



## The Records, Patterns, and Projections of Aetiology-Based Chronic Kidney Disease Frequency Between 2015 and 2025 in Maiduguri, Nigeria

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### Abstract

Chronic kidney disease (CKD) has emerged as a major global public health concern, affecting populations in both developing and developed countries. The number of individuals at risk of progressing to end-stage renal disease (ESRD) continues to rise steadily, placing increasing pressure on healthcare systems. This growing burden is largely attributed to limited understanding of the underlying pathways of kidney disease progression, inadequate early detection, and insufficient implementation of evidence-based preventive and therapeutic strategies. In many low- and middle-income regions, including Nigeria, these challenges are further compounded by limited access to diagnostic facilities, poor awareness, and delayed clinical intervention. This study examined the records, trends, and projections of aetiology-based chronic kidney disease incidence in Maiduguri, Nigeria. A comprehensive desktop review was conducted using relevant keywords such as "kidney disease" and "kidney disease in Maiduguri," both individually and in combination, across multiple academic databases and search engines. In addition, hospital-based records obtained from the University of Maiduguri Teaching Hospital were analyzed to evaluate temporal trends, demographic distribution, and incidence patterns of CKD within the study area. The review revealed a substantial volume of scholarly output globally, with approximately 18,280 publications identified under the general keyword "kidney disease," while 1,790 publications were specifically related to kidney disease in Maiduguri. Statistical analysis of hospital records showed that time period ( $F_{9,27} = 2.53$ ;  $p = 0.03$ ) was a significant determinant of the increasing CKD trend at the 95% confidence level, indicating a progressive rise in disease incidence over time. Gender was also identified as an influential factor ( $F_{3,27} = 2.54$ ;  $p = 0.08$ ), demonstrating significance at the 90% confidence level, suggesting possible gender-related differences in disease occurrence and vulnerability. The findings confirm a consistent increase in CKD cases in Maiduguri over the study period. Furthermore, a positive correlation was observed between the number of diagnosed kidney disease cases and population growth, highlighting the influence of demographic expansion on disease prevalence. These results underscore the urgent need for improved surveillance, early detection programs, and targeted public health interventions to mitigate the rising burden of chronic kidney disease in Maiduguri and similar settings.

### Keywords

chronic kidney disease, Incidence, health claims data; Mortality; Global burden of disease; Incidence trends, Kidney dysfunction,

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## Introduction

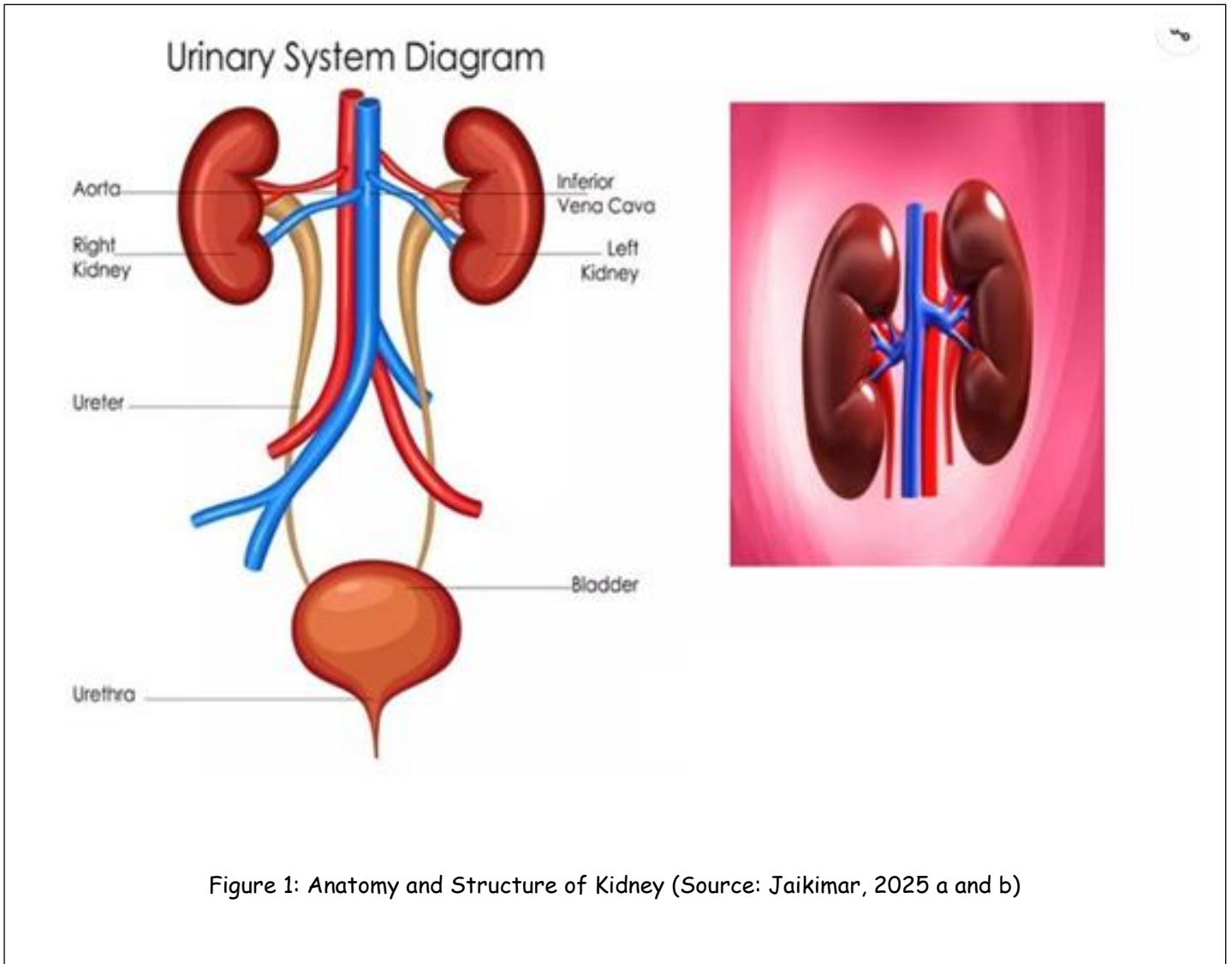
Chronic kidney diseases are frequent public health issues and problems, which involves abnormalities in kidney function or structure that continue and persist for not less a period of three or four months (Zhong et al., 2017; Mfungana, 2018; Laguipo, 2018; Shahbazi et al., 2025). Figures 1 and 2 show the anatomy, shape and structure of a normal and diseased kidney, respectively. The progression condition of these ChKDs affect more than 10 percent of the world population, which is equivalent to more than  $8.00 \times 10^8$  (Süleymanlar et al., 2011). ChKDs are posing significant challenges in low- and middle-income countries, which are less equipped to address and control its consequences (UN, 2025; WHO, 2025a, b and c).

These ChKDs have emerged as the leading cause of mortality worldwide. Figure 3 presents the causes of ChKD. Figure 4 shows the molecular mechanism of ageing of kidney. In addition, ChKDs are non-communicable diseases that have shown an increase in deaths and illness in the recent century. Recent global research on the causes of ChKDs has established that groundwater pollution with selected metals, such as lead, cadmium, manganese, copper, iron, and chromium. Cadmium and lead pollutions, which are prevalent in developing countries such as Africa and Asia, endanger water and food supplies due to the high toxicity of these metals even at low concentrations (UN, 2025; WHO, 2025a, b, and c).

Figure 5 shows further causes of ChKDs established in the literature. Health problems and issues associated with ChKDs include degenerative neurological conditions, cardiovascular diseases, kidney damage, respiratory diseases, and cancer (UN, 2025; WHO, 2025a, b and c). Figure 6 presents the common symptoms of ChKD found

with man. There have been previous studies on kidney diseases, the issues and challenges of kidney problems worldwide, such as:

- a. Causes of kidney failure and treatment (Ahmed et al., 2025; Arora et al., 2013; Bairey et al., 2019; Bothe et al., 2024; 2025; Aletras et al., 2025; BD, 2021; Berezin et al., 2024; Birkov et al., 2020 and Ying et al., 2024);
- b. Incidence, challenges and progress (Chou et al., 2021; Chukwuonye et al., 2018; Cobo et al 2016; Couser et al., 2011; Echouffo-Tcheugui and Kengne, 2012; Edvardsson et al., 2018; Emem et al., 2007; Hu et al., 2020; Hardhanti and Rochmawati, 2025; Bukar et al., 2019; Ene-Iordarache et al., 2016; Gao et al., 2021; Brennan et al., 2021; Camara et al., 2017; Cockwell and Fisher, 2020);
- c. Risk factors, models, trend, and burden of chronic kidney failure and disease (Huda and Alam, 2012; Isa et al., 2025; Kumar et al., 2025; Laguipo, 2018; Lea and Nicholas, 2002; Medgyesi et al., 2025; Mfungana et al., 2018; Neugarten and Golestaneh, 2019; Otoh et al., 2005; Polito et al., 2009; Soerensen and Chertow, 2025; Tangir et al., 2011; Tonelli and Riella, 2014; Tran et al., 2025; Von Samson-Himmelstijerma et al., 2025; Xie et al., 2023; Yin et al., 2022; Goni et al., 2025; Grace et al., 2012 and Zandi-Nejad et al., 2006; Folkerts et al., 2021).



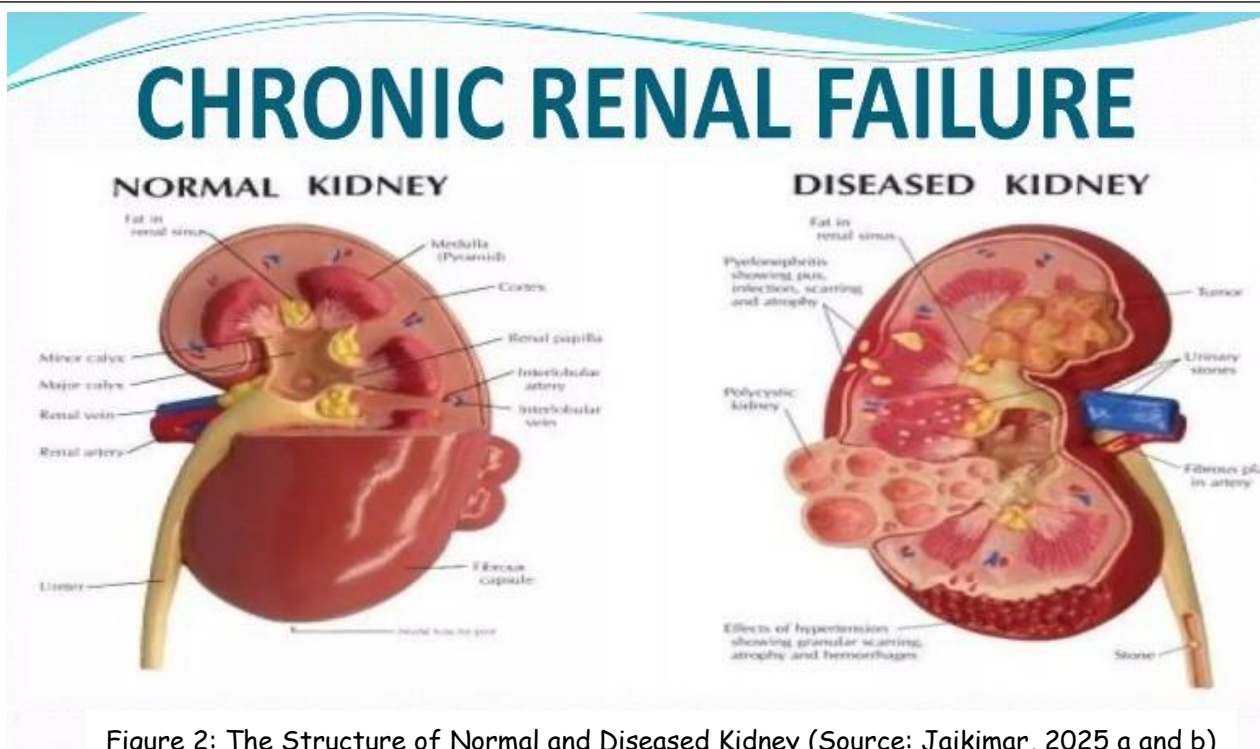


Figure 2: The Structure of Normal and Diseased Kidney (Source: Jaikimar, 2025 a and b)

