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ARTICLE

Anemia prevalence and its impact on health-related quality of life in Indian diabetic kidney disease patients: Evidence from a cross-sectional study

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Abstract

Aim: The aim of the study was to determine the prevalence, predictors of anemia, and its impact on health-related quality of life among diabetic kidney disease (DKD) patients.

Methods: Patients with a confirmed diagnosis of type 2 diabetes mellitus (T2DM), and had any stages of CKD (stages I to IV), based on their estimated glomerular filtration rate (eGFR) were enrolled in the study. Anemia was defined using the World Health Organization (WHO) criteria and quality of life was assessed using the EQ-5D scale. All the statistical analysis was performed using SAS v9.4.

Results: A total of 323 patients completed the study. The mean ± SD age of patients was 56 ± 11.25 years, and 51.7% were female. Mean duration of diabetes was 9.6 ± 4.57 years. A total of 227 (70.27%) had anemia as per the WHO criteria. Linear association was observed between the eGFR and hemoglobin. After controlling for the possible confounders in multivariate logistic regression analysis, older age (odds ratio [OR]: 2.46 [95% CI: 1.16 to 5.28], $P = .021$), diabetes duration (OR: 1.53 [95% CI: 1.04 to 2.25], $P = .022$), and CKD stage III (OR: 3.63 [95% CI: 0.99 to 13.32], $P = .004$) were found to be significantly associated with the anemia. Consistently lower EQ-5D index values were observed for the anemic group.

Conclusion: This study reported a high prevalence of anemia and impaired quality of life among DKD patients. Routine screening of anemia can be the most preventive measure to deal with this burdening co-morbid condition.

KEYWORDS

anemia, chronic kidney disease, diabetic kidney disease, epidemiology, nephrology, quality of life

1 | INTRODUCTION

Type 2 diabetes mellitus (T2DM) is one of the prominent risk factors for the development of chronic kidney disease (CKD).[1] CKD is highly prevalent with an estimated global prevalence of 11 to 13%.[2] Developing countries across the world are experiencing an increase in diabetes population, while India currently represents almost half of the global diabetes burden (adult) with an overall prevalence of 72 million.[3] With increasing prevalence of diabetes population, the numbers of co-morbid CKD cases and other associated conditions are also expected to increase substantially.[4–9] A recent multicenter observational study found that more than 40% of the T2DM patients had CKD as co-morbid condition.[10]

The patients with diabetes and CKD presented a unique cohort of diabetic kidney disease (DKD) population, which is identified by elevated urine albumin excretion or reduced glomerular filtration rate (GFR) or both.[11] It is evident from previous studies that, DKD patients are linked with several complications such as anemia, cardiovascular disease, and bone mineral disorder.[12,13] Several epidemiological studies found a high prevalence of anemia in DKD patients.[14,15] Anemia of DKD present at various stages and is considered as the triad for the cardiovascular risk.[16]

In DKD patient's, anemia is responsible for morbidity and all-cause mortality.[17] Furthermore, CKD is more progressive in T2DM patients with anemia as one of the attributable factor contributing the CKD progress to end-stage kidney disease.[18–20] The anemic CKD patients often report poor quality of life, cognitive impairment, sleep disturbances, and ultimately impart increased economic burden.[21–23] A cross-sectional survey study conducted in EU-5 region found CKD patients with anemia to have the lower health-related quality of life (HRQoL) compared to patients without anemia with an impact more evident in nondialysis patients.[24] A retrospective claim database analysis found CKD patients with anemia to have 38% higher overall medical expenditure than nonanemic patients.[23] In addition, the direct and indirect cost of treatment is also higher for anemic dialysis patients compared to untreated patients.[21] Early identification and treatment of anemia have been shown to slow the kidney disease progression, delay the renal replacement therapy, and stabilize the renal function in nondialysis CKD patients.[25,26] It also improves cardiac function, enhancing the quality of life, and reducing hospitalization and mortality rates.[25–27] Hence, presumably, early detection can be a cost-effective approach to deal with this burdening co-morbid condition.[28]

Despite the epidemiological, humanistic, and economic burden associated with co-morbid anemia in CKD population, clinical practice guidelines do not recommend routine screening for anemia and it often remains as an underdiagnosed and undertreated problem.[29–31] Furthermore, there is a dearth of evidence from the Indian settings reporting burden of anemia and its impact on patient's quality of life living with T2DM and kidney disease. Therefore, the aim of the study was to assess the prevalence of anemia and its correlation with the kidney function and quality of life in nondialysis Indian T2DM patients with CKD.

