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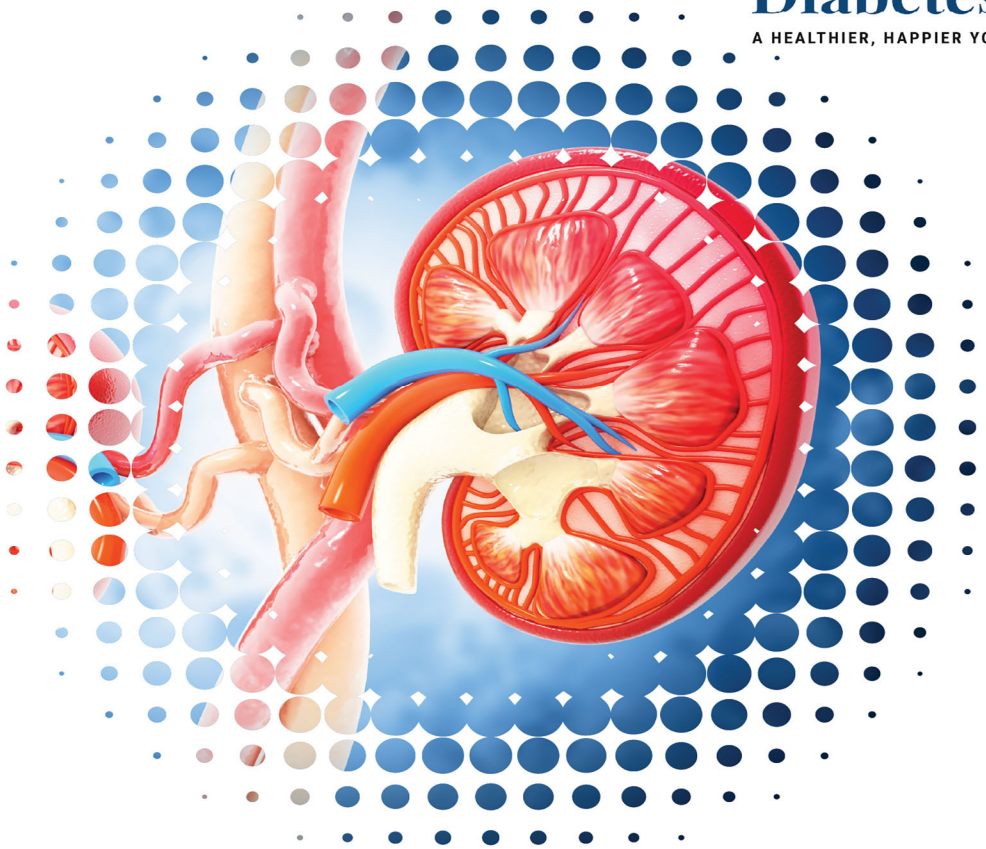

Early Diagnosis of Diabetic Kidney Disease

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JAYPEE

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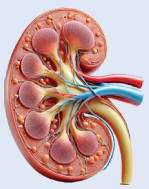
1 Epidemiology and Burden of Diabetic Kidney Disease

Vijay Viswanathan, Sivashankari Selva Elavarasan



- Diabetic kidney disease: Introduction and definition
- Diabetic nephropathy and diabetic kidney disease
- Epidemiology of DKD in the World
- Epidemiology of DKD in India
- Global burden of DKD and CKD
- Burden of DKD and CKD in India
- Early diagnosis of DKD

Abstract

Diabetic kidney disease (DKD) is one of the major serious complications of diabetes mellitus that affects 30–40% of people living with diabetes. DKD is a clinical diagnosis characterized by persistent albuminuria and a decreased estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m^2. It becomes the need of the hour to study the global burden of DKD due to the high mortality rates associated with the disease, which is responsible for a significant social and economic burden on the healthcare system. A recent multicentric nationwide study estimated the prevalence of chronic kidney disease (CKD) among people with type 2 diabetes to be 32%. It remains a major global challenge to tackle the burden of CKD in a resource-limited setting like India because the treatment rendered is costly and requires long-term consistent management. This review highlights the important epidemiological findings of DKD and the substantial burden of the disease on the healthcare system in India and around the globe. Nationwide screening of people with DKD remains the key to identifying and treating them before they develop further complications.

Keywords: Chronic kidney disease, epidemiology, India, burden, type 2 diabetes.

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INTRODUCTION

Diabetes mellitus (DM) is a chronic, debilitating, devastating, and serious metabolic disease that is also considered a major health problem worldwide. It can cause a significant burden to the healthcare system of the entire nation due to its inconceivable complications. It has been estimated that 589 million people aged between 20 and 79 years are affected globally by the disease, which represents 11% of the world population. These numbers are expected to increase to 853 million by 2050. In the Southeast Asian region, 1.1 billion people are affected by diabetes, with India leading the list of top

five countries with nearly 90 million people with diabetes in the age group between 20 and 79 years. India accounts for one in every seven people who are affected by diabetes globally.[1] According to a study by the Indian Council of Medical Research – India Diabetes (ICMR-INDIAB), the overall prevalence of diabetes in India was 11.4% with approximately 101 million people affected by the disease.[2] These numbers are expected to increase rampantly over the years with the alarming increase in the population.