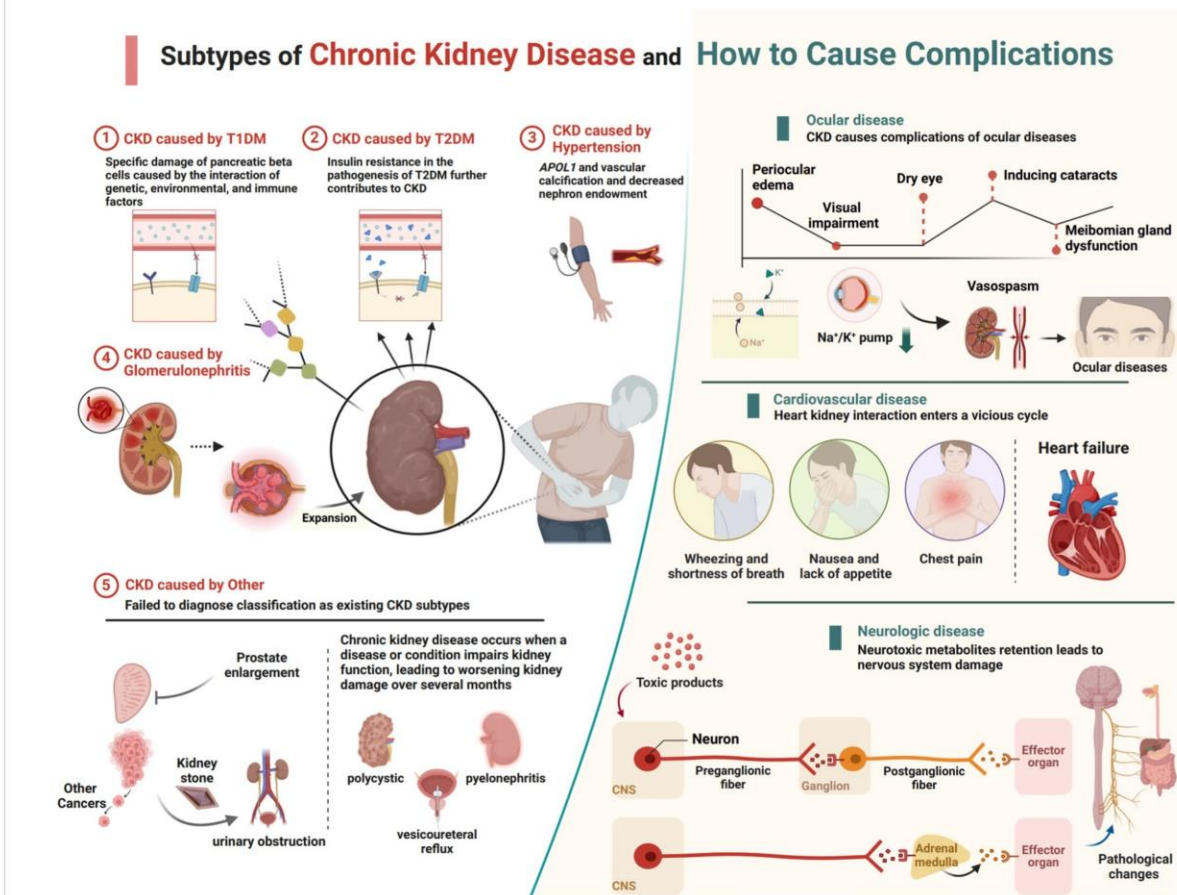


Figure 3 the causes of chronic kidney disease (Source: Guo et al., 2025b)

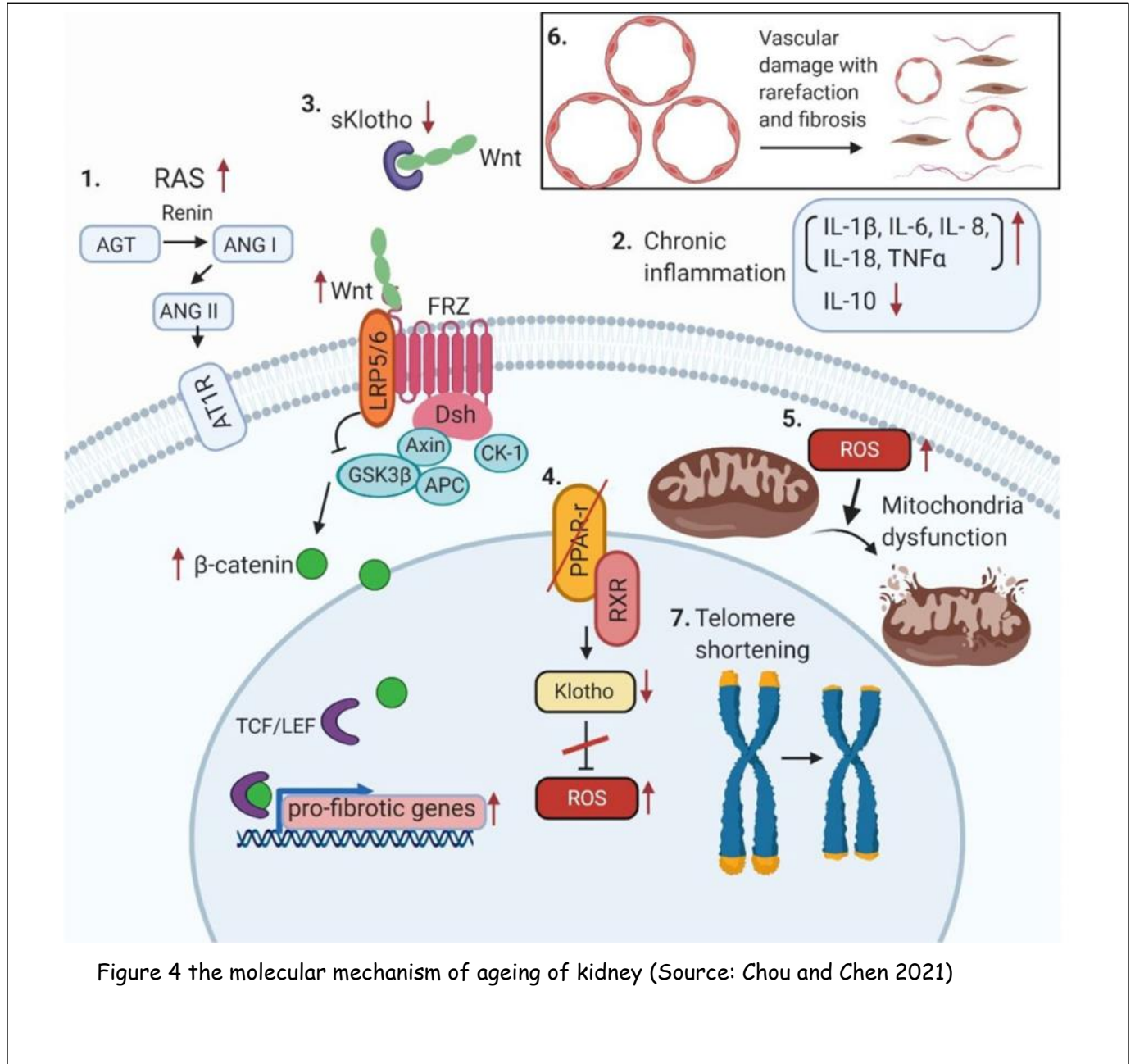
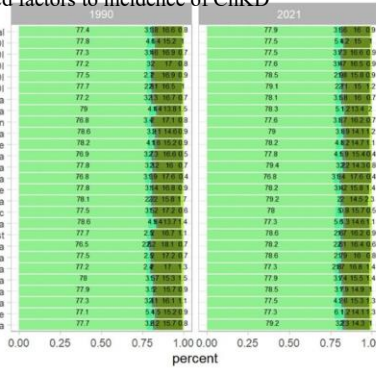
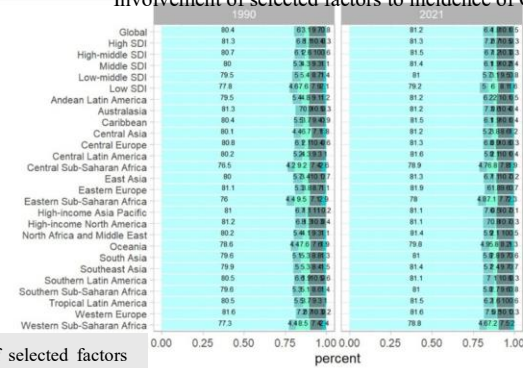


Figure 4 the molecular mechanism of aging of kidney (Source: Chou and Chen 2021)

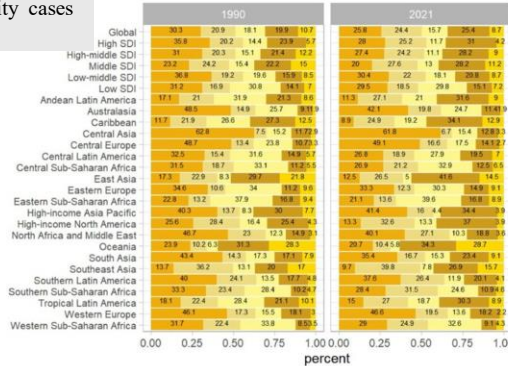
Involvement of selected factors to incidence of ChKD



Involvement of selected factors to incidence of ChKD



Involvement of selected factors to mortality cases of ChKD



Involvement of selected factors to Dialysis cases of ChKD

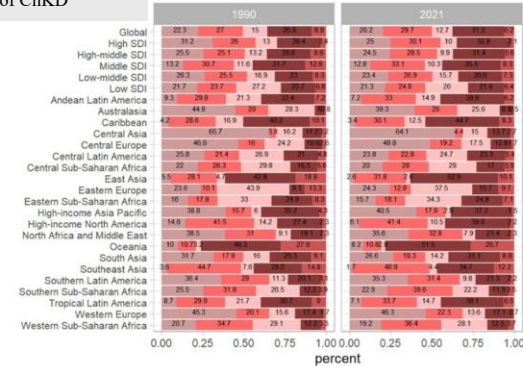


Figure 5 Further causes of ChKD established in the literature (Source: Guo et al., 2025a)

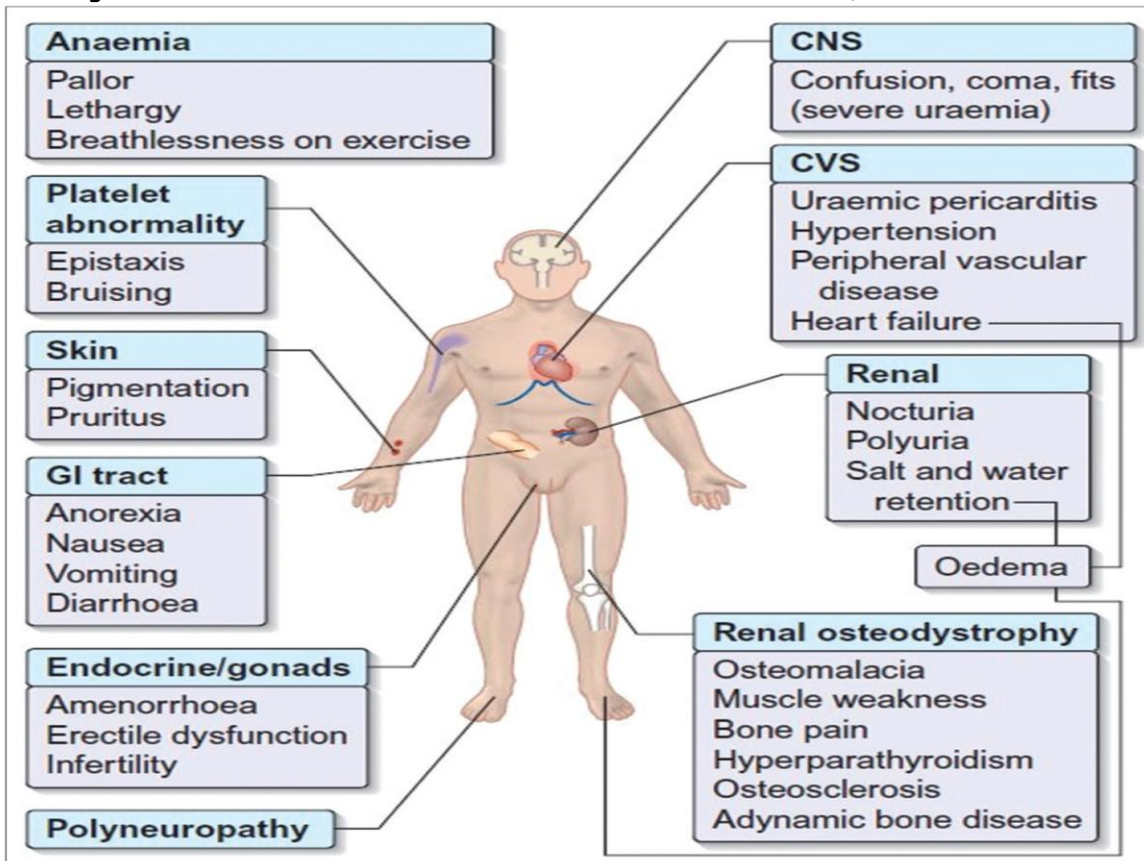


Figure 6 presents the common symptoms of ChKD found with man (Source Akpor et al., 2021)

- d. Analysis of national, global and regional burden of ChKD (Zhang et al., 2008; Zhang and Rothenbacher, 2008; Ying et al., 2024; Chen et al., 2025; Wang et al., 2025a, c and b; Wei et al., 2024; Guo et al., 2025a and b; Cao et al., 2025; Chatterjee and Prabhakar, 2025; Lopez-Garrigos et al., 2025; Malyszko et al., 2025; Meshram et al., 2026; He et al., 2025; Qiang et al., 2025; Pan et al., 2025; Xu et al., 2025; Yu et al., 2025; Hallan et al., 2006; Jiang and Zhang, 2025; Krol-Kulikowska et al., 2025; Leevey et al., 2007; Li et al., 2025a and b; Mills et al., 2015; Mitra et al., 2024; Mitsides et al., 2023; Mohammed et al., 2024; Osunde 2025; Nwankwo et al., 2006; Owasa et al., 2023; Rafferty et al., 2025; Ricardo et al., 2015; Sapna et al., 2025; Webster et al., 2017; White et al., 2005; 2025; Woo et al., 2012; Yamagata, 2023; Yin et al., 2022; Zhao et al., 2021 and Huang et al., 2025), and
- e. Imaging kidney, kidney stone imaging techniques and kidney stone detection (Bribane et al., 2016; Ebrahimi and Mariano, 2015; Rao, 2004; Ibrahim et al., 2018).

In all these previous studies, data and information on kidney diseases, the issues and challenges of kidney problems in Maiduguri, Nigeria is limited in all these documents and literature. The current research conducted a desktop review on ChKDs and examined various records, trends of kidney disease in Maiduguri, utilising records available in Maiduguri Teaching Hospital

## MATERIALS AND METHODS

In this study on kidney diseases, the issues and challenges related to kidney problems are explored. Information, recent and relevant data such as numerical values, figures and images were extracted and collected from relevant databases utilizing several search engines and links such as PubMed link; Taylor and Francis Online link, ScienceDirect link, Scopus link, Google Scholar link, Web of Science link, Wiley Online Library link, Elsevier link, SpringerLink, American Chemical Society Publications link, Magiran link, Multi Digital Publication Institute link, Frontiersin link, and Royal Society of Chemistry Publishing link utilising the keywords such as kidney, kidney disease, hypertension, adults, young trend of kidney disease, male, female, disease progression, low protein, renal, chronic disease, non-communicable disease, obesity and kidney disease in Maiduguri, individually and in combination. In summary, a desktop review was conducted using the keywords. In addition, the records and trends of kidney disease in Maiduguri were studied using records available in the University of Maiduguri Teaching Hospital. The outcome of the literature search, data, and records of kidney diseases were analysed statistically,

utilising Microsoft Excel, and the effects of selected factors on the trend of kidney disease were established.