2 | METHODS

2.1 | Participant and design

This cross-sectional study was conducted on T2DM patients with established CKD (stages I to IV), attending outpatient department of Endocrinology at Hakeem Abdul Hameed Centenary (HAHC) Hospital, Jamia Hamdard, New Delhi, India for their routine clinic visit. The study was conducted for a period of 1.2 years from April 2017 through May 2018.

Prior to the enrolment, the study was explained by the principal investigator or their designee. Each patient provided written informed consent before their enrolment. The study protocol, informed consent documents, and case report forms (CRF) were approved by the Jamia Hamdard Institutional Ethics Committee (JHIEC-2017 (04/17). The study was conducted as per the guideline of the Declaration of Helsinki[32] and written in accordance with the statement for Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting an observational study.[33] Participants were assured of their confidentiality and anonymity of their identity.

Patients were selected using predefined inclusion and exclusion criteria. Patients of either sex were included in the study who; (a) aged 18 years or above; (b) had confirmed diagnosis of T2DM from their medical records; (c) had any stages of CKD (stages I to IV), based on their estimated glomerular filtration rate (eGFR), and (d) had a willingness to participate in the study. Type 1 diabetes mellitus patients, or patients receiving dialysis or had gone for transplantation, or had any acute condition, or had any known hematologic disease were excluded from the study.

2.2 | Sample size determination

Previously published studies reported the prevalence of anemia among T2DM patients between 12 and 41.4%.[15,34–38] So, in this study, the proportion was estimated to be 25% with a precision of 5% and a z value of 1.96. So, based on this formula, the minimum sample size required for this study was 288.

2.3 | Data collection and laboratory procedures

A predesigned CRF was used to capture demographic characteristics like age, sex, habits, marital status, etc. Anthropometric parameters and blood pressure were recorded by trained study personnel. Blood pressure was measured at two times; first at 5 min of rest and the second one at sitting position using Richter auscultatory sphygmomanometers. The average of both blood pressures (systolic and diastolic) was finally recorded.

Patients were asked to come again on the next day, after an overnight fast of at least 8 h, for the routine blood tests. A blood sample of 5 mL was collected by trained study personnel for estimating glycated hemoglobin (HbA1c), serum creatinine, fasting plasma glucose (FPG), and complete blood count (CBC), and other tests of kidney function (urea, albumin, sodium, potassium, and chloride), and liver function (total cholesterol, triglyceride, high density lipoprotein, low density lipoprotein, very low density lipoprotein). The HbA1c test was performed by using fully automated high-performance liquid chromatography using the BIORAD testing system. Serum creatinine was determined by a modified Jaffe colorimetric method using fully automated siemens adiva-1800 chemistry analyzer (Siemens Healthcare Pvt Ltd., Mumbai, India). The FPG was determined by using a fully automated Roche Cobas 6000 analyzer (Roche, Mannheim, Germany). Hemoglobin level was determined from the CBC using the automated analyzer. The entire tests were performed in the central pathology lab of HAHC hospital.

2.4 | Study definitions

World Health Organization (WHO) defined anemia as serum hemoglobin level ≤13 g/dL in male and ≤12 g/dL in the female.[39,40] T2DM was defined on the basis of FPG (≥126 mg/dL), or HbA1c level (≥6.5%), or random blood sugar (≥200 mg/dL) as per the American Diabetes Association guidelines from their medical records.[41] Patients HbA1c records were also reviewed in order to assure accurate

glycemic control. HbA1c level below 7 was considered as good glycemic control and HbA1c ≥7 was considered as poor glycemic control. The CKD was defined on the basis of kidney function as determined by means of eGFR. The Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation was used to calculate the eGFR (mL/min/1.73 m^2).[42] CKD stages were classified according to the National Kidney Foundation (NKF) Kidney Disease Outcomes Quality Initiative guidelines (KDOQI).[43] KDOQI guidelines classified CKD into following stages based on eGFR; Stage I CKD (eGFR ≥90 mL/min/1.73 m^2), Stage II CKD (eGFR 60-89 mL/min/1.73 m^2), Stage III CKD (eGFR 30-59 mL/min/1.73 m^2), Stage IV CKD (eGFR 15-29 mL/min/1.73 m^2), and Stage V CKD (eGFR <15 mL/min/1.73 m^2).