Diabetes is also associated with significant micro as well as macro complications because it can affect the eyes, nerves, kidneys, heart, and feet. These complications can even be life-threatening and can affect the social and physical quality of life. One of the most common long-term and important complications of diabetes seems to be diabetic kidney disease (DKD) which can affect 30–40% of all the people affected by diabetes.[3] Globally, the incidence of chronic kidney disease (CKD) due to diabetes increased by 74%, which was about 1.4 million in 1990 to 2.4 million in 2017.[4] Among the adults living worldwide, diabetes remains the leading cause of end-stage kidney disease (ESKD).[5] This condition is characterized by failure of the kidneys to function normally and they require dialysis or transplantation for their survival. It has also been predicted that only 27–53% of the people with ESKD have access to renal replacement therapy (RRT), leaving middle and low-income countries with limited access to the various treatment modalities.[6]



Diabetic kidney disease affects 30–40% of all the people affected by diabetes. Globally, the incidence of CKD due to diabetes increased by 74%, which was about 1.4 million in 1990 to 2.4 million in 2017. Among the adults living worldwide, diabetes remains the leading cause of ESKD.

DEFINITION OF DIABETIC KIDNEY DISEASE

Diabetic kidney disease is a clinical diagnosis characterized by persistent albuminuria and a decreased estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m^2. When the patient's urine tests positive for albumin for >3 months, it is called persistent albuminuria. There can also be a persistent increase in the albumin-creatinine ratio (ACR ≥30 mg/g). A decline in eGFR and an increase in albuminuria can both have undesirable consequences such as ESKD and eventually death.

Albuminuria can be divided into three categories based on Kidney Disease Improving Global Outcomes (KDIGO) 2012 **(Fig. 1)**.[7]



Diabetic kidney disease is a clinical diagnosis characterized by persistent albuminuria and a decreased estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m^2.

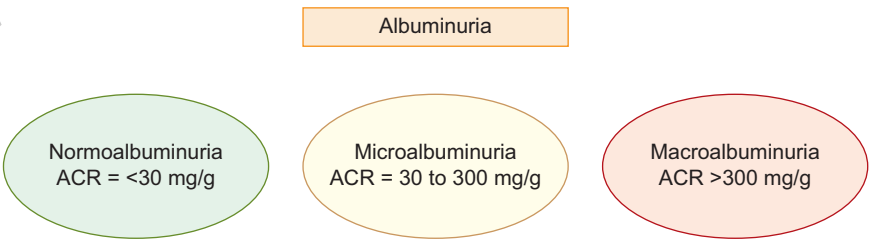

FIG. 1: The different categories of albuminuria based on Kidney Disease Improving Global Outcomes (KDIGO).[7]

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DIABETIC NEPHROPATHY AND DIABETIC KIDNEY DISEASE

Diabetic nephropathy (DN) is a classic term that refers to specific functional and structural damages that can occur to the kidneys of people with diabetes. It refers to a standard pattern of glomerular disease. Proteinuria is usually accompanied by hypertension and retinopathy along with a decline in kidney function. However, in some cases, DN is not accompanied by diabetic retinopathy and that does not always exclude its diagnosis.[8] This term eventually evolved into a more generic term called DKD due to the diversity and complexity involved in the pathogenesis of renal impairment among people living with diabetes. This could be the most possible reason for considering DKD as a syndrome rather than a single disease.[9] There is no distinct pathological entity involved in DKD. There can be a variety of reasons for the same namely any unspecified acute kidney injury or hypertensive nephrosclerosis.

According to KDIGO, DN was exclusively used to refer to the histological diagnosis seen in a renal biopsy which includes thickening of the glomerular basement membrane, mesangial expansion accompanied with/without nodular lesions typically described as Kimmelstiel–Wilson lesion, any disruption of the endothelium or loss of podocytes. These changes can ultimately result in the loss of nephron. However, DKD is rather a clinical diagnosis that refers to CKD among people with diabetes.[10]

Mogensen classified DN into five stages based on the natural history of the disease.[11] The five classic stages of DN are illustrated in **Table 1**.

TABLE 1: Shows the classification of DN into five stages by Mogensen.[11]

Stage 1	Hyperfiltration and hypertrophy
Stage 2	Silent nephropathy
Stage 3	Incipient nephropathy
Stage 4	Overt nephropathy
Stage 5	End-stage renal failure

There are five stages in the development of DN which can be depicted in **Figure 2**.[12]

Diabetic kidney disease is a relatively new term established by the Kidney Disease Outcomes Quality Initiative (KDOQI) in the year 2007, it was previously known as diabetic nephropathy.[13] DKD is also recognized as the most common cause of ESKD and keeping in mind the magnitude of the problem, ESKD can be rightly described as "a medical catastrophe of worldwide dimension".[14] Despite the novel biomarkers and approaches for the diagnosis of DKD, its accuracy without a renal biopsy remains questionable, especially in clinical settings.