## RESULTS AND DISCUSSIONS

Results from this study are discussed in the following categories: desktop review, publications on global burden of non-communicable diseases; global, regional, and international burden of ChKD; trend of ChKD globally and population growth in Maiduguri, population of ChKD patients in Maiduguri, trend of ChKD in Maiduguri and effects of selected factors on trend of ChKD in Maiduguri.

### a. Desktop Review

The desktop review provides 18280 publications (journal articles, books, conference proceedings) available on the stated keywords through several search engines globally. Figure 7a presents the trend of various publications, data, and information on the kidney, kidney disease, several types and categories of kidney diseases, causes and treatment of various kidney diseases. The figure revealed that there are five stages or phases of these publications. The first phase, which was the early exponential phase, was between 1900 and 1950. This phase provides basic information and data on the structure of normal and diseased kidneys with basic remediation solutions. Between 1930 and 1980 was a linear progression, which can be said to

provide further data and information on the initial basic data and information. The second exponential phase of the publications was between 1980 and 2005, which was a period of the development of kidney disease detection techniques, while between 2005 and 2012 was seen as experimental utilisation of the new detection techniques. The last phase, which started from 2012, was an exponential stage due to advances in technologies and the availability. Figure 7b shows the involvement of various links and search engines to the number of publications on the kidney, kidney disease, several types and categories of kidney diseases, causes and treatment of various kidney diseases.

Figures 8a and 8b present data and information on the kidney, kidney disease, several types and categories of kidney diseases, causes and treatment of various kidney diseases between 2011 and 2020 and well as journals that contributed 2 or more publications on the keywords. Figure 8c shows countries with high-quality publications on kidney and kidney disease. Figure 9 shows the overlay visualisation map of selected keywords according to the selected publication periods. Results from Figures 8 and 9 established that there is an increase in the publications of the selected keywords even in the professional journals. Conference proceedings and books.

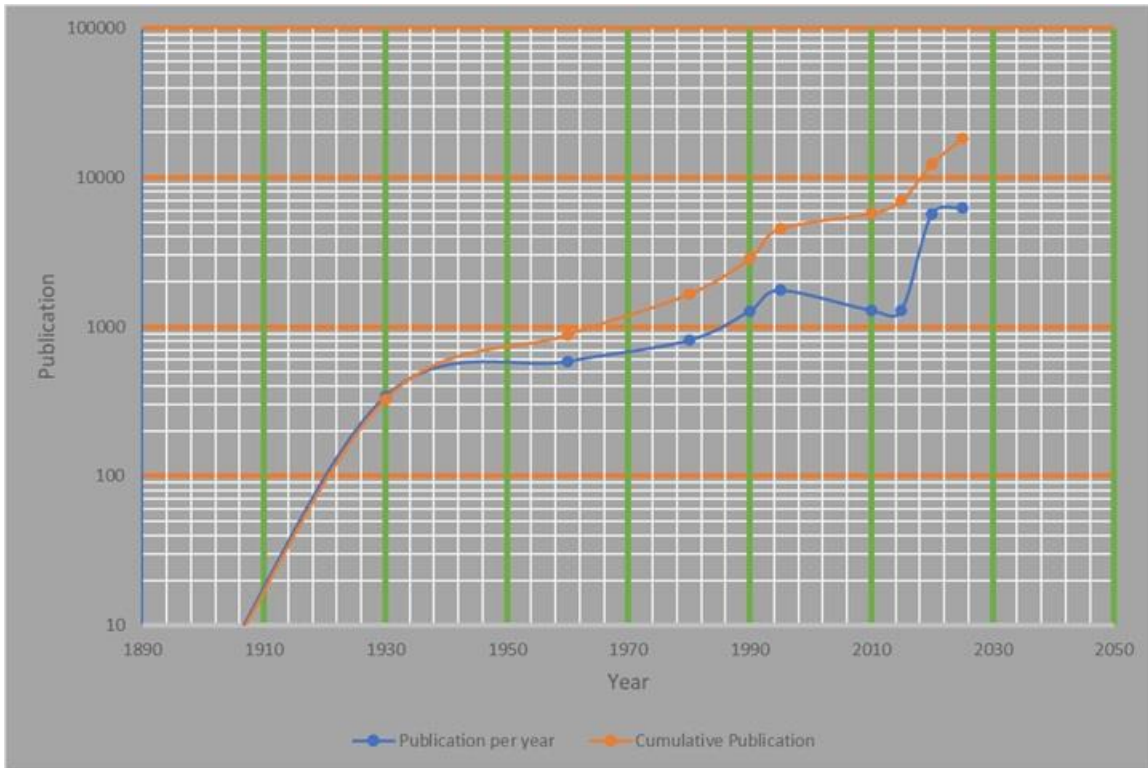


Figure 7a the trend of various publications, data, and information on the kidney, kidney disease, several types and categories of kidney diseases, causes and treatment of various kidney diseases

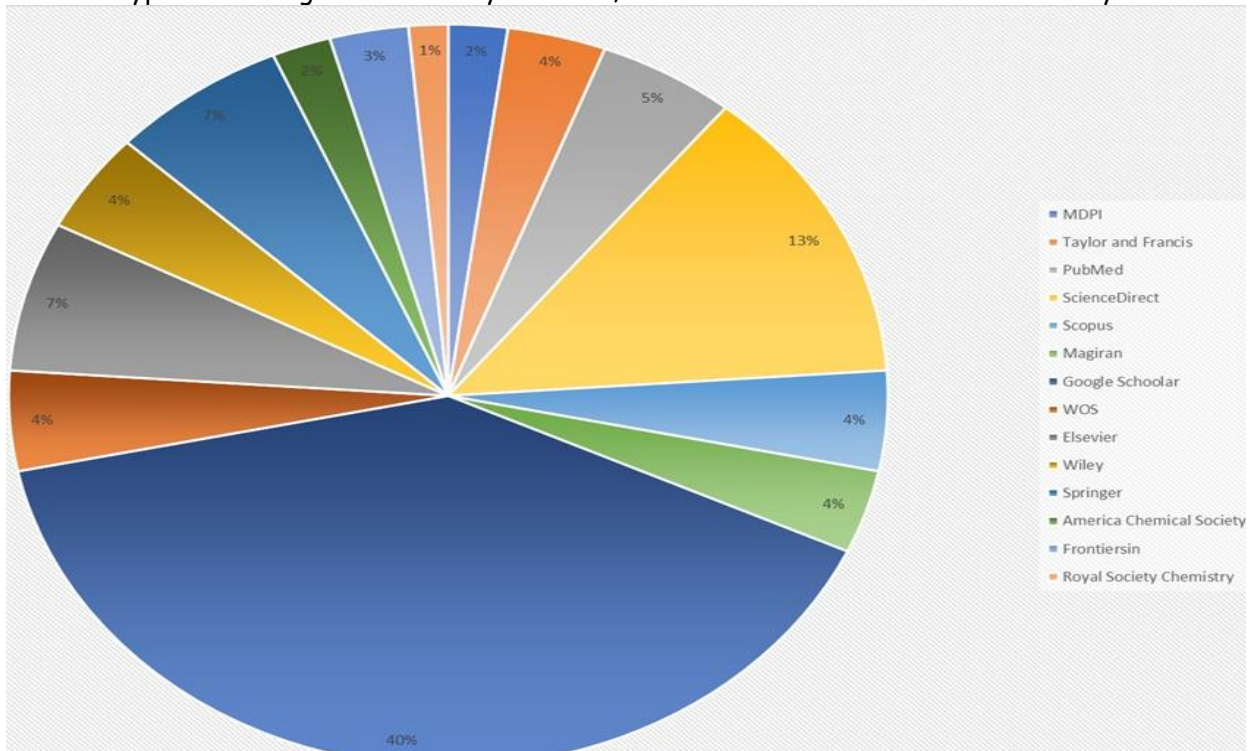


Figure 7b contribution of various links and search engines to the number of publications on the kidney, kidney disease, several types and categories of kidney diseases, causes, and treatment of various kidney diseases

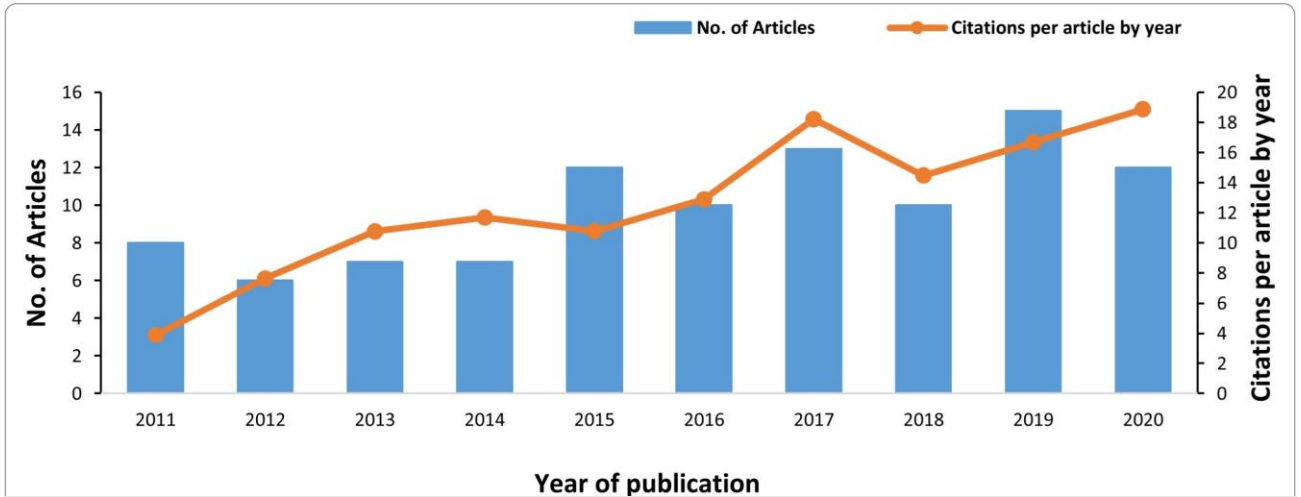


Figure 8a data and information on the kidney, kidney disease, several types and categories of kidney diseases, causes and treatment of various kidney diseases between 2011 and 2020 (Source: Yin et al., 2022)

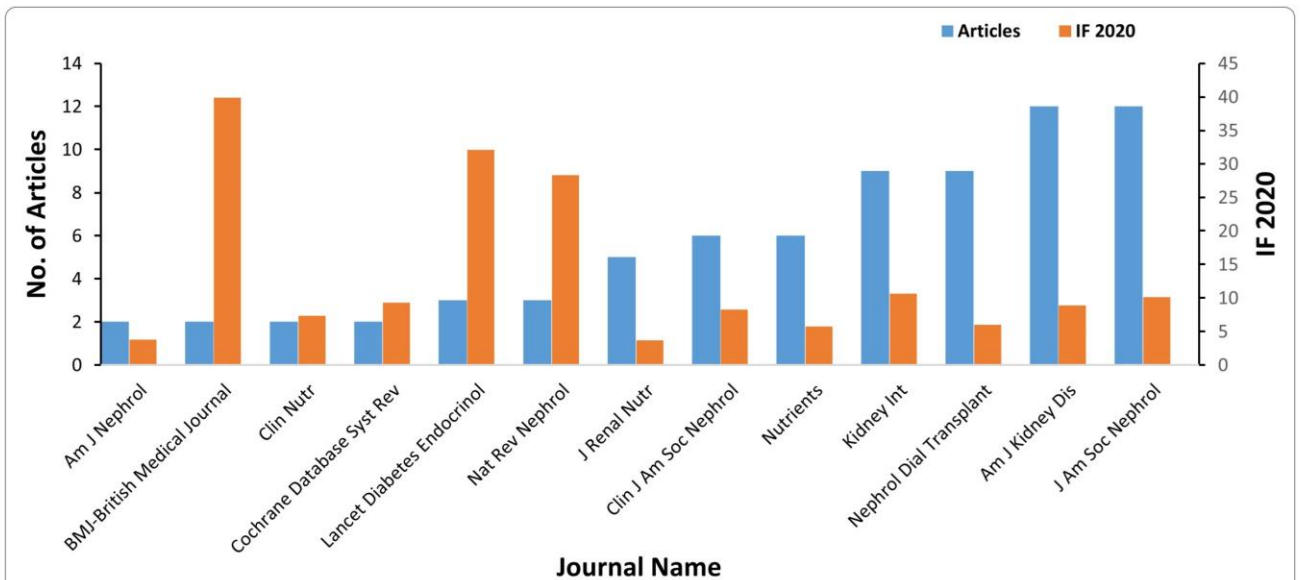


Figure 8b: Journals that contributed 2 or more publications on the keywords. data and information on the kidney, kidney disease, several types and categories of kidney diseases, causes and treatment of various kidney diseases between 2011 and 2020 (Source: Yin et al., 2022)



In addition, these figures revealed that developed countries are working hard on ways to address kidney disease problems, which indicates that African and Asian countries must not be left behind.

**Publications on global burden of non-communicable diseases; global, regional, and international burden of chronic kidney disease; trend of chronic kidney disease globally**

Literature such as Zhang et al. (2008); Zhang and Rothenbacher (2008); Ying et al. (2024); Chen et al.(2025); Wang et al.(2025a, c and b); Wei et al.(2024); Guo et al.(2025a and b); Cao et al.(2025); Chatterjee and Prabhakar(2025); Lopez-Garrigos et al.(2025); Malyszko et al.(2025); Meshram et al.(2026); He et al.(2025); Qiang et al.(2025); Pan et al.(2025); Xu et al.(2025); Yu et al.(2025);Hallan et al.(2006); Jiang and Zhang(2025); Krol-Kulikowska et al.(2025); Leevey et al.(2007); Li et al.(2025a and b); Mills et al.(2015); Mitra et al.(2024);Kovesdy (2022); Lakkis and Weir (2018); Lao et al. (2024); Mitsides et al.(2023); Mohammed et al.(2024); Osunde 2025); Nwankwo et al.(2006); Ovwasa et al.(2023); Rafferty et al.(2025); Ricardo et al.(2015); Sapna et al.(2025); Webster et al.(2017); White et al.(2005; 2025); Woo et al.(2012); Yamagata (2023); Yin et al.(2022).

