Disease Study 2019, global incident cases of CKD have more than doubled from 7.80 million in 1990 to 18.99 million in 2019, with disability-adjusted life years (DALYs) nearly doubling from 21.50 million to 41.54 million during this same period (5,6). The age-standardized incidence rate (ASIR) reached 233.65 per 100 000 population in 2019, demonstrating a consistent upward trajectory with an estimated annual percentage change (EAPC) of 0.69, while the age-standardized DALY rate increased to 514.86 per 100 000 (5,7). This alarming trend represents a persistent challenge for healthcare systems worldwide, with almost all countries experiencing increased ASIR and over half showing rising age-standardized DALY rates from 1990 to 2019 (5).

The etiological landscape of CKD has been increasingly dominated by preventable cardiometabolic conditions that require integrated management approaches. Type 2 diabetes mellitus and hypertension have emerged as the predominant causes of CKD globally, accounting for approximately 85% of incident cases and 66% of DALYs in 2019 among known etiologies, with these conditions demonstrating the highest growth rates in age-standardized DALY rates (5). High systolic blood pressure has been identified as a significant contributor to CKD-related deaths and disability, particularly in regions with high sociodemographic index (SDI) values (8). Population growth has been recognized as the primary driver of increasing CKD incident cases and DALYs globally, suggesting that demographic transitions will continue to shape kidney disease epidemiology in the coming decades. Recent predictive modeling studies suggest that while incident cases of CKD are expected to continue rising through 2030, there is potential for global death rates to decrease, possibly reflecting improvements in disease management and healthcare access (9).

The period from 2019 to 2023 represents a critical timeframe for examining kidney disease trends given the unprecedented global health disruptions that occurred during this interval. This period encompasses the COVID-19 pandemic, which may have significantly impacted kidney disease detection, management, and outcomes through direct viral effects on kidney function, healthcare access disruptions, and changes in risk factor profiles (7,9). Understanding the most recent epidemiological patterns of kidney failure during this dynamic period is essential for healthcare planning, resource allocation, and policy development. Comprehensive analysis of 2019-2023 data would bridge the gap between established pre-pandemic trends and emerging patterns, providing crucial insights into the resilience of kidney care systems and identifying vulnerable populations requiring enhanced support.

Objectives

This study aimed to comprehensively analyze global and regional trends in kidney failure incidence over the five-year period from 2019 to 2023, establishing current epidemiological patterns and identifying populations at heightened risk for adverse outcomes. The research will quantify changes in incidence rates across different geographic regions, allowing for targeted intervention development and resource allocation to address disparities in kidney disease burden.

Materials and Methods

Study design

This ecological study assessed the incidence of kidney failure across 78 countries using data from the International Society of Nephrology (ISN) for the years 2019 and 2023, analyzing trends over these five years. The data derived from the ISN Global Kidney Health Atlas (GKHA) from the website of ISN available at (https://gkha.theisn.org/).

Data extraction

The data source for extracted data in this study was ISN-GKHA (International Society of Nephrology-Global

Kidney Health Atlas) (https://gkha.theisn.org/). We analyzed datasets from 2019 and 2023 to identify temporal trends in the incidence of kidney failure. Data on kidney failure incidence were extracted for 78 countries across 10 regions across the world for the years 2019 and 2023. To evaluate trends, we calculated changes in kidney failure incidence over these five years, providing insights into regional and global patterns.

Outcomes

The primary outcome of this study is the reporting of kidney failure incidence across 78 countries spanning 10 regions worldwide, while the secondary outcome focuses on analyzing global trends in kidney failure incidence from 2019 to 2023 within these countries.

Data analysis

In this study, we reported the incidence of kidney failure by calculating the annual number of new cases per million population (PMP). To assess trends in incidence, we compared the kidney failure rates from 2023 to those from 2019 for each country, allowing us to identify changes over the five-year period. The mapping of incidence rates was employed to uncover patterns and clusters of kidney failure occurrences, allowing for an assessment of geographical trends throughout the study period across the world.