We used modified kuppuswamy's socioeconomic scale to assess the economic status of the patient.[44] According to Kuppuswamy's scale, socioeconomic status was divided into five subscales on the basis of occupation, education, and family income scores, that is, upper, upper middle, lower middle, upper lower, and lower. Patient who falls into the lower middle to upper class was grouped as middle class. So, the patient was categorised into two classes, that is, lower class or middle class.

2.5 | Health-related quality of life assessment

HRQoL was assessed using the EuroQol Group's generic EQ-5D-3L utility score. It is based on the descriptive system of patients HRQoL and comprised of five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension is further classified into three levels no problems, some problems, and extreme problems.

2.6 | Statistical analysis

Descriptive statistics were used for presenting the demographic characteristics. We used the χ^2 test and Student's *t*-test for the comparison of categorical and continuous variables. Categorical variables were presented by count and percentages and continuous variables were presented as mean and standard deviations. Spearman's rank correlation test was used to examine the correlation of hemoglobin with single continuous variables. Initially univariate then multivariate logistic regression was performed in order to identify the independent predictors of anemia. Receiver operating characteristics (ROC) curve was plotted to investigate the eGFR cut-off levels against anemia status. A *P*-value of <.05 was considered statistically significant.[45] All the statistical analysis was performed using SAS v9.4.

3 | RESULTS

3.1 | Patient's characteristics

A total of 365 patients participated in the study, of which 42 were excluded as they fulfill the exclusion criteria. The mean ± SD age of patients was 56 ± 11.25 years, and 51.7% were female. The majority (96.3%) was married and had no funding source for the treatment. Three quarters of patients (77.7%) were from lower socioeconomic status and 63.5% were educated. Mean duration of diabetes was 9.6 ± 4.57 years and approximately 43.3% of the patients had a family history of diabetes. There was no significant difference between the anemic and nonanemic patients regarding sex, marital status, BMI, family history of diabetes, education, occupation, substance use, family income, and co-morbidities. A detailed demographic and clinical characteristic of study participants are presented in Tables 1 and 2, respectively.

3.2 | Prevalence and distribution of anemia

The mean hemoglobin level in male and female was found to be 10.55 ± 1.52 g/dL ($P < .05$) and 10.31 ± 1.61 g/dL ($P < .05$), respectively. A total of 227 (70.27%) had anemia as per the WHO criteria. The prevalence in female was 114 (50.2 %) and in male was 113 (49.8%). According to the treatment threshold (Hb < 11 g/dL for both sexes), 123 (38.08%) patients had anemia of which 71 (21.98%) were females and 52 (16.09%) were male. Anemia prevalence increases as the CKD worsening from 18.9 (stage I CKD) to 42.8% (stage III CKD).

Age, BMI, diabetes duration, systolic blood pressure, diastolic blood pressure, and serum creatinine were found to be inversely correlated with the level of hemoglobin. On the other hand, factors like HbA1c, FPG, postprandial glucose, albumin, and eGFR were positively correlated with the level of hemoglobin (Table 3). Linear association was observed between the eGFR and hemoglobin in the Pearson correlation analysis (Figure 1). The optimization of sensitivity and specificity, taken from ROC tabulations and plots (Figure 2), was at an eGFR cut-off of 66.8 mL/min/1.73 m^2 for predicting anemia at the treatment level, with a sensitivity of 71.37% (65.01-77.15%) and specificity of 59.38% (48.87-59.29%), and area under the ROC curve of 0.69 (0.62-0.75).

3.3 | Predictors of anemia

Anemic patients were significantly older (57.1 ± 11.24 years' vs 53. ± 10.81 years, $P = .003$), had a long duration of diabetes (10.4 ± 4.39 vs 8.7 ± 4.84 years, $P = .012$), lower eGFR (70 ± 24.10 vs 85.5 ± 24.50, $P \leq .000$), higher serum creatinine (1.1 ± 0.62 vs 1 ± 0.48, $P = .025$), and serum uric acid (5.3 ± 1.48 vs 4.9 ± 1.41, $P = .014$) than nonanemic patients. In bivariate analysis, older age (OR: 2.89 [95% CI: 1.77 to 4.73], $P \leq 0.000$), insurance as a source of funding (OR: 0.23 [95% CI: 0.10 to 0.48], $P \leq .000$), duration of diabetes (OR: 1.95 [95% CI: 1.19 to 3.19], $P = .007$), CKD stage II (OR: 1.74 [95% CI: 0.99 to 3.08], $P = .052$) and CKD stages III- IV (OR: 6.12 [95% CI: 3.00 to 12.45], $P \leq .000$) were found to be significantly associated with the anemia (Table 4). After controlling for the possible confounders in multivariate logistic regression analysis, only older age (OR: 2.46 [95% CI: 1.16 to 5.28], $P = .021$), diabetes duration (OR: 1.53 [95% CI: 1.04 to 2.25], $P = .022$), and CKD stages III-IV (OR: 3.63 [95% CI: 0.99 to 13.32], $P = .004$) were found to be significantly associated with the anemia (Table 4).