Zhao et al. (2021 and Huang et al. (2025) information on global burden of non-communicable diseases; global, regional, and international burden of ChKD; trend of ChKD globally. Figures 10 to 14 provide information on the global burden of non-communicable diseases; the global, regional, and international burden of ChKD; trend of ChKD globally. Figure

10a shows the incidence of ChKD worldwide in 1990.

Figure 10b presents incidence of ChKD worldwide in 2021 Figure 10c shows the seath due to ChKD globally in 1990 Figure 10d presents death due to ChKD globally in 2021 Figure 11a shows AS incidence rates of ChKD between 1990 and 2021 Figure 11b shows AS incidences of mortality rates of ChKD between 1990 and 2021 Figure 11c shows the AS disability adjusted life years rates of ChKD between 1990 and 2021 Figure 11d presents AS incidence rates of ChKD between 1990 and 2021 Figure 11d shows AS incidence rates of ChKD between 1990 and 2021 Figure 12 presents Worldwide distribution and AAnPCs in AS incidence rates per 100 000 of ChKD at the national level. Figure 12a shows ASi rates of ChKD in 1990.

Figure 12b shows ASi rates of ChKD in 2021. Figure 12c presents ASi rates of ChKD in 2022. Figure 12d shows ASi rates of ChKD in 2030. Figure 12d shows AAnPCs of ChKD and ASi rates between 1990 and 2030. Figure 13 shows changes in the population of ChKD new cases between 1990 and 2030 globally in relation to aetiology and sex. Figure 14 presents the burden of ChKD assigned to high fasting plasma glucose by age and sex. The all-cause AS mortality rate and AS disability adjusted life years rates of ChKD are assigned to high fasting plasma glucose globally in different age groups. All these figures revealed that there are significant regional, national and global disparities in the global burden of non-communicable diseases; global, regional, and international burden of ChKD; trend of ChKD.(Li et al., 2025a)  $6.74 \times 10^8$  individuals were affected worldwide in 2021,

with an AS incidence rate of a 0.8% decrease from 1990. The AS incidence rate was a modest increase of 0.5% in high-income North American countries, which indicates a stable global burden, the mortality rate was high at 20.6 %, and disability adjusted life years rates improved significantly with 90.8%.

In East Asia, it was a substantial reduction in the AS incidence rate (11.7%), with a notable decline in mortality (11.1%) and disability adjusted life years rates, indicating effective disease management. Sub-Saharan Africa continued to display a high AS incidence rate of 8324.3% in the West Sub-Saharan Africa, 9037.9% in the South Sub-Saharan Africa, and 9165.2% in the central Sub-Saharan Africa, with corresponding increases in disability adjusted life years rates in Central Asia and Southeast Asia. In addition, the highest AS incidence rate in Central Asia and Southeast Asia, with Southeast Asia establishing particularly high mortality and disability adjusted life years rates (Li et al., 2025a; Wei et al., 2024; Shahbazi et al 2025; Li et al 2025b; Cao et al., 2025; Chatterjee and Prabhakar, 2025; Lopez-Garrigos et al., 2025;

Malyszko et al., 2025; Meshram et al., 2026; He et al., 2025; Qiang et al., 2025; Pan et al., 2025; Xu et al., 2025; Yu et al., 2025; Yin et al., 2022; Jiang and Zhang, 2025; Krol-Kulikowska et al., 2025; Ying et al., 2024; Levey and Coresh, 2012; Loausa et al., 2020; Luyckx et al., 2017; Rabelink and Little (2013); Romagnani et al., 2017; Rossing et al., 2024; Ruiz-Ortega et al., 2020).

In the case of Central Asia and Southeast Asia, with Southeast Asia, significant reductions in mortality rate in terms of ChKD and Dialy, indicating a robust benefit of the healthcare system. Overall, regions with low Socio-Demographic Indexes (SoDI), such as South Asia and Sub-Saharan Africa, had the heaviest ChKD burdens, compared to high-income regions such as the high-income regions of Western Europe and Asia Pacific, which had fairly lighter ChKD burdens. In the case of incidence trends, from 1990 to 2021, there are some countries that have experienced rapid increases in ChKD incidence. These countries are Guatemala (9.8%), Cameroon in West Africa (9.3%), Tanzania in East Africa (9.2%), Nicaragua (8.6%), and Oman (7.1%).

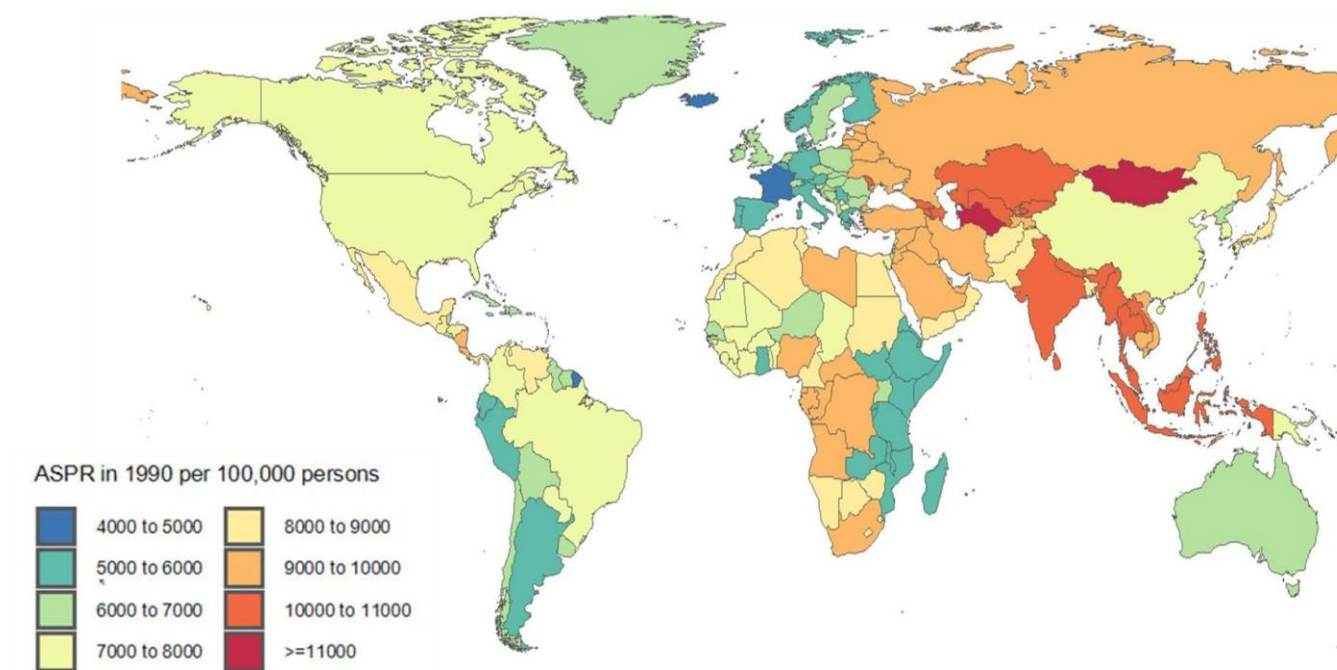


Figure 10a Incidence of ChKD worldwide in 1990 (Source: Li et al 2025a)

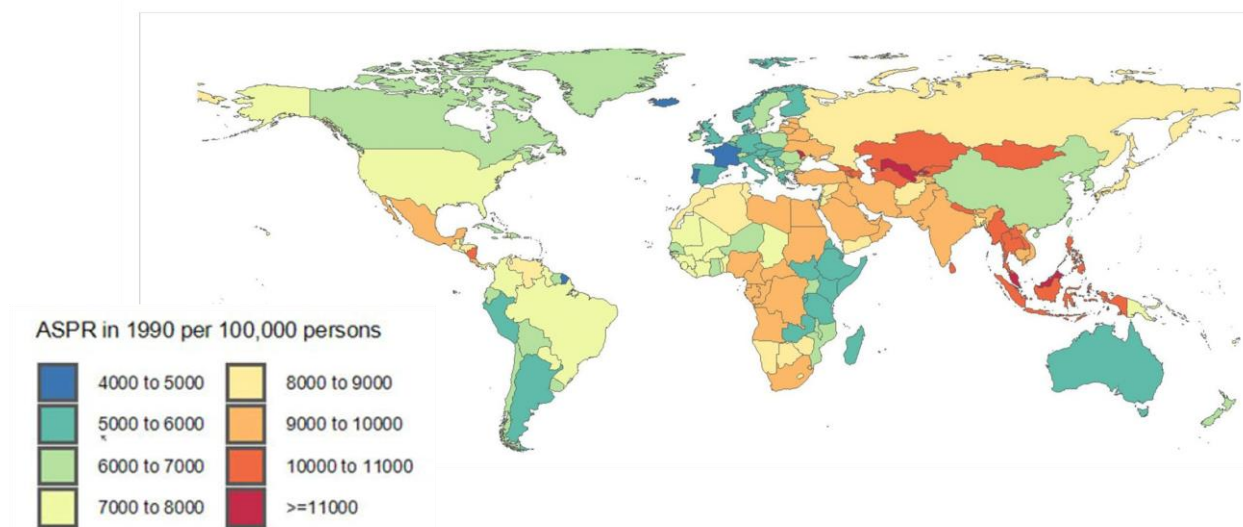


Figure 10b Prevalence of ChKD worldwide in 2021 (Source: Li et al 2025a)

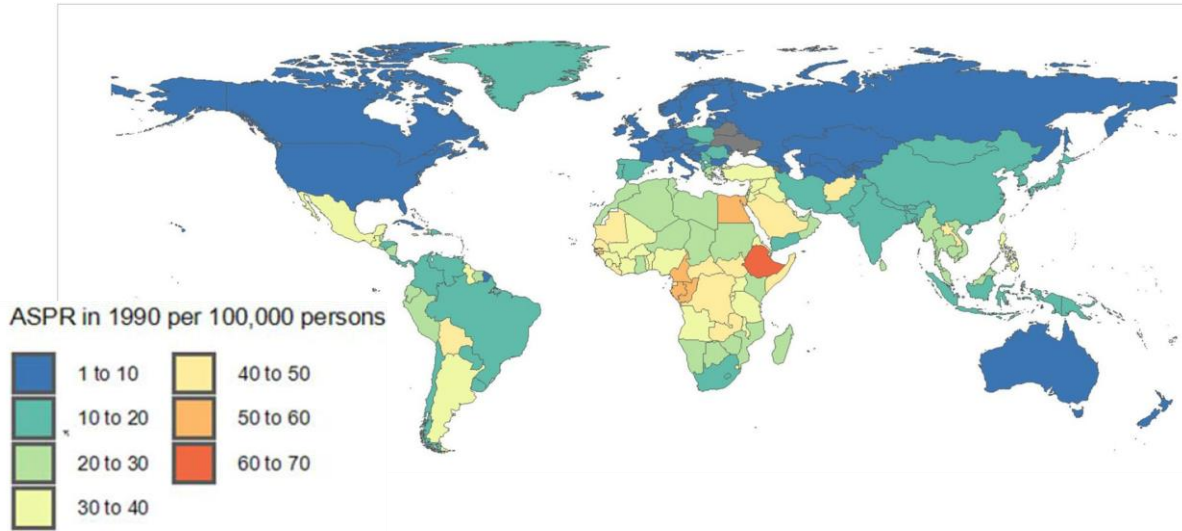


Figure 10c Death due to ChKD globally in 1990 (Source: Li et al 2025a) (ASPR Age-standardised prevalence rate)

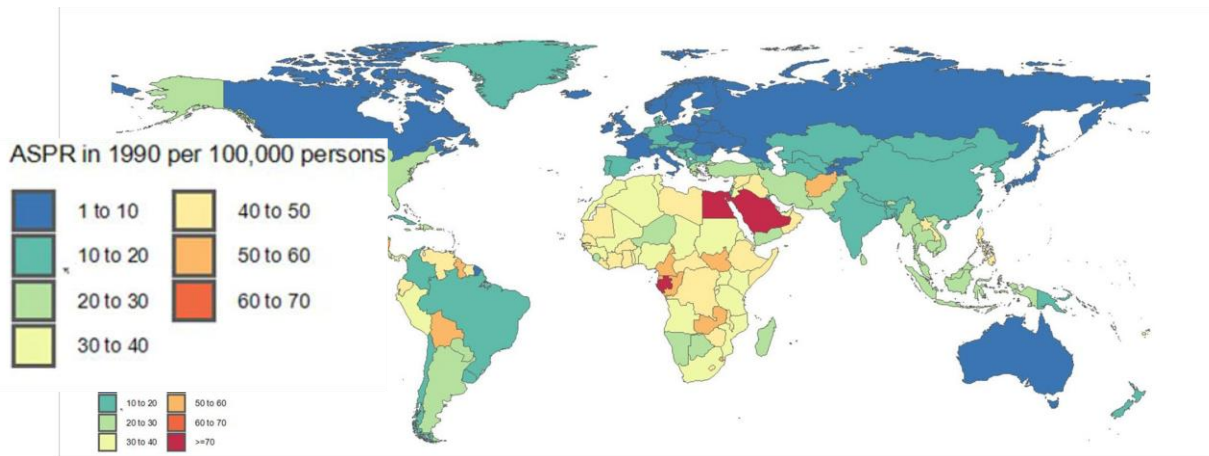


Figure 10d Death due to ChKD globally in 2021 (Source: Li et al 2025a)