Results

A comparative analysis of kidney failure incidence PMP between 2019 and 2023, based on data from the ISN, reveals notable variations across different countries and regions. High-income nations such as Australia, Austria, Belgium, Bulgaria, Canada, Chile, Croatia, Cyprus, France, Greece, Iceland, Italy, Japan, Korea, Portugal, Taiwan, the United Kingdom and the United States generally experienced increases in incidence. In contrast, others, like the Czech Republic, Denmark, Estonia, Finland, the Netherlands, Norway, Panama, Slovak Republic, Spain, Sweden and Switzerland saw decreases. Among lower-middle-income countries, Bangladesh and Nicaragua showed increased incidence, whereas Honduras experienced a substantial decrease. Upper-middle-income countries presented a mixed picture; for instance, Albania, Argentina, Belarus, Brazil, Colombia, Cuba, Dominican Republic, Guatemala, Indonesia, Mexico, Paraguay, Peru, Thailand, and Ukraine reported higher incidence rates in 2023 compared to 2019, while Ecuador, El Salvador, and Serbia recorded lower rates. In 2019, Paraguay exhibited the minimum incidence at 20 PMP, while Taiwan reported the maximum at 493 PMP; by 2023, Paraguay and South Africa shared the minimum incidence at 40 PMP, and Taiwan's incidence increased to a maximum of 529 PMP. The greatest decrease in incidence was observed in Panama (-273 PMP), while the largest increase was in Mexico (+172 PMP). Notably, several countries including Bahrain, Brunei Darussalam, Egypt, Georgia, Iran, Malaysia, Morocco, Oman, Philippines, Saudi Arabia, Slovenia, and South Africa showed no change in incidence between 2019 and 2023. These trends underscore the diverse and evolving landscape of kidney failure incidence globally, reflecting varying healthcare systems, risk factors, and data collection methodologies (Table 1).

The global kidney health atlas presents data on the incidence of kidney failure in 2019, defined as the annual number of new kidney failure cases per million population, reflecting the growth in severe kidney disease. The median incidence of treated kidney failure worldwide was 144 cases per million population in 2019. The incidence of kidney failure was categorized based on new cases per million population. Kidney failure incidence, measured as new cases per million population. The highest incidence rates (above 213.8 PMP) were concentrated in countries like the United States, Mexico, Portugal, South Korea, Japan, Thailand, Malaysia, Taiwan, Czechia, and Hungary. Conversely, the lowest incidence rates (ranging from 20.2 to 92.5 PMP) were observed in Iran, Russia, Iceland, Colombia, Peru, Nicaragua, Paraguay, Bolivia, Egypt, Ukraine, Belarus, and Bangladesh. Many other countries, mentioned in Table 1, fell within the middle range of 92.5 to 213.8 PMP. Data were unavailable for some countries such as China and India (Figure 1).

In 2023, the median incidence of treated kidney failure was 146 cases PMP. High-income countries like the USA, Mexico, Portugal, Tunisia, Greece, South Korea, Japan, Thailand, Malaysia, Taiwan, and Indonesia exhibited the highest incidence (over 226 PMP). Conversely, Russia, South Africa, Iran, Iceland, Colombia, Peru, Nicaragua, Paraguay, Bolivia, Egypt, Ukraine, Belarus, and Bangladesh had the lowest incidence (19 to 96.6 PMP). Other countries listed in Table 1 showed incidence rates between 96.6 and 171.6 PMP. Data for some large countries, such as India, was unavailable (Figure 2).

Discussion

The results indicated that the trend of kidney failure incidence rates between 2019 and 2023 reveals a complex global landscape characterized by regional and national variations. While some high-income countries, such as Taiwan, Korea, and Chile, experienced notable increases, others, like the Czech Republic and Panama, saw decreases. Among middle-income countries, the trends were mixed, with countries such as Indonesia, Mexico, and Tunisia reporting notable increases, while others such as Ecuador and El Salvador experienced substantial declines. The stability observed in certain countries like Bahrain, Egypt, Georgia, and South Africa suggests consistent healthcare infrastructure or data collection practices.