TABLE 1 Background characteristics of T2DM patients included in the study ($n = 323$)

Variables	Anemic ($n = 227$)	Nonanemic ($n = 96$)	Total ($n = 323$)	*P* value
Age groups				0.000
<50	74 (32.5%)	57 (59.3%)	131 (40.55%)	
≥50	153 (67.5%)	39 (40.7%)	192 (59.45%)	
Gender				.465
Male	113 (49.8%)	43 (44.8%)	156 (48.3%)	
Female	114 (50.2%)	53 (55.2%)	167 (51.7%)	
Marital status				.754
Married	219 (96.5%)	92 (95.8%)	311 (96.3%)	
Unmarried	8 (3.5%)	4 (4.2%)	12 (3.72%)	
Source of funding				.056
Self	214 (94.28%)	76 (79.17%)	290 (89.78%)	
Insurance	13 (5.72%)	20 (20.83%)	33 (10.22%)	
BMI categories				.160
Normal	97 (42.73%)	33 (33.93%)	130 (40.24%)	
Overweight	78 (34.36%)	42 (43.75%)	120 (37.16%)	
Obese	52 (22.91%)	21 (22.32%)	73 (22.60%)	
Family history of diabetes				.461
No	132 (58.1%)	51 (53.1%)	183 (56.7%)	
Yes	95 (41.9%)	45 (46.9%)	140 (43.3%)	
Education				.745
Illiterate	84 (37.0%)	34 (35.4%)	118 (36.5%)	
Primary school	66 (29.1%)	25 (26.0%)	91 (28.2%)	
High school	53 (23.3%)	28 (29.2%)	81 (25.1%)	
Graduate	24 (10.6%)	9 (9.38%)	33 (10.2%)	
Occupation				.895
Employed	155 (68.3%)	67 (69.8%)	222 (68.7%)	
Unemployed	72 (31.7%)	29 (30.2%)	101 (31.3%)	
Substance use (Alcohol, smoking, tobacco chewing)				.311
Yes	55 (24.2%)	18 (18.8%)	73 (22.6%)	
No	172 (75.8%)	78 (81.2%)	250 (77.4%)	
Family income				.332
Less than 20 000 INR	192 (84.6%)	77 (80.2%)	269 (83.3%)	
More than 20 000 INR	35 (15.4%)	19 (19.8%)	54 (16.7%)	
Socioeconomic status				.662
Lower	178 (78.4%)	73 (76.0%)	251 (77.7%)	
Middle	49 (21.6%)	23 (24.0%)	72 (22.3%)	
Co-morbidities				.251
Yes	85 (37.4%)	29 (30.2%)	114 (35.3%)	
No	142 (62.6%)	67 (69.8%)	209 (64.7%)	
Duration of diabetes				.003
<10 years	107 (47.1%)	61 (63.5%)	168 (52%)	
≥10 years	120 (52.9%)	35 (36.5%)	155 (48%)	
CKD Stage				<.000
Stage I	43 (18.9%)	38 (39.6%)	81 (25.1%)	
Stage II	87 (38.3%)	44 (45.8%)	131 (40.5%)	
Stages III-IV	97 (42.8%)	14 (14.6%)	111 (34.4%)	

BMI, body mass index; CKD, chronic kidney disease; INR, Indian national rupees.