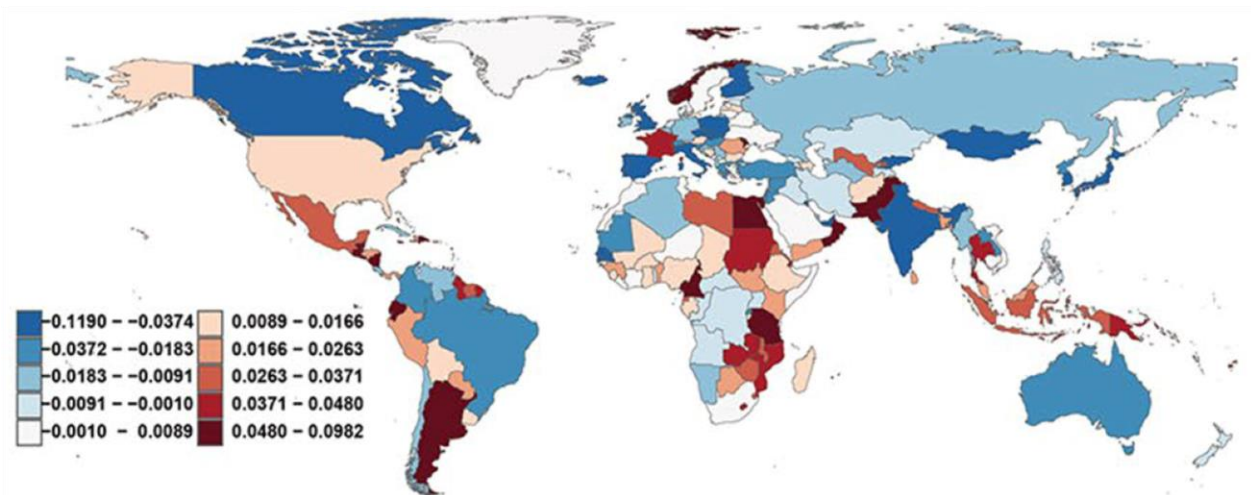


Figure 11a AS incidence rates of ChKD between 1990 and 2021 (Source: Li et al 2025b)

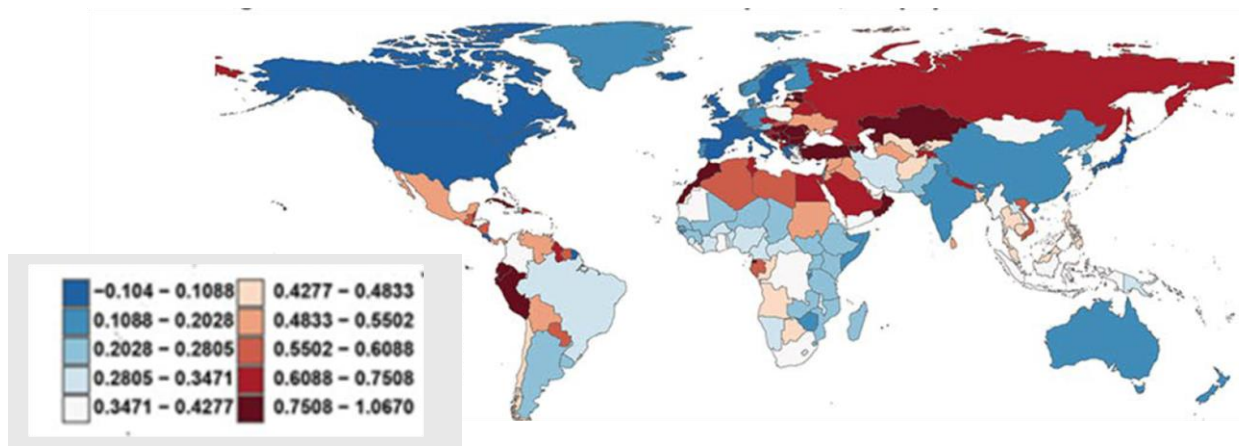


Figure 11b AS mortality rates of ChKD between 1990 and 2021 (Source: Li et al 2025b)

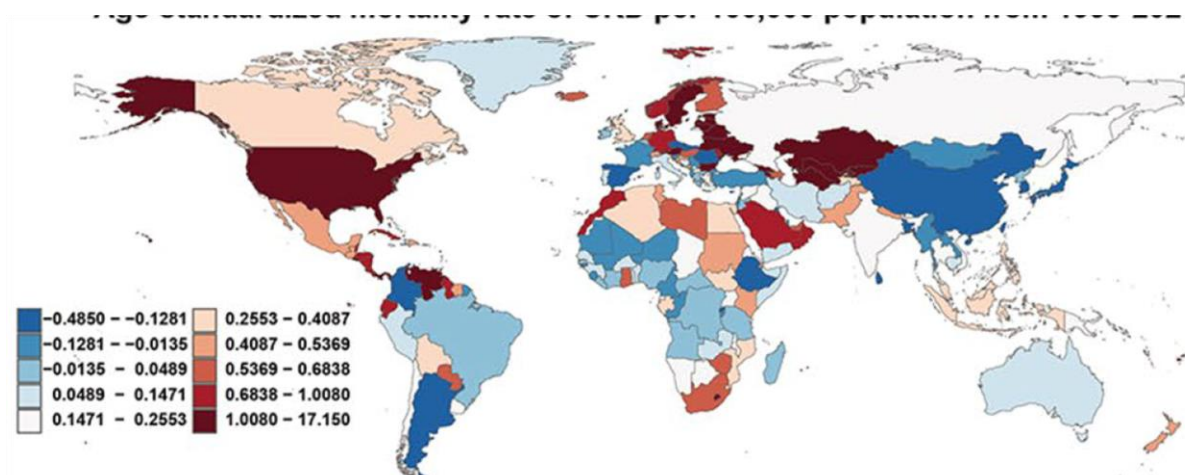


Figure 11c AS disability adjusted life years rates of ChKD between 1990 and 2021 (Source: Li et al 2025b)

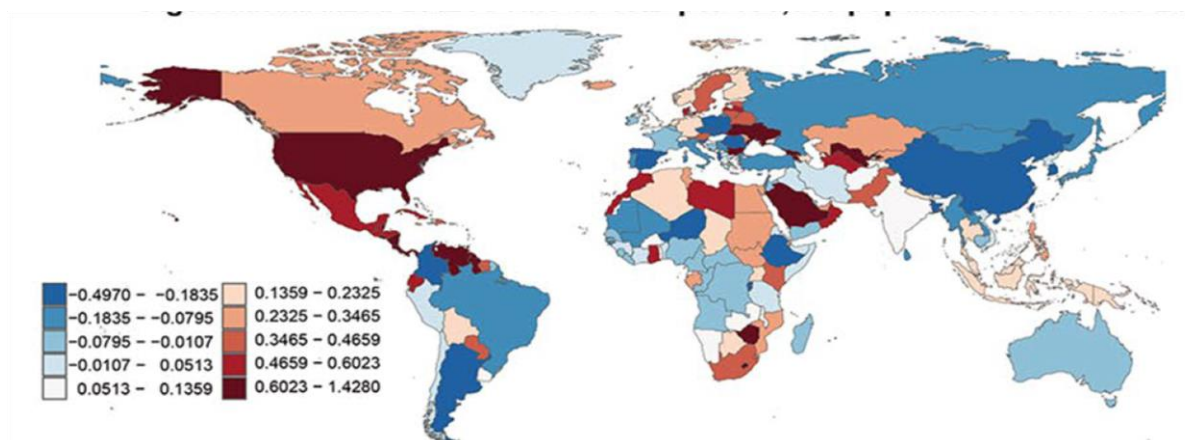


Figure 11d AS prevalence rates of ChKD between 1990 and 2021 (Source: Li et al 2025b)

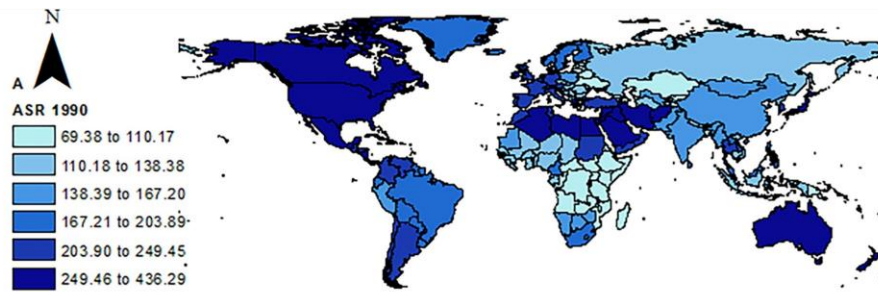


Figure 12a: ASR of ChKD in 1990

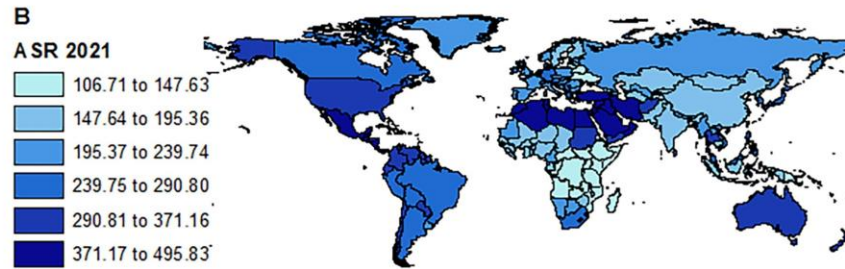


Figure 12a: ASR of ChKD in 1990

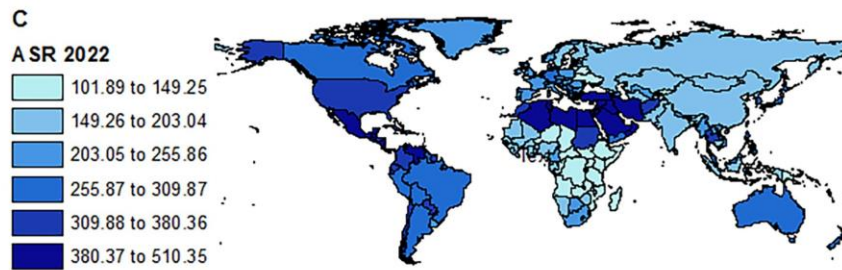


Figure 12c: ASR of ChKD in 2022

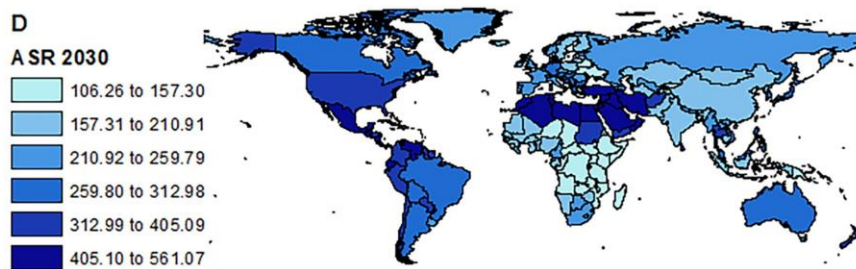


Figure 12d: ASR of ChKD in 2030

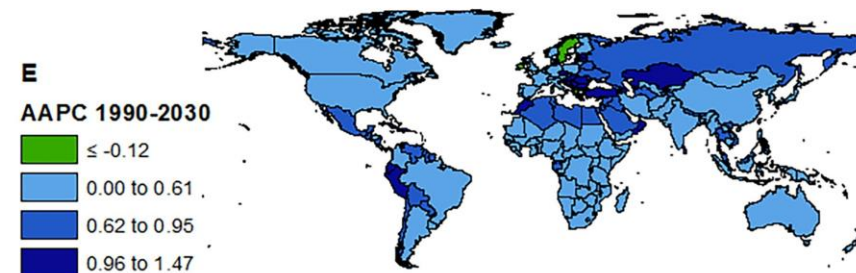


Figure 12d: AAPC of ChKD ASR between 1990 and 2030

Figure 12 Worldwide distribution and average annual percentage changes (AAPCs) in ASi rates per 100 000 of ChKD at the national level. (Source Shahbazi et al., 2025)