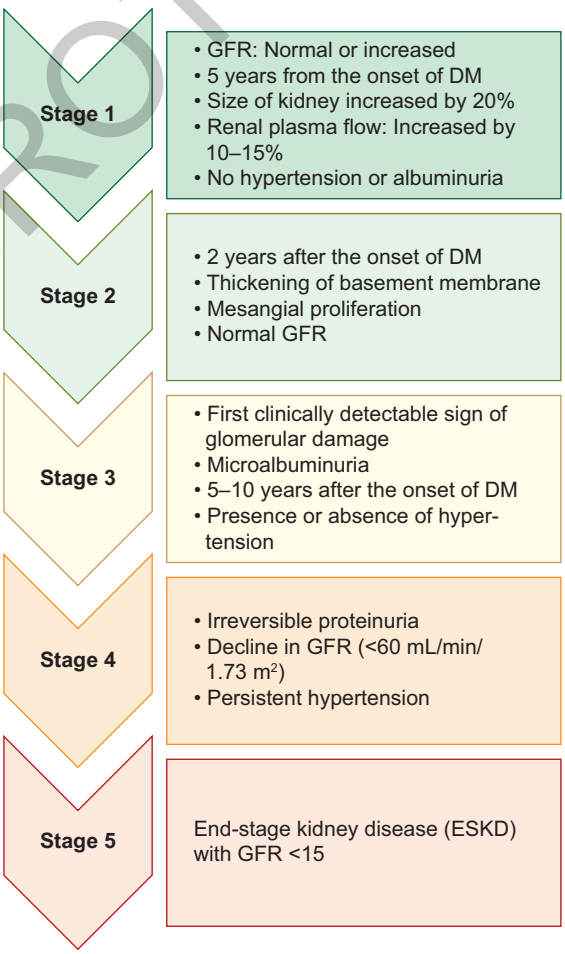

FIG. 2: Shows the five stages of diabetic nephropathy.[12]

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Diabetic nephropathy (DN) is a classic term that refers to specific functional and structural damages that can occur to the kidneys of people with diabetes. According to KDIGO, DN was exclusively used to refer to the histological diagnosis seen in a renal biopsy. DKD is a clinical diagnosis that refers to CKD among people with diabetes.

EPIDEMIOLOGY OF DIABETIC KIDNEY DISEASE IN THE WORLD

There are two best type 2 diabetes long-term cohorts namely the Pima Indian population and the UKPDS (United Kingdom Prospective Diabetic Study). Among the 5,000 participants in the UKPDS study cohort, it was observed that after 15 years long follow-up, 38% of the study participants developed microalbuminuria (cut-off was set for persistent albuminuria as ≥50 mg/L), and 29% of them presented with decreased eGFR[15] (cut off was set for persistent decline in eGFR was set as ≤60 mg/min/1.73 m^2. Preceding the use of RAAS inhibitors, the progressive incidence of macroproteinuria (≥1 g/gCr) was observed to be 50% with an average of 20 years of duration of diabetes among the Pima Indians. The prevalence of DKD among US adults was found to be between 25% (among younger adults) to 50% (among the older population), with the incidence of microalbuminuria increasing among the younger population and a decline in eGFR more common among the elders.[16] The progression from microalbuminuria to macroalbuminuria occurred at the rate of 2.8% per year and further progression from macroalbuminuria to ESKD developed at the rate of 2.3% every year. At the initial diagnosis of type 2 DM, 7.3% had microalbuminuria which eventually increased to 17.3%, 24.9%, and 28% at 5, 10, and 15 years, respectively.[17]

In a cross-sectional study conducted among 32,208 people with T2D across 33 countries, the prevalence of micro- and macroalbuminuria was found to be 38.8% and 9.8%, respectively.[18] The prevalence of micro- and macroalbuminuria among different races can be best illustrated in **Figure 3**.

According to Parving, Asians, and Hispanics recorded the highest prevalence of microalbuminuria (43.2% and 43.8%) as well as macroalbuminuria (12.3% and 10.3%) as depicted in the figure.[19] Similarly, the lowest prevalence of micro as well as macroalbuminuria was reported among Caucasians (33.3% and 7.6% respectively). Among the Japanese population, the prevalence of decreased GFR (<60 mL/min/1.73 m^2) and microalbuminuria was 10.5% and 31.6% respectively.[20] Among the people living with diabetes in Egypt, Jordan, and Libya, the prevalence of diabetic nephropathy was observed to be 42%, 33%, and 25% respectively.