TABLE 2 Comparisons of clinical and laboratory data of patients with and without anemia

Variables	Anemic (mean ± SD)	Nonanemic (mean ± SD)	Total (mean ± SD)	*P* value
Age (year)	57.1 (11.24)	53.1 (10.81)	56 (11.25)	.003
BMI (kg/m^2)	26.8 (4.81)	26.7 (3.82)	26.8 (4.53)	.760
Systolic blood pressure (mmHg)	139 (19.32)	136.8 (14.71)	138.4 (18.08)	.263
Diastolic blood pressure (mmHg)	83.1 (12.82)	80.5 (13.75)	82.3 (13.14)	.109
Duration of diabetes (years)	10.0 (4.39)	8.7 (4.84)	9.6 (4.57)	.012
HbA1c (%)	8.7 (2.19)	8.9 (2.44)	8.7 (2.26)	.393
FPG (mmol/L)	170.1 (68.57)	169.3 (64.41)	169.9 (67.26)	.921
PPG (mmol/L)	245.8 (89.76)	252.7 (90.97)	247.9 (90.03)	.533
Blood urea (mg/dL)	29.9 (10.56)	29.3 (10.03)	29.7 (10.40)	.664
Serum creatinine (mg/dL)	1.1 (0.62)	1.0 (0.48)	1.1 (0.58)	.025
Serum uric acid (mg/dL)	5.3 (1.48)	4.9 (1.41)	5.2 (1.47)	.014
Serum protein total (g/dL)	7.5 (0.86)	7.5 (0.80)	7.5 (0.84)	.994
Albumin (g/dL)	3.8 (0.85)	3.9 (0.77)	3.8 (0.83)	.398
Globulin (g/dL)	4.0 (0.49)	3.9 (0.51)	4.0 (0.50)	.178
Sodium (mEq/L)	127.4 (30.50)	121.9 (35.01)	125.8 (31.95)	.158
Potassium (mEq/L)	4.7 (0.63)	4.6 (0.80)	4.7 (0.68)	.200
Chloride (mEq/L)	104.2 (5.56)	104.1 (10.36)	104.1 (7.31)	.927
eGFR (mL/min/1.73 m^2)	70 (24.10)	85.5 (24.50)	74.6 (25.21)	<.000
Hemoglobin (g/dL)	10.4 (1.58)	13.5 (1.07)	11.4 (2.02)	<.000
Total cholesterol (mg/dL)	158.1 (38.57)	159.7 (42.38)	158.5 (39.68)	.735
Triglyceride (mg/dL)	129.1 (51.33)	133.9 (81.21)	130.6 (61.64)	.596
HDL cholesterol (mg/dL)	50.0 (14.13)	44.6 (12.05)	48.4 (13.75)	.001
LDL cholesterol (mg/dL)	114.5 (33.33)	113.2 (32.67)	114.1 (33.09)	.744
VLDL cholesterol (mg/dL)	26 (10.67)	27.4 (16.38)	26.4 (12.63)	.430

BMI, body mass index; eGFR, estimated glomerular filtration rate; FPG, fasting plasma glucose; HbA1c, glycated hemoglobin; HDL, high-density lipoproteins; LDL, low-density lipoproteins; PPG, postprandial glucose; VLDL, very low-density lipoprotein.

3.4 | Impact of anemia on HRQoL

Consistently lower EQ-5D index values were observed for the anemic group as compared to nonanemic T2DM patients with CKD. Anemic patients have a poor quality of life as compared to the nonanemic (Table 5). The proportion of patients reporting problems in all the five domains of HRQoL were significantly higher in the CKD stages III-IV ($P < .05$) (Figure 3).

4 | DISCUSSION

Epidemiological studies conducted in Indian settings showed an increasing prevalence of CKD among T2DM patients; however, these studies not provided insights into the epidemiology of DKD in association with anemia. To date, no other studies have focused on the epidemiology of anemia in T2DM patients with nondialysis CKD in India. This was the first cross-sectional, noninterventional study to assess the anemia prevalence among nondialysis T2DM CKD patients.

The current study demonstrates a higher prevalence of anemia in Indian T2DM patients with non-dialysis CKD. Anemic patients were significantly older, had a long duration of diabetes, and lower eGFR as compared to nonanemic patients. Furthermore, patients >50 years of age, long duration of diabetes (>10 years), and CKD (eGFR <60 mL/min/1.73 m^2) was found to be the independent predictors of anemia. Anemia prevalence in person with diabetes altered kidney function in our study was comparable with the documented prevalence rate from other parts of the world.