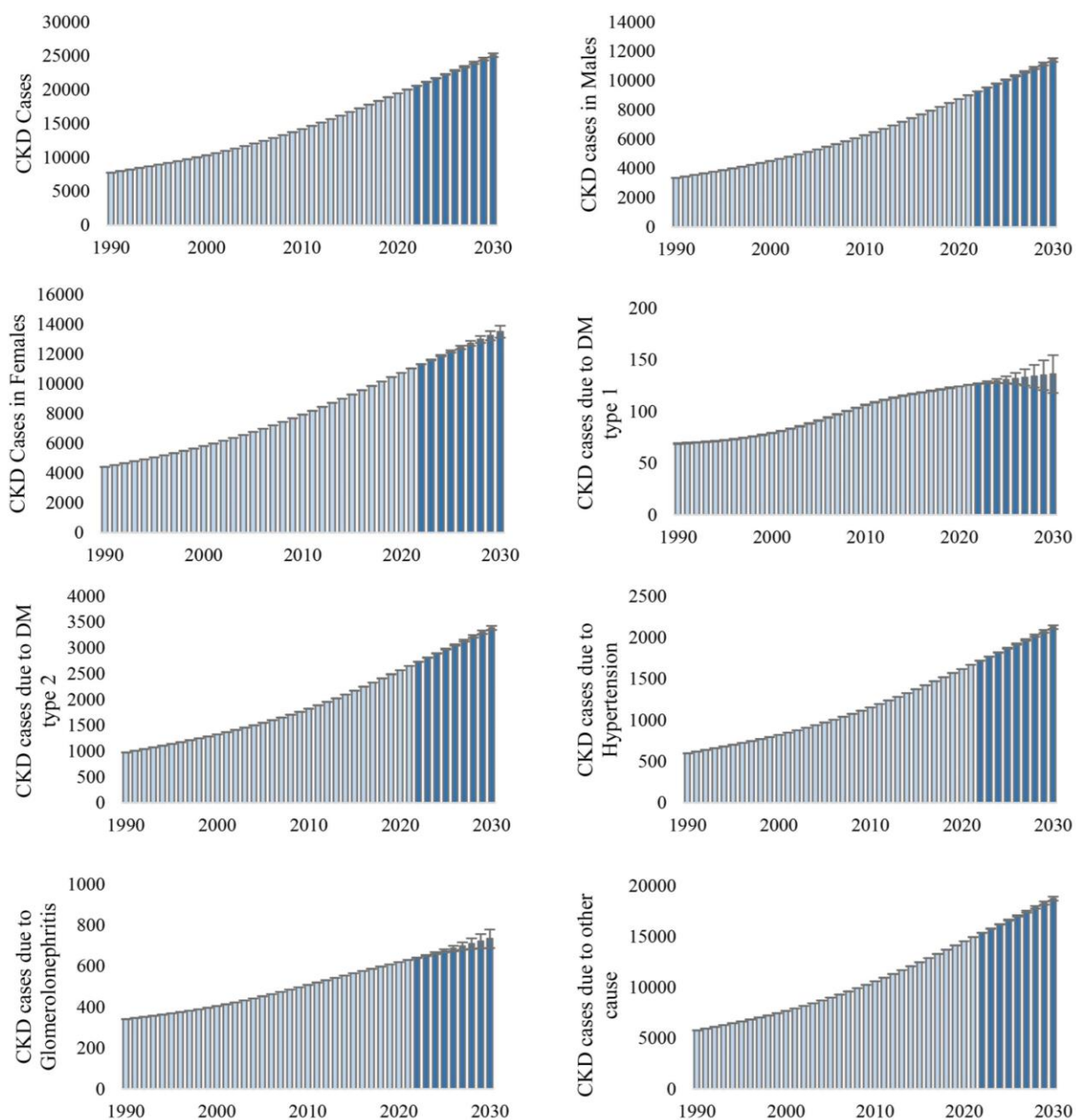


Figure 13 Changes in the population of ChKD new cases between 1990 and 2030 globally in relation to aetiology and sex.(Source Shahbazi et al 2025)

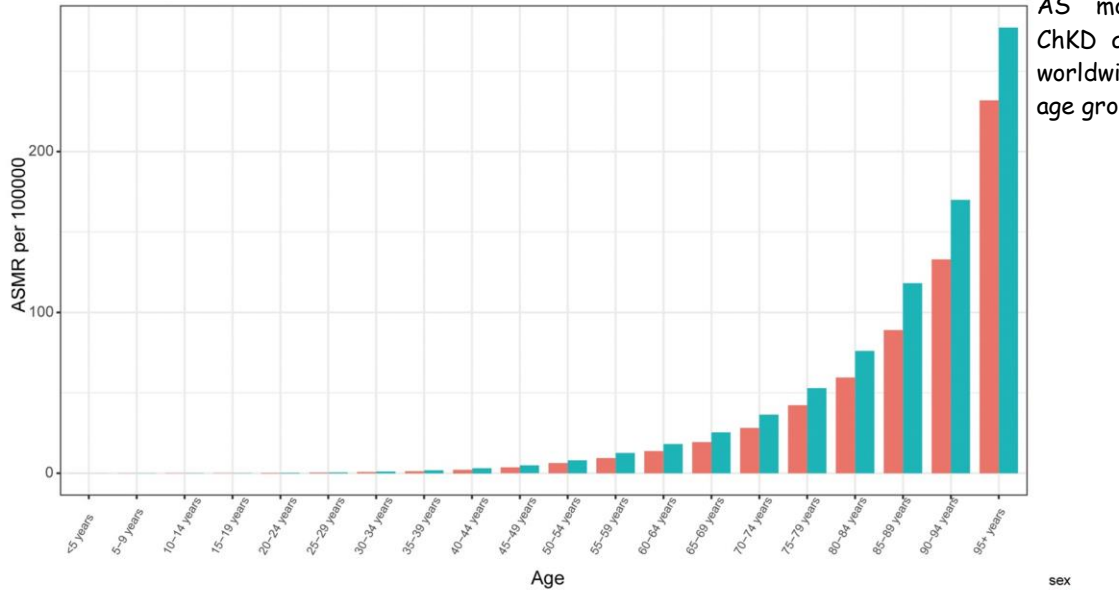


Figure 14 a: The all-cause AS mortality rate of ChKD assigned to HFPG worldwide in different age groups.

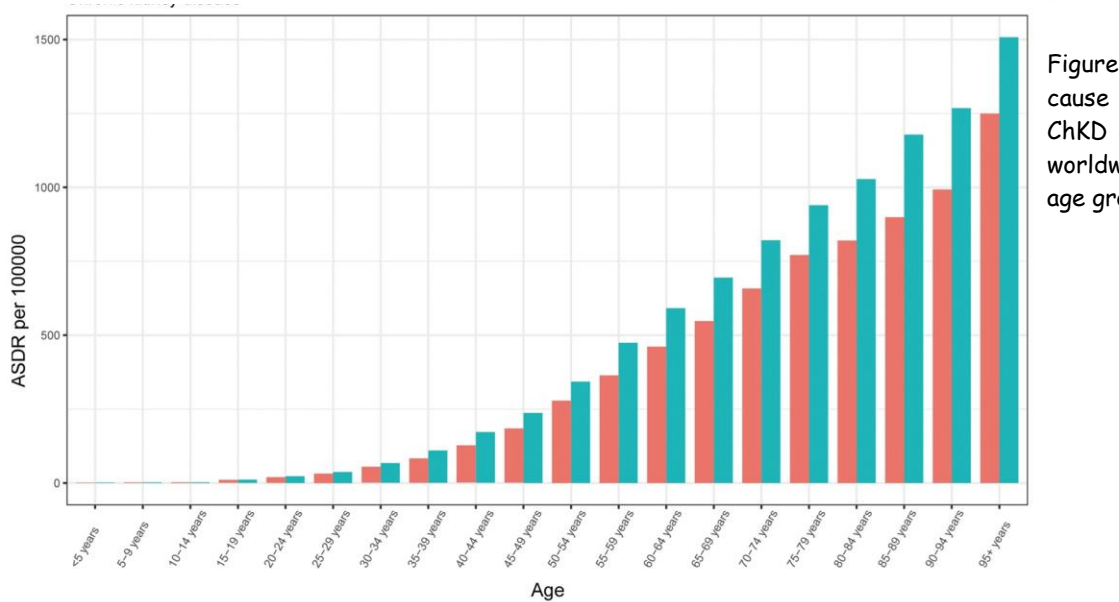


Figure 14 b: The all-cause AS Dialy rate of ChKD assigned to HFPG worldwide in different age groups.

Figure 14: The burden of ChKD assigned to high fasting plasma glucose by age and sex. (Source: Wei et al., 2024)

These increases in ChKD incidence indicate a growing concern on ChKD burden across and within these nations (Li et al., 2025a; Wei et al., 2024; Shahbazi et al 2025; Li et al 2025b; Cao et al., 2025; Chatterjee and Prabhakar, 2025; Lopez-Garrigos et al., 2025; Malyszko et al., 2025; Meshram et al., 2026; He et al., 2025; Qiang et al., 2025; Pan et al., 2025; Xu et al., 2025; Yu et al., 2025; Yin et al., 2022; Jiang and Zhang, 2025; Krol-Kulikowska et al., 2025; Ying et al., 2024).

Equally, from 1990 to 2021, there are some countries that have experienced significant improvement in the reduction of ChKD. These countries are Italy (9.5%), Taiwan in the Province of China (8.2%), Spain (8.1%), Canada (7.1%), and Portugal (6.8%). These reductions in ChKD incidence in these stated countries are reflection of substantial progress in ChKD control management and prevention. In the case of Mortality trends of ChKD, between 1990 and 2021, there are some countries that experienced the fastest and most rapid or increases in mortality. These countries are Ukraine (1714.7%), Armenia (953.1%), Georgia (272.5%), Belarus (182.4%), and Uzbekistan (182.1%).

These substantial increases in the mortality trend of ChKD emphasize a worsening ChKD burden in and around these stated countries. Unlike Ukraine, Armenia, Georgia, Belarus, and Uzbekistan, there are some countries that experienced notable reductions and improvements in the mortality rate in ChKD. These countries are Poland (48.5%), Kuwait (47.9%), Cyprus (47.8%), the Republic of Korea (41.8%), and the Maldives (40.3%). These reductions and improvements highlight vital and significant advancements in technologies, ChKD management with available treatment facilities (Li et al., 2025a; Wei et al., 2024; Shahbazi et al 2025; Li et al 2025b; Cao et al., 2025; Chatterjee and Prabhakar, 2025; Lopez-Garrigos et al., 2025; Malyszko et al., 2025; Meshram et al., 2026; He et al., 2025; Qiang et al., 2025; Pan et al., 2025; Xu et al., 2025; Yu et al., 2025; Yin et al., 2022; Jiang and

Zhang, 2025; Krol-Kulikowska et al., 2025; Ying et al., 2024).

In the case of Dially trends in ChKD, between 1990 and 2021, there are some countries that experienced the largest increases in the value of Dially. These countries are El Salvador (142.8%), Armenia (126%), Lesotho (117.9%), Venezuela (106%), and American Samoa (104.7%). These increases and trends established a substantial and complex worsening of the ChKD burden within and around these countries. Contrary to observations in countries like El Salvador, Armenia, Lesotho, Venezuela, and American Samoa, there are some regions and countries that show significant improvements and reduction in the case of Dially trends in ChKD.

These highlighted countries are Kuwait (49.7%), Poland (49.2%), the Maldives (46.6%), Ethiopia (45.3%), and Cyprus (42.8%). These reductions and improvements established a remarkable success and achievement in comprehensive ChKD prevention, management and intervention efforts. Age and sex distribution in the case of ChKD between 1990 and 2021, the figure revealed that the incidence of ChKD began to increase noticeably in both males and females at ages between 20 and 24. It was established that as the age of these individuals' advances, the incidence of ChKD increases and the incidence was at peak between 65 and 69 years for males and at peak between 70 and 74 years for females. It was observed that after the peak years, the incidence of ChKD declined for both males and females. It was observed that between 30 and 34 age group, the incidence in ChKD among females is more than the incidence rate in ChKD among males. The higher level trend of the females was maintained consistently thereafter (Li et al., 2025a; Wei et al., 2024; Shahbazi et al 2025; Li et al 2025b; Cao et al., 2025; Chatterjee and Prabhakar, 2025; Lopez-Garrigos et al., 2025; Malyszko et al., 2025; Meshram et al., 2026; He et al., 2025; Qiang et al., 2025; Pan et al., 2025; Xu et al., 2025; Yu et

al., 2025; Yin et al., 2022; Jiang and Zhang, 2025; Krol-Kulikowska et al., 2025; Ying et al., 2024).

#### **Socio-Demographic Index and disability-adjusted life years correlation:**

Figures established that between 1990 and 2021 the SoDI increases, ChKD burden initially reduces and declines but later rises again around a SoDI value of 0.6. It was observed that some regions show a reverse pattern. Dialy rates increase with the SoDI until a specific point before its reduction. These observations are common in some regions such as Western Europe, Southern sub-Saharan Africa, and Central America. Some regions, like Central America, and Central sub-Saharan Africa have higher-than-expected ChKD burdens, while Tropical Latin America and South Asia experience lower-than-expected ChKD burdens.

#### **Risk Factor Analysis chronic kidney disease:**

Figure 15 provides the key selected health factors of risk to ChKD with their involvement in to Dialys. The figure provides a n summary of the primary and basic health risk factors associated with ChKD and their relative involvements to Dialy. Globally, the key risk factors are high systolic blood pressure (HSBP, 24.8%), HFPG (36%), low fruit intake (7.4%), high body mass index (23.4%), low vegetable intake (5.9%), low temperature (3.8%), high sodium intake (3.8%) and lead exposure (3.4%).

Regionally, HFPG contributes most significantly to Dialy, especially in the Caribbean (54.1%), High-Income North America (50.8%), Oceania (49.7%), and Tropical Latin America (49.4%). HSBP is particularly impactful in Central Europe (35.1%), followed by Tropical Latin America (33.2%) and Western Europe (31.5%). High body mass index exerts the greatest influence and impacts in High-Income North America (42.8%), Tropical Latin America (38.8%), and Oceania (37.4%). Additionally, low fruit intake plays a notably significant role in the Middle East (15%) and East Asia (12%) (Li et al., 2025a; Wei et al., 2024; Shahbazi et al 2025; Li et al 2025b; Cao et al., 2025; Chatterjee and

Prabhakar, 2025; Lopez-Garrigos et al., 2025; Malyszko et al., 2025; Meshram et al., 2026; He et al., 2025; Qiang et al., 2025; Pan et al., 2025; Xu et al., 2025; Yu et al., 2025; Yin et al., 2022; Jiang and Zhang, 2025; Krol-Kulikowska et al., 2025; Ying et al., 2024).

In summary, literature and desktop review revealed that high body mass index, HFPG, and HSBP as fundamental global risk factors for ChKD with a varying involvement across regions. These involvements across the regions are as follows:

- a) Caribbean and High-Income North
- b) In high-income North America and the Caribbean, it was HFPG, and
- c) In Central Europe and Tropical Latin America, it was the impact of HSBP.

Such regional and international variations indicate the need for regional and internal specific risk ChKD factor mitigation plans and techniques.

#### **Population growth in Maiduguri, population of chronic kidney disease patients in Maiduguri, trend of chronic kidney disease in Maiduguri and effects of selected factors on the trend of chronic kidney disease in Maiduguri.**

Figures 16 to 19 provide information and data on population growth in Maiduguri, population of ChKD patients in Maiduguri, trend of ChKD in Maiduguri and effects of selected factors on the trend of ChKD in Maiduguri. A desktop review on ChKD in Maiduguri provides 1790 publications (journal articles, books, conference proceedings) available on the stated keywords through several search engines globally. Figure 16a presents the incidence of ChKD among 1,686 participants utilised in literature (Mohammed et al., 2024).