The worldwide prevalence of DKD and non-diabetic kidney disease (NDKD) is best illustrated in the **Table 2** below. Among the various countries, China, India, and the United States seem to be leading in the prevalence of DKD **(Table 2)**.[21]



Asians and Hispanics recorded the highest prevalence of microalbuminuria (43.2% and 43.8%) and macroalbuminuria (12.3% and 10.3%). Among the various countries, China, India, and the United States seem to be leading in the prevalence of DKD.

EPIDEMIOLOGY OF DIABETIC KIDNEY DISEASE IN INDIA

In India, DKD is a serious major public health problem imposing a huge burden on the society as well as on the nation. The pattern of renal disease in India was studied by MK Mani who stated that there were no peculiar renal diseases that were prevalent among the Indians. The most common reasons for which the patients visited a renal unit were identified as chronic renal failure (CRF) (43%) and nephrotic syndrome (14.8%). Diabetic

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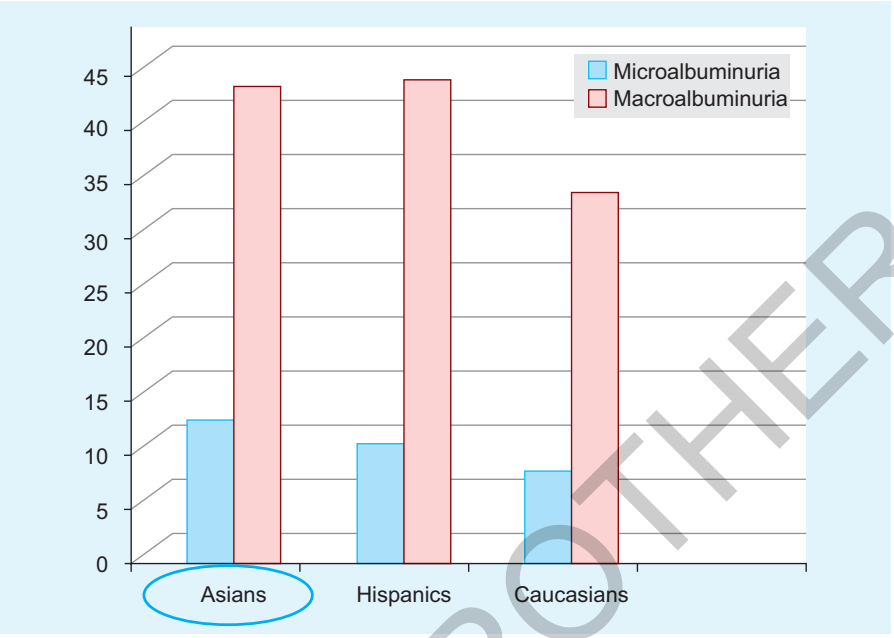

FIG. 3: Illustrates the prevalence of both micro as well as macroalbuminuria among the different races.[19]

TABLE 2: Shows the prevalence of diabetic kidney disease (DKD) and nondiabetic kidney disease (NDKD) across the major countries and continents.[21]

Continent/Country	*Prevalence of DKD (in %)*	*Prevalence of NDKD (in %)*
China	6–74	16–64
USA	28–63	19–53
India	35–56	23–50
Europe	34–85	14–62
Africa	24–55	44–69

nephropathy, chronic interstitial nephritis, and chronic glomerulonephritis were the various common causes considered responsible for CRF. Among them, diabetic nephropathy (30.3%) was the most common cause of CRF. In a country like India where we have more lean diabetics who are at a greater risk of developing proteinuria and the kidney function declines more rapidly when compared to their counterparts who are obese and diabetic. In a survey conducted by Mani et al. among the rural population, 7.5% of the people were identified to be at risk of developing CRF.[22]

In 2017, approximately 697 million people were affected globally by CKD, with India being ranked as the second most affected country with nearly 115 million people affected by CKD.[23] In a population-based survey conducted in two major cities Delhi and Chennai in India, the prevalence of CKD and albuminuria was found to be 8.7% and 7.1% respectively.[24] According to Chennai Urban Rural Epidemiology Study 45 (CURES 45), the prevalence of overt nephropathy and microalbuminuria was 2.2% and 26.9% respectively among urban Asian Indians.[25] Similarly in another study from India by Vijay et al., proteinuria was found in approximately one-third of the people with noninsulin dependent diabetes mellitus (NIDDM) and it was also reported that the risk of nephropathy increased along with duration of diabetes.[26] It was also reported in a 12-year observational study by Viswanathan et al. that around 44.1% of people living with T2D developed proteinuria during the

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subsequent years of follow-up.[27] Similarly, two studies from North India reported the prevalence of nephropathy among people with newly diagnosed T2D. Mir et al. reported the prevalence of nephropathy as 32.9%,[28] and microalbuminuria was recorded in 24.7% and proteinuria was reported in 6.2% among people newly diagnosed with T2D.[29] Substantial efforts have been taken to compile the number of people living with DKD in different stages across the nation **(Fig. 4)**.