The reported variations in kidney failure incidence across high and middle-income countries reflect complex interplays of socioeconomic, environmental, and healthcare factors. Previous research has demonstrated that

Table 1. Global kidney failure incidence rates by country and year; comparative analysis of 2019 and 2023 data from the international society of nephrology

Country		Region	Incidence (PMP)		Incidence changes (PMP)
			2019	2023	
High-income	Australia	OSEA	117	127	10
	Austria	Western Europe	133	135	2
	Bahrain	Middle East	208	208	0
	Belgium	Western Europe	187	197	10
	Brunei Darussalam	OSEA	393	393	0
	Bulgaria	Eastern & Central Europe	156	170	14
	Canada	North America & Caribbean	200	208	8
	Chile	Latin America	169	226	57
	Croatia	Eastern & Central Europe	180	191	11
	Cyprus	Eastern & Central Europe	193	284	91
	Czech Republic	Eastern & Central Europe	243	216	-27
	Denmark	Western Europe	128	108	-20
	Estonia	Eastern & Central Europe	85	74	-11
	Finland	Western Europe	102	94	-8
	France	Western Europe	165	170	5
	Greece	Western Europe	251	269	18
	Hungary	Eastern & Central Europe	222	222	0
	Iceland	Western Europe	89	108	19
	Ireland	Western Europe	88	88	0
	Italy	Western Europe	144	165	21
	Japan	North & East Asia	296	306	10
	Korea, Rep.	North & East Asia	311	360	49
	Kuwait	Middle East	141	142	1
	Latvia	Eastern & Central Europe	110	121	11
	Lithuania	Eastern & Central Europe	107	113	6
	Netherlands	Western Europe	117	106	-11
	New Zealand	OSEA	119	133	14
	Norway	Western Europe	106	100	-6
	Oman	Middle East	120	120	0
	Panama	Latin America	462	189	-273
	Poland	Eastern & Central Europe	149	153	4
	Portugal	Western Europe	236	260	24
	Puerto Rico	Latin America	433	437	4
	Qatar	Middle East	123	164	41
	Romania	Eastern & Central Europe	177	191	14
	Russian Federation	NIS & Russia	59	88	29
	Saudi Arabia	Middle East	145	145	0
	Singapore	OSEA	333	364	31
	Slovak Republic	Eastern & Central Europe	154	122	-32
	Slovenia	Eastern & Central Europe	126	126	0
	Spain	Western Europe	142	152	10
	Sweden	Western Europe	121	113	-8
	Switzerland	Western Europe	101	99	-2
	Taiwan	North & East Asia	493	529	36
	United Kingdom	Western Europe	116	151	35
	United States	North America & Caribbean	378	410	32
	Uruguay	Latin America	166	227	61

Table 1. Continued

Country		Region	Incidence (PMP)		Incidence changes (PMP)
			2019	2023	
Lower-middle income	Bangladesh	South Asia	51	64	13
	Bolivia	Latin America	95	116	21
	Egypt	Africa	56	56	0
	Honduras	Latin America	177	96	-81
	Morocco	Africa	144	144	0
	Nicaragua	Latin America	24	33	9
	Philippines	OSEA	172	172	0
	Tunisia	Africa	159	242	83
Upper-middle income	Albania	Eastern & Central Europe	88	126	38
	Argentina	Latin America	165	198	33
	Belarus	NIS & Russia	62	93	31
	Bosnia and Herzegovina	Eastern & Central Europe	112	111	-1
	Brazil	Latin America	194	209	15
	Colombia	Latin America	80	122	42
	Cuba	Latin America	103	123	20
	Dominican Republic	Latin America	208	226	18
	Ecuador	Latin America	178	19	-159
	El Salvador	Latin America	390	223	-167
	Georgia	NIS & Russia	203	203	0
	Guatemala	Latin America	125	146	21
	Indonesia	OSEA	135	306	171
	Iran	Middle East	81	81	0
	Malaysia	OSEA	259	259	0
	Mexico	Latin America	355	527	172
	Paraguay	Latin America	20	40	20
	Peru	Latin America	30	65	35
	Serbia	Eastern & Central Europe	88	82	-6
	South Africa	Africa	22	22	0
	Thailand	OSEA	346	377	31
	Turkey	Eastern & Central Europe	140	139	-1
	Ukraine	NIS & Russia	29	40	11

Note: Reproduced with permission from the ISN-Global Kidney Health Atlas, produced by the International Society of Nephrology. 2023. Available at http://www.theisn.org/global-atlas.

structural inequities significantly influence kidney disease burden. A 2023 study examining historical redlining in US cities found that residence in neighborhoods designated as "hazardous" by discriminatory housing policies was associated with significantly higher kidney failure incidence rates compared to more privileged areas, suggesting historical policies continue to shape present-day kidney health inequities (10). This may partially explain some of the geographic variations observed in the 2019-2023 data.