A multicenter study from Italy found 61.7% prevalence of anemia in person with diabetes and CKD.[15] A cross-sectional audit report from the United Kingdom found 59% anemia prevalence among older adults attending diabetic clinics.[46] Likewise, Dousdampanis et al carried out a cross-sectional study to understand the prevalence of anemia among 101 diabetes mellitus patients with CKD stages (III-IV) and found 60% anemia prevalence.[14] Similarly, a population-based study was conducted in 44 countries of northern Georgia and noted 78.6% prevalence of anemia in person with diabetes.[47] The reason for the higher prevalence could be the older age of the participants as age is the risk factor for the development of anemia.[48] A multicentre cross-sectional study from Barcelona and China also reported a high prevalence of anemia (58.5 and 51.5%) in patients with nondialysis CKD.[49,50] Studies from Korea (44.9%), Cameroon (41.4%), Iran (30%), and United States

TABLE 3 Correlation between hemoglobin level and other variables

Variables	Correlation with hemoglobin	*P* value
Age (years)	−0.248	<.001
BMI (kg/m^2)	−0.053	.333
Duration of diabetes (years)	−0.208	.000
Systolic blood pressure (mmHg)	−0.106	.055
Diastolic blood pressure (mmHg)	−0.127	.022
HbA1c (%)	0.132	.017
FPG (mmol/L)	0.054	.330
PPG (mmol/L)	0.088	.111
Blood urea (mg/dL)	−0.042	.447
Serum creatinine (mg/dL)	−0.148	.007
Serum uric acid (mg/dL)	−0.055	.316
Serum protein total (g/dL)	−0.042	.448
Albumin (g/dL)	0.199	.000
Globulin (g/dL)	−0.076	.167
Sodium (mEq/L)	−0.078	.160
Potassium (mEq/L)	0.003	.951
Chloride (mEq/L)	0.014	.790
eGFR (mL/min/1.73 m^2)	0.103	.000
Total cholesterol (mg/dL)	0.029	.596
Triglyceride (mg/dL)	0.034	.538
HDL cholesterol (mg/dL)	−0.030	.591
LDL cholesterol (mg/dL)	0.041	.457
VLDL cholesterol (mg/dL)	0.039	.474

BMI, body mass index; eGFR, estimated glomerular filtration rate; FPG, fasting plasma glucose; HbA1c, glycated hemoglobin; HDL, high-density lipoproteins; LDL, low-density lipoproteins; PPG, postprandial glucose; VLDL, very low-density lipoprotein.

(15.4%) reported a lower prevalence of anemia person with diabetes with altered kidney function.[34,35,51,52] The reason for lower prevalence could be attributed to the geographical variation, the age of the study population, and living style. In our study, the prevalence of anemia increased with the progressing CKD stages. A similar effect was observed in large-scale, cross-sectional, US multicenter survey, where the prevalence was found to be increased with the decline in renal function.[53] Evidence from Chinese cross-sectional study also reported the similar observation, the prevalence of anemia increased from 22.4 to 79.2% from stage-I CKD to Stage-IV CKD.[50] Likewise, Loutradis conducted a nested case-control study and found a higher prevalence of anemia in T2DM CKD patients with advanced CKD stages.[54] The relationship between anemia and the progression of renal failure is well supported by observational and interventional studies and considered anemia as an independent risk factor for CKD progression.[25,55,56]

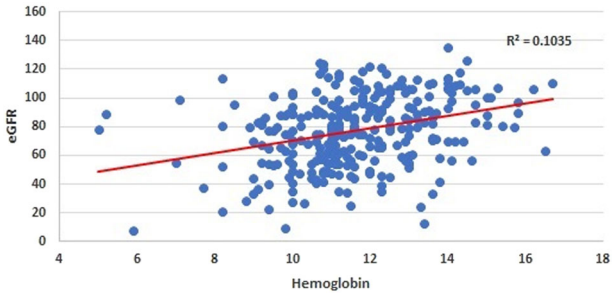

FIGURE 1 Correlation between hemoglobin level and the eGFR

In this study, eGFR was directly correlated with the hemoglobin and inversely correlated with the serum creatinine level. A similar finding was reported by Kazmi et al[57] in a retrospective cohort study. This finding was also supported by Feteh et al[35] and New et al,[58] they also found a linear relation between the eGFR and hemoglobin level. Several cross-sectional studies reported older age, long duration of diabetes, and CKD as an independent predictor of anemia.[35,46,59] This study also revealed similar findings. Real-world evidence suggests poor HRQoL among the population with chronic conditions (diabetes, anemia, and asthma).[60] A cross-sectional study from Japan found a decrease in HRQoL with the progression of CKD stages.[61] Similar findings were reported in this study.