The study established that 366 participants had ChKD, which indicates 21.7%, 218 (59.6%) females had ChKD and 148 males had ChKD. Statistical evaluation established that there was a significant difference between the genders with ChKD (F-value = 17.598,  $p= 0.0001$ ). The significant risk factors for ChKD among the participants in

Maiduguri were age, female sex, body mass index (greater than 25 kg/m<sup>2</sup>), hyperuricaemia, and systolic hypertension. In the study, the other risk factors in ChKD that were not significant were the use of non-steroidal anti-inflammatory drugs, herbal drugs, a history of Pregnancy-induced hypertension, Use bleaching cosmetics, and a family history of kidney disease. Figure 17b shows information on the incidence rate of ChKD in selected wards (10) in Maiduguri. The figure revealed that Gwange ward had the highest incidence of ChKD of 30.5%, and Mairi ward had the lowest, 15.6%.

This result shows that occupation (Driver, Retired, Farmer, Civil servant, Tailor, Manual labourer, Housewife, Security, and Mechanic) and environmental (air and water quality) factors can contribute to ChKD. More on other health, environmental pollution, environmental health, water and sanitation practices, factors that influence ChKD worldwide can be established in the literature such as Schumacher et al.(2021); Selby and Taal (2024); Thomas et al. (2016); Zhang et al. (2015); Francis et al. (2024); GBD (2020); KDOQI (2002); Sulaiman et al. (2018); Kaze et al. (2018); Olarenwaju et al. (2020); Chukwonye et al. (2018); USRDS (2023); Csaba (2022);Poudyal et al. (2022); Abd-ElHafeez et al. (2018); Garcia-Garcia et al. (2015); Wokoma et al.( 2016); Chen et al.

(2009); Sundstrom et al. (2022); Hill et al. (2016); Hannan et al. (2021); Abu et al. (2019).

Figure 17a presents the number of publications on ChKD in Maiduguri. The figure provides 1790 publications (journal articles, books, conference proceedings) available on the stated keywords (on ChKD in Maiduguri) through several search engines. The figure revealed that publications on ChKD in Maiduguri can be grouped into three stages or phases.

The first phase, which was the early exponential phase, was between 1950 and 1995. This phase provides basic information and data on the awareness of diseased kidneys with basic remediation solutions. Between 1995 and 2020, it was a linear progression, which can be said to provide further data and information on the initial basic data and information. The second exponential phase of the publications was between 2020 and 2025, which was a period of the development of kidney disease detection techniques, and experimental utilization of the new detection techniques. Figure 17b shows the number of publications on ChKD in Maiduguri based on the link and search engine. The figure established that Google Scholar provided the highest number of publications (50%), which can be assigned to the multifunctionality of the link

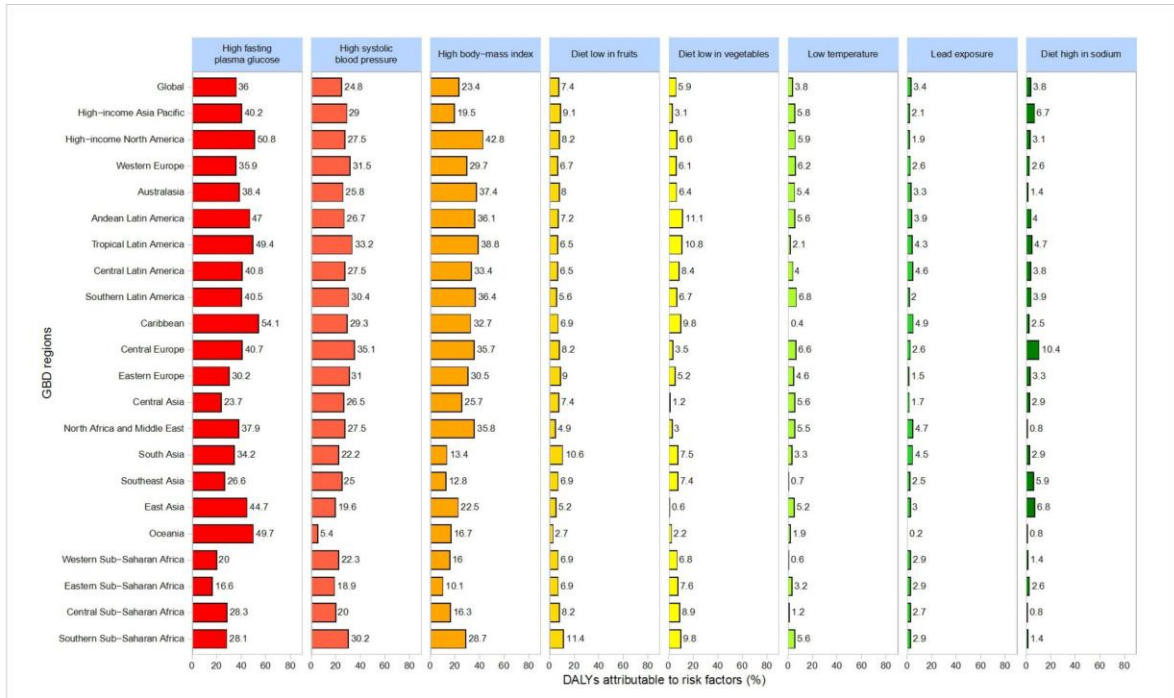


Figure 15 Key selected health factors of risk to ChKD with their involvement in to Dialys. (Source: Li et al., 2025a)

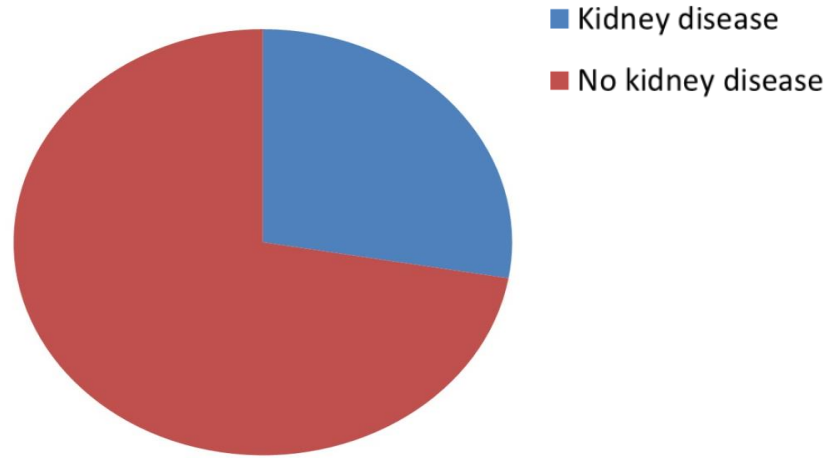


Figure 16a Distribution of ChKD patients (Source: Mohammad et al., 2024)

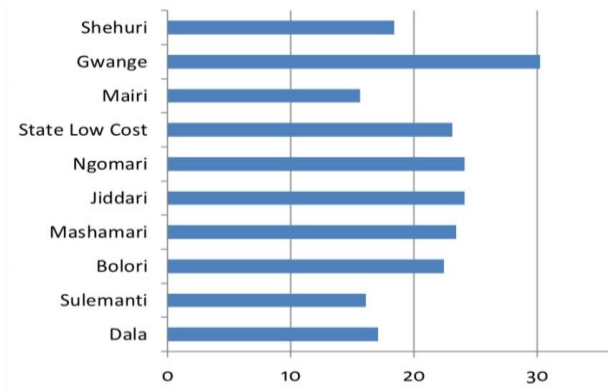


Figure 16b Frequency of ChKD patients per ward (Source: Mohammad et al., 2024)

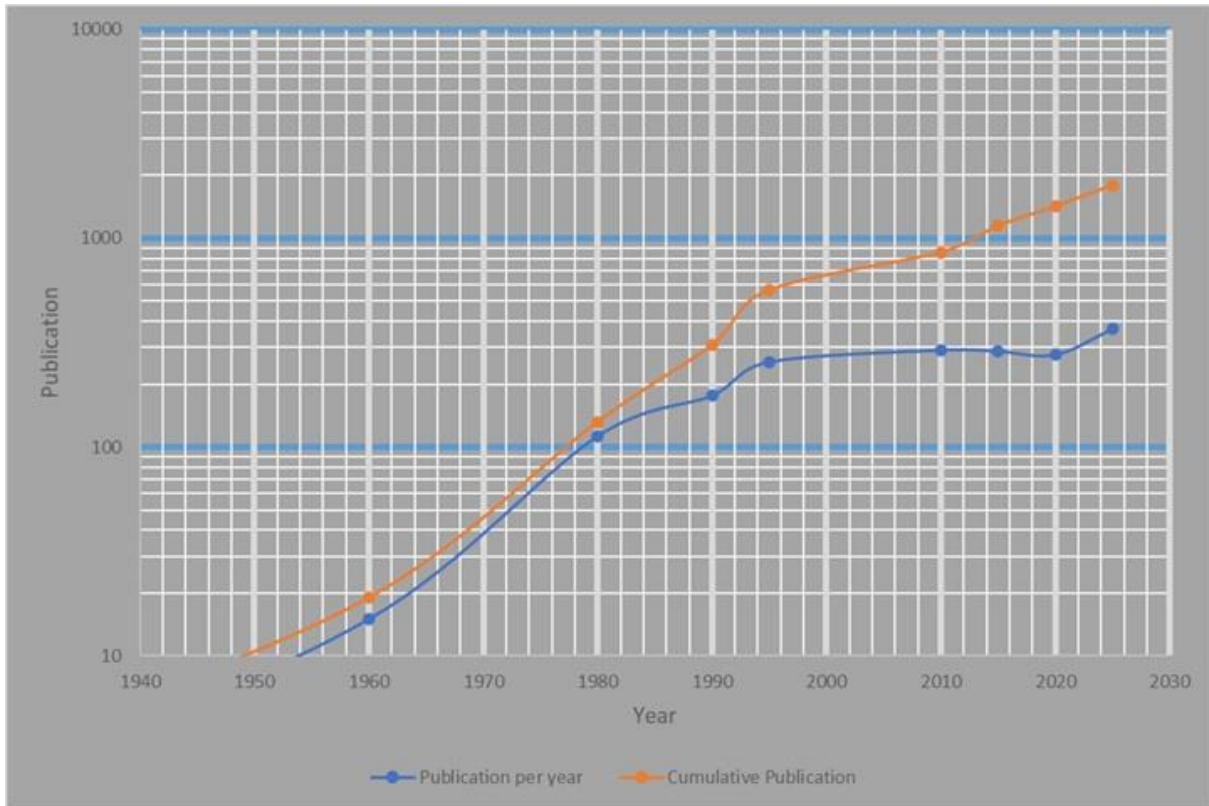


Figure 17a Number of publications on ChKD in Maiduguri

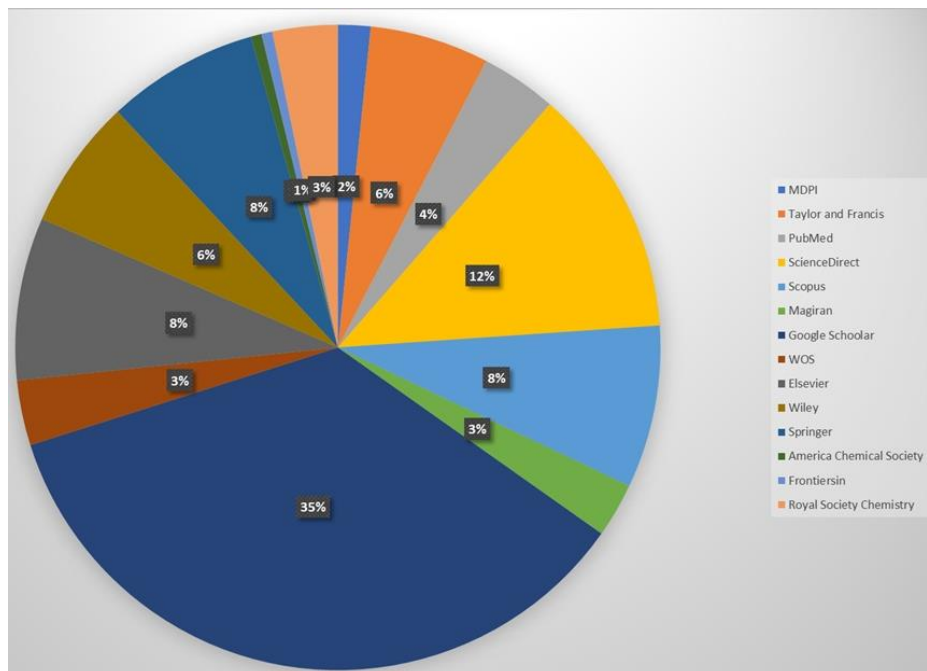


Figure 17b Number of publications on ChKD in Maiduguri based on the link and search engine