The COVID-19 pandemic, which emerged during this period, likely contributed to changing patterns in kidney failure incidence. Research has documented increased risk of CKD following COVID-19 infection, potentially explaining some of the increases observed in certain countries (11). A 2023 meta-analysis identified a risk factor such as black race for acute kidney injury in COVID-19 patients, a factor that varies in prevalence across different countries (12). Furthermore, national healthcare policies regarding dialysis access and reimbursement contribute significantly to disparities in reported incidence rates between countries. Research examining dialysis facility ownership in the US found significant disparities in outcomes based on profit status, highlighting how healthcare system structures influence kidney failure management (13). Additional research has called for national policies to provide scheduled dialysis and transplantation for all people with kidney failure, including undocumented immigrants, pointing to policy gaps that may affect reported incidence rates (14). Longitudinal data from Japan showed increasing rates of urgent dialysis following acute hypertension from 2010 through 2019, suggesting that even in high-income countries with advanced healthcare systems, the burden

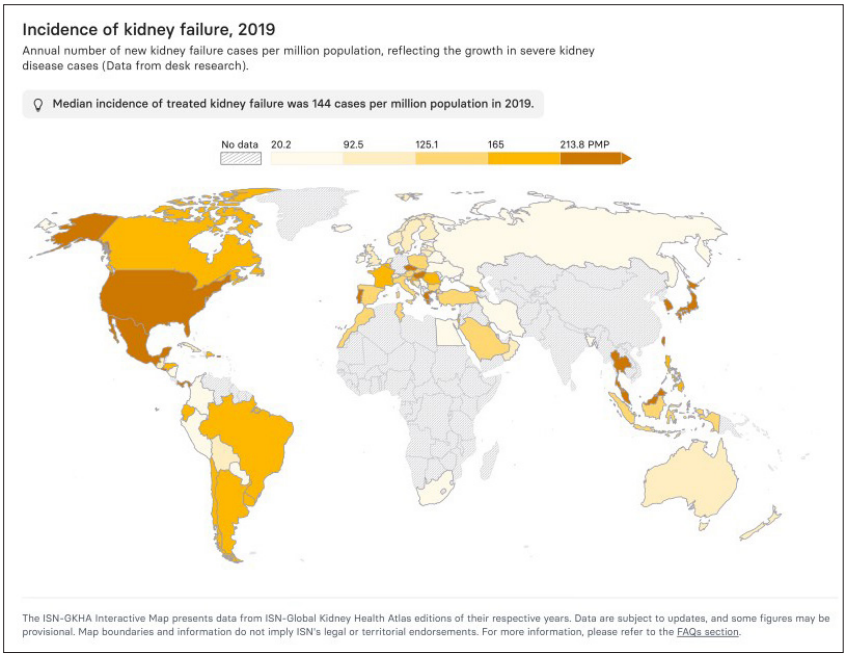

Figure 1. Global distribution of kidney failure incidence (Case per million population), 2019. Note: Reproduced with permission from the ISN-Global Kidney Health Atlas, produced by the International Society of Nephrology. 2023. Available at http://www.theisn.org/global-atlas.