The proportion of participants in stages 4 and 5 was higher in the North zone when compared to the other zones. It has also been estimated that on average 170,000–250,000 new patients may require RRT annually. More than 60% of patients with stage 5 CKD were managed only conservatively without dialysis.[30] In a recent multicentric cross-sectional CITE study, the prevalence of CKD was 32% which was calculated using the data of 3,325 patients from 28 centers all over India for a period of 3 months. In this real-world observational study, the various risk factors associated with CKD among people with diabetes was also analyzed.[31] It remains a major challenge to treat a substantial number of people, especially in a country like India with limited resources and financial constraints.



In 2017, approximately 697 million people were affected globally by CKD, with India being ranked as the second most affected country with nearly 115 million people affected by CKD. It remains a major challenge to treat a substantial number of people, especially in a country like India with limited resources and financial constraints. In a recent multicentric cross-sectional CITE study, the prevalence of CKD among people with diabetes was 32%.

GLOBAL BURDEN OF DIABETIC KIDNEY DISEASE AND CHRONIC KIDNEY DISEASE

It is very important to study the global burden of DKD due to the high mortality rates associated with the disease which in turn is responsible for a significant social and economic burden on the healthcare system. A multinational collaborative study was conducted by Global Burden of Disease in 2019 which was used to measure the burden of 369 diseases across 204 countries around the globe which also included the trends

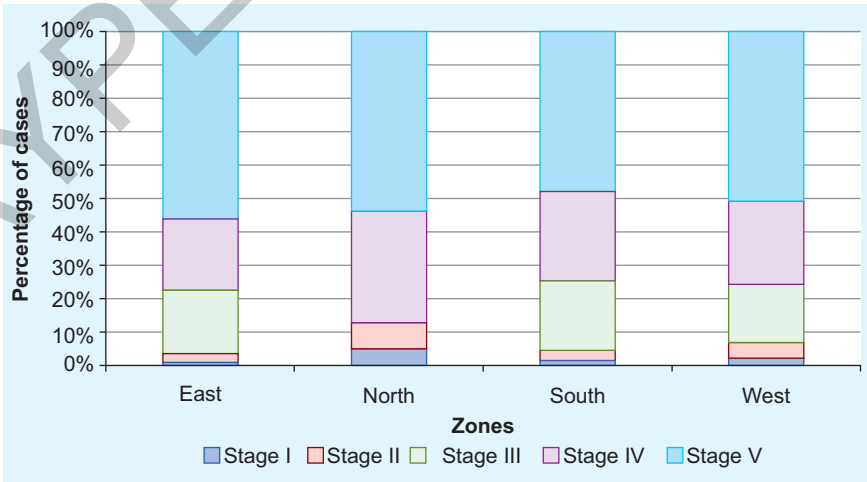

FIG. 4: Shows the percentage of people living with diabetic kidney disease (DKD) in different zones such as East, West, North, and South regions in India.[30]

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in various diseases from 1990 to 2019. In this chapter, the global epidemiological characteristics of people living with DKD are enumerated. In the year 2019, approximately 2,500,000 cases were reported worldwide and they also estimated that there was a 21.8% increase in the number of cases since 1990. The number of deaths that were recorded was 406,000, the global incidence as well as the death rates increased with age, with the highest peak in the number of deaths recorded in the age group between 75 and 79 years.[32] There is an alarming increase in the age-standardized death rates for people aged between 20 and 59 years and living with DKD worldwide **(Fig. 5)**.

In 2010, nearly 2.3 million people died due to lack of access to renal replacement therapy (RRT). This is more common, especially in low-income countries in Africa as well as Asia. Globally, the prevalence of RRT is expected to rise to 5.4 million by 2030 and in Asia, it is expected to increase to 2 million from the present 1 million.[33] The lack of national screening programs and the unavailability of a unified CKD registry worldwide to track cases before ESKD are among the challenges faced by healthcare professionals that contribute further to the burden of DKD.[34] However, in 2005, a CKD registry was established in India to collect data and maintain a record of patients' demographics, etiology, analyze the differences in patterns of practice, as well as study regional variations across India.

People living with DKD are considered to be at a greater risk for cardiovascular diseases which is also responsible for the substantial economic burden. Many countries across the globe do not have the appropriate patient care facilities for people affected by DKD with a significant impact on the quality of life. The annual direct cost associated with CKD management increased dramatically with the increasing stages of CKD.[35] There is an urgent need to tackle the disease in its early stages to prevent its progression to advanced stages which can in turn contribute to the substantial economic burden.