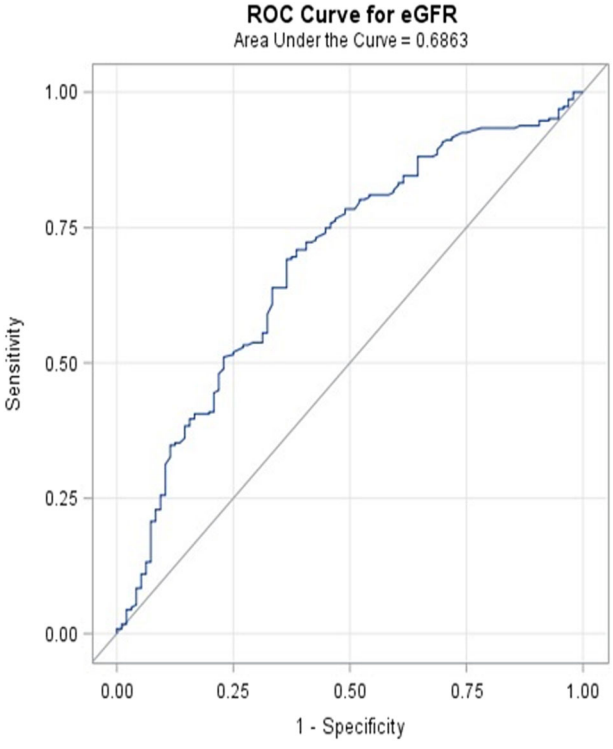

FIGURE 2 Receiver operating characteristic curve for prediction of anemia

TABLE 4 The unadjusted and adjusted odds ratio for occurrence of anemia

Variables	Anemic (*N* = 227)	Crude odds ratio (95% CI)	*P*-Value	Adjusted odds ratio (95% CI)	*P*-Value
Age groups					
<50 years	74 (32.5%)	Referent		Referent	
≥50 years	153 (67.5%)	2.89 (1.77, 4.73)	<.0001	2.46 (1.16, 5.28)	.021
Gender					
Female	114 (50.2%)	Referent			
Male	113 (49.8%)	1.22 (0.75, 1.97)	.413	1.16 (0.83, 1.67)	.370
Source of funding					
Self	214 (94.28%)	Referent			
Insurance	13 (5.72%)	0.23 (0.10, 0.48)	<.0001	0.14 (0.05, 0.88)	.12
BMI Categories					
Normal	97 (42.73%)	Referent		Referent	
Overweight	78 (34.36%)	0.63 (0.36, 1.08)	.097	0.51 (0.23, 1.11)	.544
Obese	52 (22.91%)	0.84 (0.44, 1.60)	.603	0.57 (0.23, 1.40)	.525
Family history of diabetes					
Yes	95 (41.9%)	Referent		Referent	
No	132 (58.1%)	1.22 (0.75, 1.98)	.40	1.04 (0.82, 1.39)	.725
Education					
Illiterate	84 (37.0%)	Referent		Referent	
Primary school	66 (29.1%)	1.06 (0.58, 1.96)	.823	0.88 (0.70, 1.06)	.155
High school	53 (23.3%)	0.76 (0.41, 1.40)	.389	0.53 (0.19, 1.49)	.241
Graduate	24 (10.6%)	1.11 (0.46, 2.63)	.806	1.02 (0.92, 1.08)	.614
Occupation					
Unemployed	72 (31.7%)	Referent		Referent	
Employed	155 (68.3%)	0.93 (0.55, 1.56)	.791	0.68 (0.30, 1.55)	.366
Substance use					
No	172 (75.8%)	Referent		Referent	
Yes	55 (24.2%)	1.38 (0.76, 2.51)	.281	1.19 (0.95, 1.47)	.145
Family income					
Less than 20 000 INR	192 (84.6%)	Referent		Referent	
More than 20 000 INR	35 (15.4%)	1.09 (0.42, 2.78)	.365	0.75 (0.40, 1.39)	.852
Socioeconomic status					
Lower	178 (78.4%)	Referent		Referent	
Middle	49 (21.6%)	0.82 (0.46, 1.43)	.482	0.33 (0.12, 1.45)	.104
Co-morbidities					
No	142 (62.6%)	Referent		Referent	
Yes	85 (37.4%)	1.38 (0.82, 2.30)	.213	1.24 (0.56, 2.73)	.589
Duration of diabetes					
<10 years	107 (47.1%)	Referent		Referent	
≥10 years	120 (52.9%)	1.95 (1.19, 3.19)	.007	1.53 (1.04, 2.25)	.022
CKD Stage					
Stage I	43 (18.9%)	Referent		Referent	
Stage II	87 (38.3%)	1.74 (0.99, 3.08)	.052	1.21 (0.88, 1.64)	.189
Stages III-IV	97 (42.8%)	6.12 (3.00, 12.45)	<.000	3.63 (0.99, 13.32)	.004
Glycemic control					
Good (HbA1c ≤ 7)	57 (25.1%)	Referent		Referent	
Poor (HbA1c > 7)	170 (74.9%)	0.93 (0.53, 1.63)	.823	0.58 (0.21, 1.64)	.311