Figure 18a: Projected population of Maiduguri

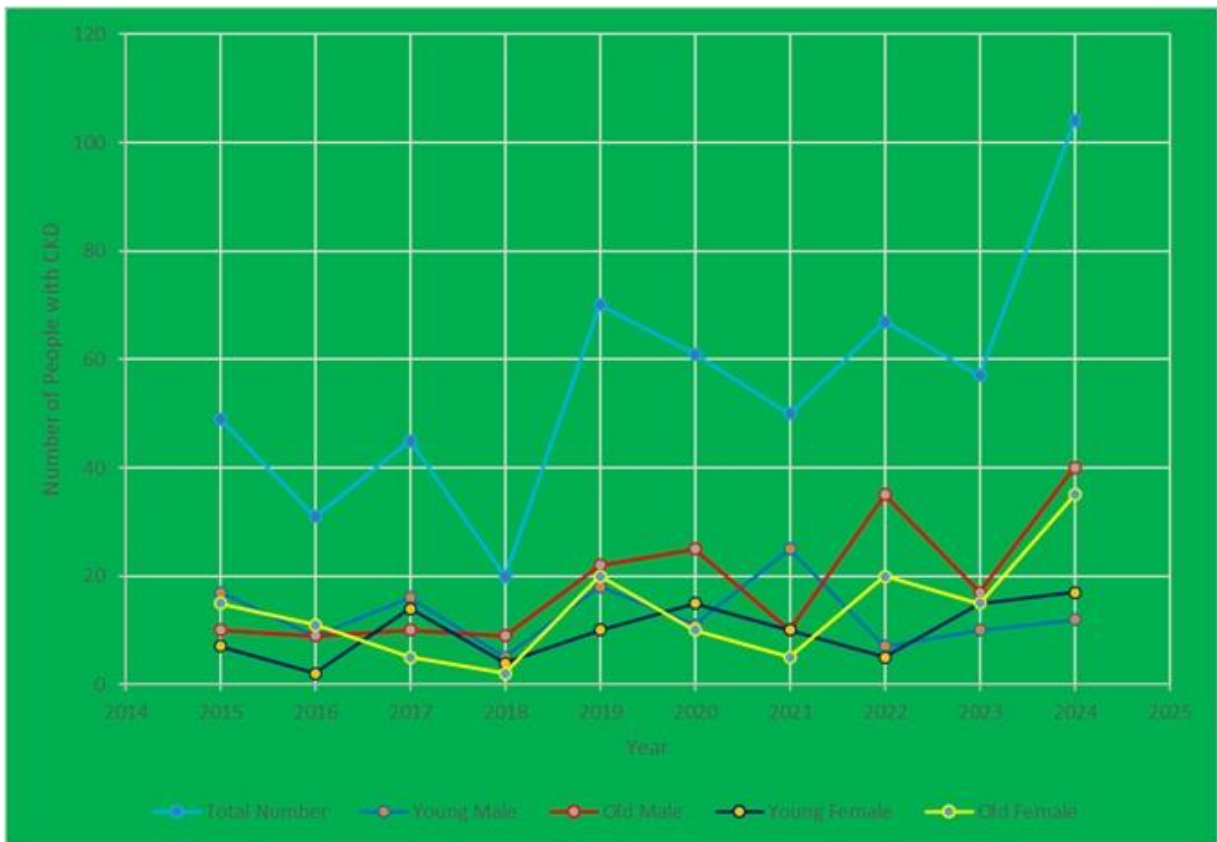


Figure 18b: Trend of ChKD population in Maiduguri between 2015 and 2024 based on gender and total

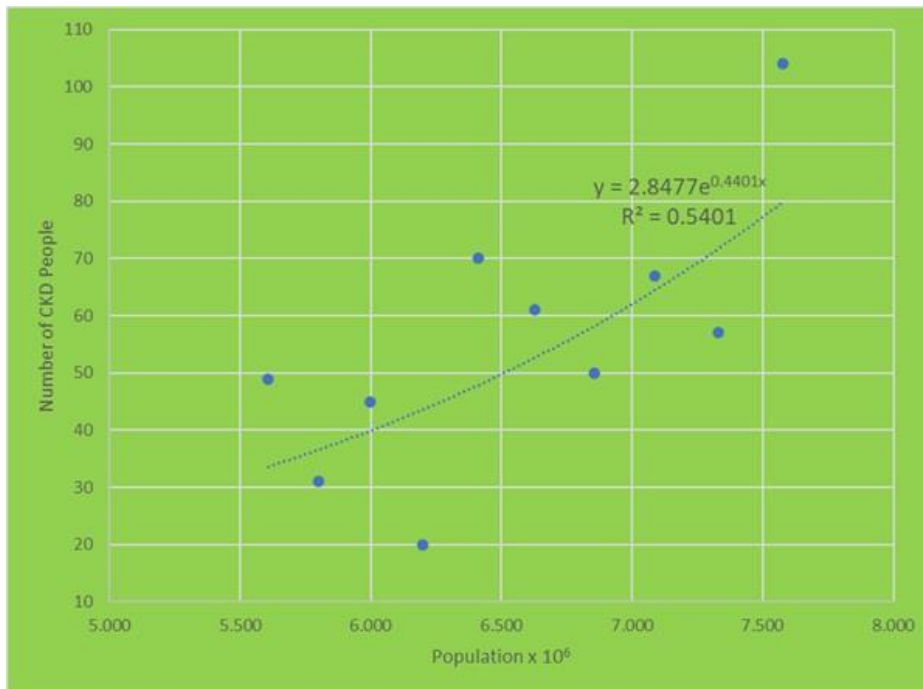


Figure 19a: Relationship between projected population and prevalence of ChKD in Maiduguri between 2015 and 2024

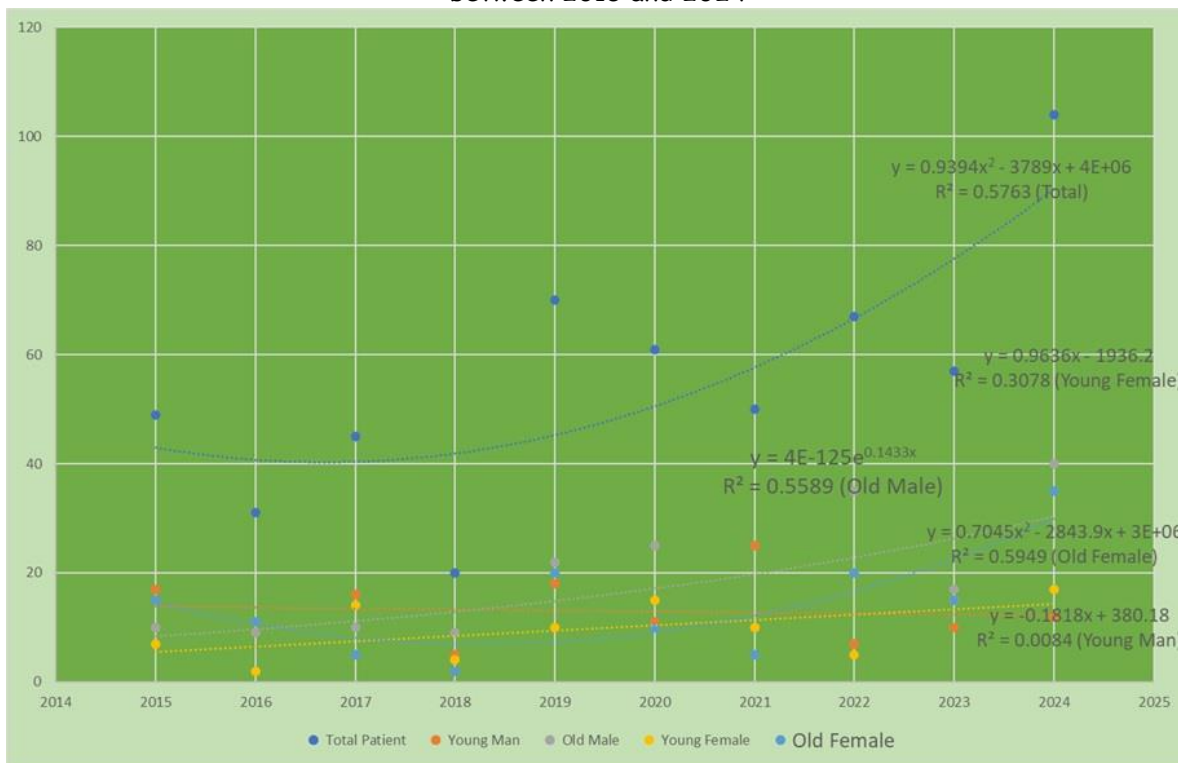


Figure 19b: Trend of prevalence of ChKD in Maiduguri between 2015 and 2024

Figure 18a presents the projected population of Maiduguri, which establishes that the population of males was lower than the population of females. Figure 18b shows the trend of the chronic kidney population in Maiduguri between 2015 and 2024 based on gender and total population, which population of old people with ChKD was higher than the population of young people with the disease.

Figure 19a presents the relationship between projected population and incidence of ChKD in Maiduguri between 2015 and 2024, which can be described as a fair relationship of square R of 0.5401. Figure 19b shows the trend of the incidence of ChKD in Maiduguri between 2015 and 2024 for all the groups. The trend is of increasing order with square R of between 0.0081 (young man) and 0.5948 (old female). Mohammad et al. (2024) reported that the incidence of ChKD established in Maiduguri was 21.7%, which is higher in magnitude than the observed value in selected studies within Nigeria such as 7.8 % in Ovwasa et al. (2023) and Okwuonu et al. (2027) for Umuahia, 12.2 % for Port Harcourt (Wachukwu et al., 2015), in Ibitoba et al. (2022), it was 22.3 % for Ado-Ekiti in Nalado et al. (2016) it was 26 % for Kano and in Afolabi et al. (2023) it was 31 % for in Southwest Nigeria.

This high incidence of ChKD in Maiduguri can be attributed to the growing trend of non-communicable diseases such as diabetes mellitus, hypertension, obesity and other diseases, with the influence of communicable diseases such as air-borne diseases, HIV infection, water-borne diseases, Hepatitis B and C infections. In addition, there is a preponderance of unidentified risk factors of ChKD in the community and region contributing (apolipoprotein L1 risk alleles, nephropathy risk variant genes, genetic factors, poverty, and poor environmental sanitation) to the burden of CKD. Table 1 shows the results of the ANOVA of the effects of year and gender

on the population of ChKD in Maiduguri. The Table revealed that year ( $F_{9,27} = 2.53$  and  $p = 0.03$ ) and gender ( $F_{3,27} = 2.54$  and  $p = 0.08$ ) are significant factors that influence on population of ChKD in Maiduguri at 95 % and 90 %, respectively. Table 2 presents the correlation between the incidence of ChKD in Maiduguri and the groups (gender and age). The Table show variable correlation coefficient of between 0.15926314 (young man) and 0.891635 (old female). The analysis and the Table revealed that all these had positive correlation coefficients, which indicates that all these groups (gender and age inform of young male and old male, young and old female) are contributing to the incidence of ChKD in Maiduguri. In addition, the Table shows that the order of their involvement in the total number of people with ChKD is old female ( $0.891635$ ) > old male ( $0.87293809$ ) > young female ( $0.64552418$ ) > young male ( $0.15926314$ ).

#### CONCLUSION

The study revealed that, despite a minor global reduction in the ChKD AS incidence rate (-0.8%) from 1990 to 2021, mortality and Dialys significantly increased in low-SoDI regions such as Southern sub-Saharan Africa, South Asia and Eastern and Central Africa. The outcome underscored limited healthcare facilities and resources as well as inadequate disease prevention and control. It was established that HSBP, high body mass index, and HFPG were crucial risk factors with variable changes in the impacts along the region.

The female incidence of ChKD exceeded male incidence of ChKD. These results provide an established scientific basis for besieged interventions and improved international teamwork to reduce the global incidence of ChKD burden. ChKD incidence is common among residents of Maiduguri, northeastern Nigeria. Further involvement studies are required to evaluate and monitor the impact of controlling the identified and unidentified risk factors on the incidence of ChKD in Maiduguri.

Table 1: the results of the ANOVA of the effects of year and gender on population of ChKD in Maiduguri.

Source of Variation	Sum of Square	Degree of freedom	Mean Square	F-value	P-value	F crit
Between the Years	1192.6	9	132.51	2.53	0.03	2.25
Between the Genders	398.5	3	132.83	2.54	0.08	2.96
Error	1414	27	52.37			
Total	3005.1	39				

Table 2 the correlation between the incidence of ChKD in Maiduguri and the groups (gender and age)

	YOUNG Male	OLD Male	YOUNG Female	OLD Female	Total Number
YOUNG Male	1				
OLD Male	-0.2562702	1			
YOUNG Female	0.274669	0.40033124	1		
OLD Female	-0.0859721	0.82947067	0.34614301	1	
Total Number	0.15926314	0.87293809	0.64552418	0.891635	1

**Abbreviations:**

AAnPCs stands for average annual percentage changes;  
 AGT stands for angiotensinogen  
 Am J Kidney Dis stands for American Journal of Kidney Diseases;  
 Am J Nephrol stands for American Journal of Nephrology;  
 ANG I stands for angiotensin I  
 ANG II stands for angiotensin II  
 ANOVA stands for Analysis of Variance  
 ARE stands for the United Arab Emirates  
 AS stands for age-standardised  
 ASi stands for age-standardised incidence  
 ASR stands for age-standardised incidence rates  
 AT1R stands for angiotensin II type 1 receptor  
 CHE stands for Switzerland.  
 ChKD stands for Chronic kidney disease  
 Clin J Am Soc Nephrol stands for Clinical Journal of the American Society of Nephrology;  
 Clin Nutr stands for Clinical Nutrition;  
 Cochrane Database Syst Rev. stands for Cochrane Database of Systematic Reviews;  
 DiALY stands for disability-adjusted life years;  
 FRZ stands for Frizzled family receptor;  
 GBR stands for the United Kingdom;  
 GSK stands for glycogen synthase kinase;

HFBG stands for high fasting plasma glucose  
 HSBP stands for high systolic blood pressure  
 IF stands for Impact factor;  
 J Am Soc Nephrol stands for Journal of the American Society of Nephrology  
 J Renal Nutr stands for Journal of Renal Nutrition.  
 Kidney Int stands for Kidney International.  
 Lancet Diabetes Endocrinol stands for Lancet Diabetes & Endocrinology;  
 LRP5/6 stands for lipoprotein receptor-related protein 5/6  
 Nat Rev. Nephrol stands for Nature Reviews Nephrology.  
 Nephrol Dial Transplant stands for Nephrology Dialysis Transplantation.  
 NLD stands for Netherlands.  
 NZL stands for New Zealand.  
 RAS stands for Renin-angiotensin system.  
 ROS stands for reactive oxygen species.  
 RXR stands for retinoid X receptor;  
 SoDI stands for Socio-Demographic Indexes  
 T1DM stands for type 1 diabetes mellitus;  
 T2DM stands for type 2 diabetes mellitus.  
 TCF/LEF stands for transcription factors involved in the Wnt signaling pathway  
 The US stands for the United States;

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