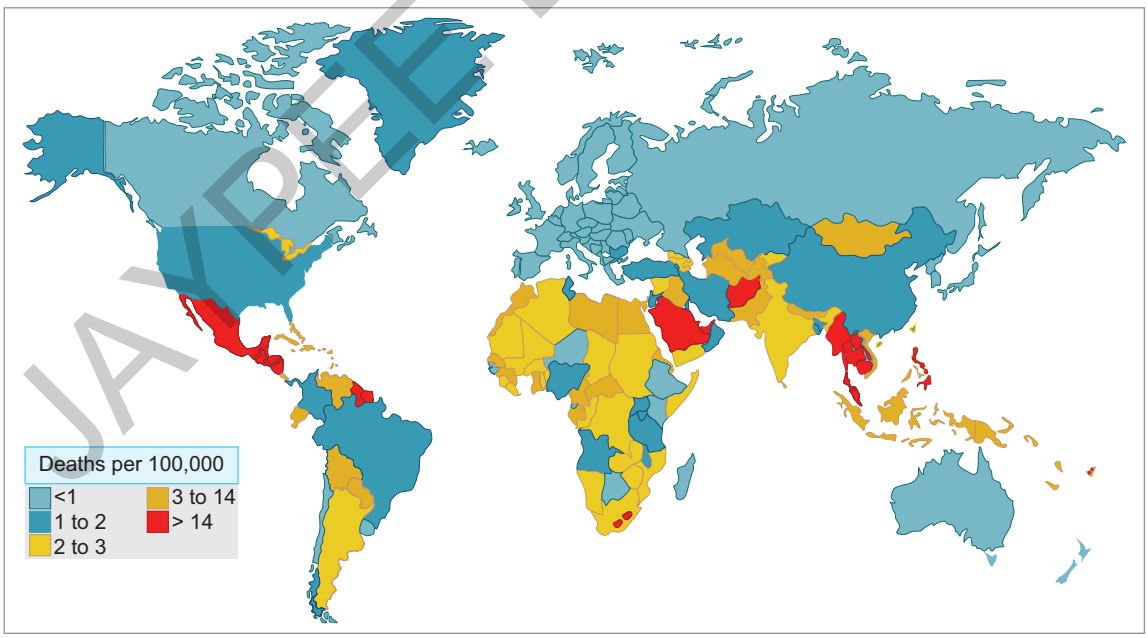

FIG. 5: Shows the age-standardized death rates recorded among people with diabetic kidney disease (DKD) aged between 20 and 59 years per 1,00,000 population in the year 2019 globally.[32]

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Globally, the prevalence of RRT is expected to rise to 5.4 million by 2030 and in Asia, it is expected to increase to 2 million from the present 1 million. The lack of national screening programs and the unavailability of a CKD registry to keep an account of cases before ESKD are some of the challenges faced by healthcare professionals that contribute further to the burden of DKD.

BURDEN OF DIABETIC KIDNEY DISEASE AND CHRONIC KIDNEY DISEASE IN INDIA

It remains a major global challenge to tackle the burden of CKD in India because the treatment rendered is very expensive and also requires long-term consistent management. A study by Satyavani et al. was done to assess the direct cost of the treatment of hospitalized people living with diabetes and CKD. Participants were classified into four groups namely, people who underwent renal transplantation, people living with CKD, diabetes, and on hemodialysis, people with CKD before ESKD, and people living with T2D but without any complications. **Table 3** summarizes the direct cost spent among people living with CKD and diabetes. Patients who underwent renal transplantation and those on hemodialysis spent more than the other groups. It was estimated that the cost of treatment for patients with ESKD who underwent dialysis and for those who underwent transplantation was found to be ₹500,000 (US $10,753) and ₹345,000 (US $7,419), respectively. Similarly, patients who were not on dialysis spent ₹100,000 (US $2150) in 2 years **(Table 3)**. People with diabetes spend four times more money when compared to people before the ESKD stage. The direct costs calculated included days spent during their hospitalization, total expenditure toward medicine, transportation, consultation fees, laboratory expenses, and the amount of money spent during their hospitalization. Approximately 70% of the patients in the dialysis group underwent dialysis almost eight times in a month. They had to undergo 12 sessions in a month. However, some patients could not afford to spend for all the sessions and were forced to skip them due to financial reasons. The source of funding for these patients was mostly from their savings (46%).[36]

This study made a huge impact because the direct cost associated with CKD in India was studied for the first time. However, this study did not take into account the indirect costs associated with CKD.