BMI, body mass index; CKD, chronic kidney disease; HbA1c, glycated hemoglobin; INR, Indian national rupees.

TABLE 5 Impact of anemia on EQ-5D index value according to disease severity

Disease severity	Nonanemic ($n = 96$) Mean (SD)	Anemic ($n = 227$) mean (SD)	*P*-value
CKD Stage I	0.88 (0.14)	0.85 (0.18)	.508
CKD Stage II	0.83 (0.22)	0.78 (0.29)	.004
CKD Stages III to IV	0.73 (0.23)	0.65 (0.30)	<.000

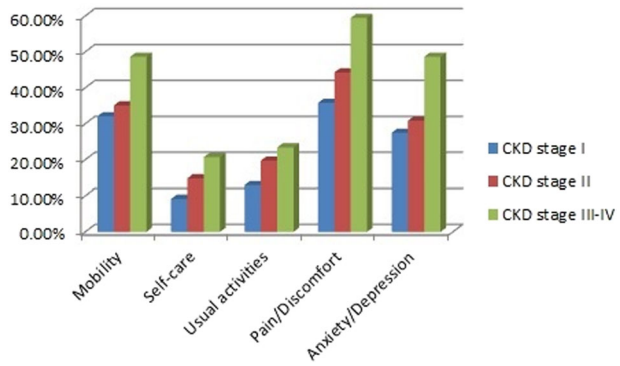

FIGURE 3 Proportion of patients reporting problems for the five EQ-5D dimensions by CKD stages

The high prevalence data in our study clearly indicates that T2DM patients with CKD who are on the risk of anemia should be screened regularly and managed more proactively since it is a modifiable risk factor of cardiovascular and renal damage. It is evident from previous studies that anemia increases the risk of dialysis and the majority of CKD patients are not receiving dialysis, as compared with patients receiving regular dialysis.[29,30,50] Hence, a call for evidence-based management algorithm is essentially required for diagnosis, prevention, awareness, and improving the care of anemia, particularly in CKD patients who are not on dialysis given the fact that the burden of T2DM is growing worldwide.

This study should be interpreted in light of certain limitations. First, the cross-sectional study design does not allow drawing true associations between anemia and their causal factors. Second, the absence of a control group impacts the viability of our findings. Third, results cannot be generalized to the entire Indian population as the patients were selected from a single center. Fourth, the reticulocyte count and hemoglobinopathies were not assessed in the studied population. Last, we cannot rule out the possibility of confounding effects of comorbidity, concomitant medication, and lifestyle factors on the diagnosis of anemia in our study. Nevertheless, this is first of its kind study, which has focused on the epidemiology of anemia in person with diabetes patients with nondialysis CKD in Indian population. A well-designed study is necessarily recommended to further identify the actual burden of anemia and associated factors in a large population.

5 | CONCLUSION

In conclusion, this cross-sectional study found a high prevalence of anemia among DKD patients with impaired HRQoL. Routine screening of anemia can be the most preventive measure to deal with this burdening co-morbid condition. However, to generalize the finding, we recommend large epidemiological studies with the comparable control group.

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CONFERENCE PRESENTATION

This topic has been presented as a poster presentation in the ISN World Congress of Nephrology, April 12–15, 2019 Melbourne, Australia. First author (Salman Hussain) received travel grant award from ISN to present this research work. Mr. Salman Hussain also served as a social media intern at ISN World Congress of Nephrology 2019.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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