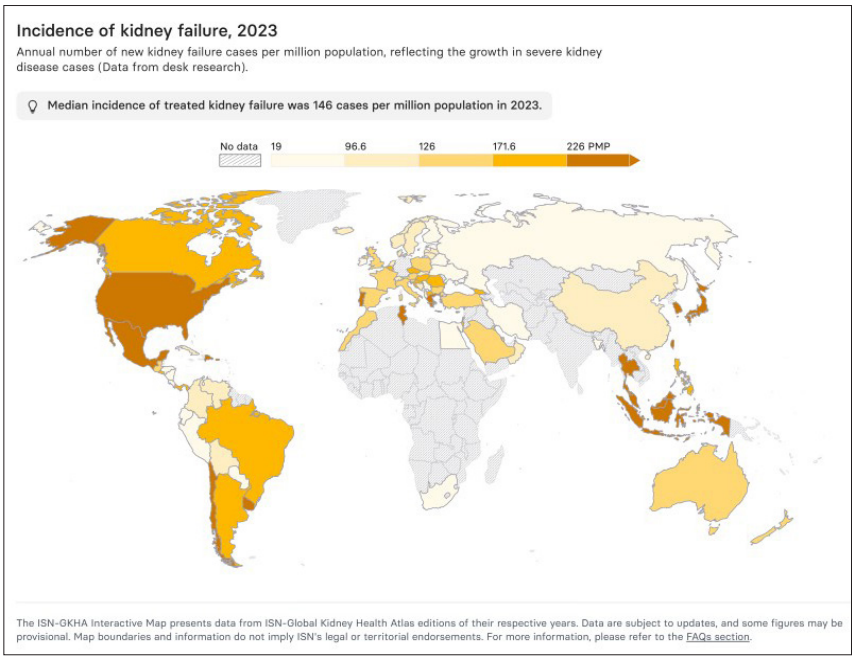

Figure 1. Global distribution of kidney failure incidence (Case per million population), 2023. Note: Reproduced with permission from the ISN-Global Kidney Health Atlas, produced by the International Society of Nephrology. 2023. Available at http://www.theisn.org/global-atlas.

of kidney failure was growing before the pandemic (15). Similarly, a nationwide population-based study in Korea demonstrated that patients with systemic sclerosis had significantly higher risk of kidney failure than controls, with larger effect sizes in more recently diagnosed patients, indicating potentially changing risk dynamics (16).

Overall, the observed variations in kidney failure incidence between 2019 and 2023 align with previous research demonstrating that kidney disease burden is shaped by complex interplays of structural inequities, healthcare system factors, and disease-specific risks. The marked regional differences observed between high and middle-income countries reflect what earlier studies have documented regarding the impact of healthcare accessibility, socioeconomic factors, and disease management approaches (10,12,14). While some countries

experienced increases and others decreases, these patterns extend trends documented in longitudinal studies predating this period (15). The COVID-19 pandemic likely exacerbated existing disparities and created new risk profiles that influenced incidence rates differentially across regions (11,12). These findings collectively underscore the need for targeted interventions addressing both social determinants of health and healthcare system factors to reduce the growing global burden of kidney failure, particularly in vulnerable populations.

Conclusion

In conclusion, the analysis of kidney failure incidence rates between 2019 and 2023 reveals a complex global landscape characterized by regional and national variations. While some high-income countries, such as Taiwan, Korea and Chile, experienced notable increases, others, like the Czech Republic and Panama, saw decreases. Among middle-income countries, the trends were mixed, with countries such as Indonesia, Mexico, and Tunisia reporting notable increases, while others such as Ecuador and El Salvador experienced substantial declines. The stability observed in certain countries like Bahrain, Egypt, Iran, Georgia, and South Africa suggests consistent healthcare infrastructure or data collection practices. These findings highlight the multifaceted nature of kidney failure epidemiology, influenced by factors such as aging populations, the prevalence of diabetes and hypertension, access to healthcare, and data reporting methodologies, necessitating tailored public health interventions and further research to address the growing burden of kidney disease worldwide. Also, these findings underscore the importance of tailored public health strategies and further research to address disparities and stabilize kidney failure trends globally.

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Authors' contribution

Conceptualization: Mahboobeh Askarizade, Hamid Nasri, and Paniz Pourpashang.
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Methodology: Farnaz Saberian, Sina Homaee, and Elham Ahmadipour.
Project management: Paniz Pourpashang.
Supervision: Mahboobeh Askarizade.
Validation: Samaneh Zandifar and Aria Jenabi.
Visualization: Samaneh Zandifar and Hamid Nasri.
Writing–original draft: All authors.
Writing–review and editing: All authors.

Conflicts of interest

There are no competing interests.

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.

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 institutional review and approval processes, which included written correspondence via 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]: researchregistry11142) website. Besides, the authors have observed ethical issues (including plagiarism, data fabrication, and double publication).

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