In a resource-limited setting like India, it becomes imperative to initiate intervention to prevent complications and thereby improve the quality of life of people living with diabetes and CKD. People living in India have a high out-of-pocket (OOP) expenditure and there are not many reimbursement insurance policies that can cover their entire healthcare costs. There were

TABLE 3: Shows the direct cost associated with chronic kidney disease (CKD) across the different study groups.[36]

Total expenditure (₹)	*Group 1 (transplantation) n = 12*	*Group 2 (dialysis) n = 45*	*Group 3 (I–IV CKD stages) n = 66*	*Group 4 (without complications) n = 86*	*p value between groups*
Transplantation or hemodialysis	360,000 (774 US $)	49,500 (1,064 US $)	–	–	
Diabetes	30,200 (649 US $)	14,400 (310 US $)	12,700 (273 US $)	3214 (69 US $)	<0.001
Total expenditure for previous 2 years	345,000 (77,419 US $)	500,000 (10,753 US $)	100,000 (2,150 US $)	30,000 (645 US $)	<0.001

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a few studies where the OOP was found to be US $7,881 in patients with CKD and undergoing renal transplantation[37] and Suja et al. reported the cost of hemodialysis in people with ESKD for 6 months was projected to be US $4,759.[38] Another study suggests that the annual average costs for patients on hemodialysis along with medication were estimated to be ₹2,13,144 (US $3181).[39] It is thus of paramount importance to establish new dialysis centers, especially in public health centers across the nation to reduce the direct expenditure associated with CKD. It also becomes indispensable to increase the number of centers that can provide such facilities in different regions thereby helping in reducing the indirect expenditure for the patients. The limited awareness about DKD among the general public, the availability of resources as well as affordability to treat the disease can be attributed to neglected treatment for the disease, thereby paving the way to complications that can ultimately result in the death of the patients.



People living in India have a high out-of-pocket (OOP) expenditure and there are not many reimbursement insurance policies that can cover their entire healthcare costs. It remains a major global challenge to tackle the burden of CKD in India because the treatment rendered is very expensive and also requires long-term consistent management.

EARLY DIAGNOSIS OF DIABETIC KIDNEY DISEASE

Prevention is always considered better than cure. Nation-wide screening of people with DKD remains the key to identifying and treating them before they develop further complications. An annual screening of people living with diabetes to evaluate their eGFR and their albuminuria must be conducted nationwide. There is a need to design nationwide multicentric studies to assess the burden of the disease because there is a paucity of data on the epidemiology of DKD in India. All people with diabetes should undergo an annual screening for CKD. The gold standard for assessing the glomerular filtration rate is to use mGFR. However, in resource-limited settings like India, we can use the CKD-EPI formula to calculate eGFR using age, sex and serum creatinine which is very simple and inexpensive. Urine albumin creatinine ratio (UACR) can be checked in a sample of spot urine for the assessment of albuminuria **(Table 4)**. Persistent albuminuria for 2 or 3 months indicates damage to the kidneys.

TABLE 4: Shows the assessments done for the early diagnosis of diabetic kidney disease (DKD) in India.[40]

Assessments for the early diagnosis of DKD in India	*Description of the assessment*
Screening	Regular screening for early diagnosis of DKD
Calculation of eGFR	Using CKD-EPI (S cr.) equation to calculate eGFR using age, sex, and serum creatinine
Assessment of albuminuria (UACR)	• UACR is estimated in spot urine to assess albuminuria • If UACR ≥30 mg/g, it indicates microalbuminuria • If UACR ≥300 mg/g, it indicates macroalbuminuria
Monitoring for evaluation of complications	Regular screening for other complications related to diabetes such as neuropathy, retinopathy, and assessment of cardiovascular risk factors
Regular assessment and follow-up	Regular monitoring of blood pressure, blood sugar, eGFR, and UACR to assess the progression of DKD

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Prevention is always considered better than cure. Nationwide screening of people living with DKD remains the key to identifying and treating them before they develop further complications. An annual screening of people living with diabetes to evaluate their eGFR and assess their albuminuria has to be conducted across the nation.

SUMMARY

Diabetic nephropathy (DN) is a classic term that refers to specific functional and structural damages that can occur to the kidneys of people with diabetes. This term eventually evolved into a more generic term called diabetic kidney disease (DKD) due to the diversity and complexity involved in the pathogenesis of renal impairment among people living with diabetes. DKD is characterized by persistent albuminuria and a decreased estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m^2. Asians and Hispanics recorded the highest prevalence of microalbuminuria. In a resource-limited setting like India, it becomes imperative to initiate intervention to prevent complications and thereby improve the quality of life of people living with diabetes and CKD. There is an urgent need to tackle the disease in its early stages to prevent its progression to advanced stages, which in turn, can contribute to the substantial economic burden. An annual screening of people living with diabetes to evaluate their eGFR and their albuminuria must be conducted across the nation.

CONCLUSION

Diabetic kidney disease is a heterogeneous and multifactorial disease with a diverse and complex pathogenesis. It has a significant socioeconomic impact on the quality of life of the patients, which can prove catastrophic due to the devastating and debilitating conditions that can arise if not treated appropriately. It is thus imperative to establish cost-effective and multidirectional strategies to prevent the development as well as progression of DKD. Early diagnosis and initiation of the most appropriate treatment can help reduce the global burden of the disease. Despite initiatives by the government of India to establish hemodialysis units and the launch of the National Organ Transplant Program to promote and facilitate renal transplantation, the burden of the disease remains unprecedented. Thus, early screening, lifestyle modifications, and prompt treatment become the need of the hour to prevent or slow the development and progression of DKD.

TAKE HOME MESSAGES

- Diabetic kidney disease is an emerging major public health problem.
- The recent trends in urbanization, increase in life-expectancy along with the alarming increase in the number of people affected by diabetes globally can be attributed to the increasing prevalence of DKD across the globe.
- Screening and early initiation of treatment can alleviate the burden of the disease and help prevent complications.

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Key Research Takeaway



Original Article

Direct costs associated with chronic kidney disease among type 2 diabetic patients in India

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ABSTRACT

The aim of this study was to estimate the direct costs of medical care among hospitalized type 2 diabetic patients with chronic kidney disease (CKD). A total of 209 (M:F, 133:76) patients were divided into groups based on the severity of kidney disease. Group 1 subjects had undergone renal transplantation (*n* = 12), group 2 was CKD patients on hemodialysis (*n* = 45), group 3 was patients with CKD, prior to end-stage renal disease (ESRD) (*n* = 66), and group 4 (*n* = 86) consisted of subjects without any complications. Details about expenditure per hospitalization, length of stay during admission, direct medical and nonmedical cost, expenditure for the previous two years, and source of bearing the expenditure were recorded in a questionnaire. Diabetic patients with CKD prior to ESRD spend more per hospitalization than patients without any complications. [Median □ 12,664 vs. 3,214]. The total median cost of CKD patients on hemodialysis was significantly higher than other CKD patients (INR 61,170 vs. 12,664). The median cost involved in kidney transplantation was □ 392,920. The total expenditure for hospital admissions in two years was significantly higher for dialysis than transplantation. Patients on hemodialysis or kidney transplantation tend to stay longer as inpatient admissions. The source of funds for the expenditure was mainly personal savings (46%). The expenditure on hospital admissions for CKD was considerably higher, and so, there is a need to develop a protocol on a cost-effective strategy for the treatment of CKD.

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Type 2 diabetes and diabetic nephropathy in India—magnitude of the problem

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It has been predicted that world wide the prevalence of diabetes in adults would increase to 5.4% by the year 2025 from the prevalence rate of 4.0% in 1995. Consequently the number of adults with diabetes in the world would rise from 135 million in 1995 to 300 million in the year 2025 [1]. It is expected that much of this increase in prevalence rate will occur in developing countries. While a 42% increase is expected in developed countries, a 170% increase is expected in the developing countries. In the latter, most of the diabetic patients are in the age range of 45–64 years, while in developed countries most of them are ⩾65 years. Therefore diabetic patients in developing countries are even more vulnerable to develop the microvascular complications of diabetes including diabetic nephropathy.

Type 2 diabetes in Asian-Indians: differences from the West

Studies from the UK have found that type 2 diabetes is three to four times more common in South Asians

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fied as one of the ethnic groups with a high prevalence of type 2 diabetes [3] and a high familial aggregation of type 2 diabetes [4]. The prevalence of type 2 diabetes was as high as 50% among the offspring of conjugal type 2 diabetic parents in India, which is the highest prevalence rate reported until now [5]. In a population-based survey in an urban population in South India, it was found that there was a 40% increase in the age—standardized prevalence of diabetes over a period of 6 years, from 8.2% in 1988–1989 to 11.6% in 1994–1995 [6].

High prevalence of maturity-onset diabetes of the young (MODY)

MODY refers to a type of non-insulin dependent diabetes in which the patients develop diabetes at <25 years of age and have clinical characteristics similar to type 2 diabetes. The prevalence of MODY in a cohort of 4560 patients was found to be 4.8% in South India [7].

Although the prevalence of obesity is less among Asian-Indians than Caucasians, the former have an increased upper body adiposity as measured by the waist to hip ratio (WHR) which is an independent risk factor for type 2 diabetes [8].

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- Integrates prevention strategies and real-world clinical experience, including Indian perspectives and referral pathways
- Key points are highlighted in a box in every chapter to enhance comprehension and make it more reader-friendly
- Well-illustrated with diagrams and flowcharts to make it visually appealing to the readers

Vijay Viswanathan MD PhD FRCP(London and Glasgow) is a Senior Diabetologist and internationally renowned researcher with recognized expertise in diabetic nephropathy and diabetic foot care. He was the first in India to be awarded a PhD in Diabetic Nephropathy by The Tamil Nadu Dr. M.G.R. Medical University, reflecting his pioneering contribution to diabetes research. He is the Head and Chief Diabetologist at MV Hospital for Diabetes, Chennai, Tamil Nadu, India, a reputed tertiary referral center for diabetes management, and President of Prof M Viswanathan Diabetes Research Centre. Dr Viswanathan has authored numerous peer-reviewed publications and has contributed significantly to the prevention and management of chronic diabetic complications. His clinical, academic, and research accomplishments have had a sustained impact on diabetes care and professional training in India and internationally.

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