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Prevalence and Correlates of Depression in Patients With Chronic Kidney Disease Undergoing Maintenance Hemodialysis at a Tertiary Care Center in Kerala

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Abstract

Introduction

Chronic kidney disease (CKD) is a disabling illness with significant physical, psychological and social consequences. Patients undergoing hemodialysis are at increased risk of developing depressive disorders. Biochemical derangements associated with kidney disease, compounded by the psychological burden of physical and social disability, are established contributory factors. Data on the prevalence and correlates of depression in CKD patients in Kerala remain scarce. Identification of depression in early stages is important in CKD patients as it is a significant predictor of disease progression, hemodialysis initiation, hospitalization, and death. This study aimed to determine the prevalence of depression in CKD patients on maintenance hemodialysis and to identify any sociodemographic, clinical, or biochemical correlates.

Materials and methods

A cross-sectional descriptive study was conducted in the Department of Nephrology, Government T.D. Medical College, Alappuzha, Kerala, over a period of one year. A total of 120 participants were enrolled in the study using consecutive sampling. Sociodemographic, clinical, and biochemical data were collected using a specially designed proforma. Depression was clinically diagnosed by a psychiatrist using ICD-10 Diagnostic Criteria for Research (ICD-10-DCR). The severity of the depressive episode was assessed using the Beck Depression Inventory-II (BDI-II). Data were analyzed using appropriate statistical tests. Multiple linear and binary logistic regression analyses were performed to identify the variables independently associated with the diagnosis of depression and depressive symptom severity.

Results

The prevalence of depression was 42.5% (51 of 120 patients; 95% CI 34.0-51.4%). Among depressed participants, severity was mild in 18 (35.3%), moderate in 26 (51.0%), and severe in 7 (13.7%). The mean BDI-II score for the whole sample was 17.25 ± 6.59 . In univariate analysis, depression was significantly associated with socioeconomic status, low body mass index, shorter duration of dialysis, erythropoietin therapy, hyponatremia, hypocalcemia, lower hemoglobin, lower serum albumin, and higher high-sensitivity C-reactive protein (hs-CRP). In multiple linear regression, lower hemoglobin ($\beta = -0.267$, $p = 0.002$) and lower serum sodium ($\beta = -0.236$, $p = 0.006$) remained independently associated with a higher BDI-II score, with the model accounting for 30.8% of the variance (adjusted $R^2 = 0.271$, $F = 8.367$, $p < 0.001$). In binary logistic regression, hemoglobin was the only variable independently associated with depression status, with each 1 g/dL lower hemoglobin corresponding to 8.20-fold higher odds of depression (95% CI 2.56-26.32, $p < 0.001$); hyponatremia fell just short of conventional significance (adjusted OR 2.55, 95% CI 1.00-6.54, $p = 0.051$).

Conclusion

The high prevalence of depression among CKD patients undergoing maintenance hemodialysis suggests that clinicians should actively screen for depressive symptoms in these patients, especially those with the identified biochemical risk factors, to enable early identification and improve quality of life.

Categories: Psychiatry, Psychology, Nephrology

Keywords: bdi score, ckd, depression, esrd, hemodialysis, hs-crp

Introduction

Depression is a leading cause of disability worldwide and one of the main contributors to the global burden of disease, affecting an estimated 332 million people. In its most severe form, depression can result in suicide [1].

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Chronic kidney disease (CKD) is one of the fastest-growing non-communicable diseases. CKD affects about 14.2% of the global adult population, or 788 million adults aged 20 years and older, according to the 2023 Global Burden of Disease study. India ranked second globally, with about 138 million cases that year [2]. A pooled meta-analysis of community studies in India found that CKD prevalence increased from 11.12% during 2011–2017 to 16.38% during 2018–2023 [3]. Hypertension and diabetes continue to be the major causes of CKD in India [4].

CKD stage V, characterized by an eGFR <15 mL/min/1.73 m² and referred to as end-stage renal disease (ESRD) once dialysis is initiated, generally requires the initiation of maintenance hemodialysis [5,6]. Hemodialysis substantially affects the quality of life and psychological state of patients. Chronic treatment, diet restriction, high treatment costs, and decreased working ability cause social and psychological disability [6].

Depression is the most common psychiatric disorder among patients with CKD [7]. The prevalence of depression is variable based on population and screening tools. Uremic symptoms, including anorexia, insomnia, and fatigue, overlap considerably with depressive symptoms, complicating diagnosis [8]. Depression in CKD arises from a complex interplay of biological, sociodemographic, and clinical factors. In Indian CKD populations, lower educational attainment and self-funded, uninsured treatment status have been independently associated with a higher likelihood of depression, reflecting the socioeconomic burden that compounds the psychological impact of chronic dialysis dependency [9]. Evaluation of depression is particularly important in patients on maintenance hemodialysis, since depression is associated with poorer treatment adherence, reduced quality of life, and a modest but significant increase in mortality risk [8,10] and carries an elevated suicide risk.

Depression associated with CKD remains particularly understudied in Kerala. Therefore, the present study had two distinct purposes. The primary purpose was confirmatory and descriptive: to estimate the prevalence of depression and the distribution of its severity among patients with CKD stage V receiving maintenance hemodialysis at a public tertiary care hospital in Kerala. The secondary purpose was exploratory: to assess the sociodemographic, clinical, and biochemical factors associated with depression, examined both as a categorical diagnosis and as a continuous measure of depressive symptom severity, and to identify which of those factors remain associated once the others are taken into account.

Materials And Methods

Study design

This descriptive, cross-sectional study was conducted in the dialysis clinic under the Department of Nephrology, Government T.D. Medical College Hospital, Alappuzha, Kerala, over one year following Institutional Ethics Committee clearance (EC/10/17). The sample size was calculated using the formula

$$n = \frac{Z^2 pq}{d^2}, \text{ where } n \text{ represents the required sample size, } Z \text{ is the standard normal deviate at a 95\%}$$

confidence level (1.96), p is the prevalence from previous studies (46%) [11], q is $1 - p$ (54%), and d is the absolute precision. A relative precision of 20% was considered, corresponding to an absolute precision of 9.2 percentage points (20% of 46%). The minimum effective sample size was 113. By using consecutive sampling, 120 CKD patients attending the hemodialysis unit were enrolled. Patients over the age of 18 who were receiving maintenance hemodialysis, had CKD stage V (eGFR <15 mL/min/1.73 m²) and were willing to provide written informed consent were included. Exclusion criteria were a diagnosed mental illness before CKD onset, severe cognitive impairment or delirium interfering with mental state evaluation, current use of antidepressants or antipsychotics, and refusal of informed consent.

Data collection

A specially designed semi-structured proforma was used to collect sociodemographic, clinical, and biochemical data (Appendix). Sociodemographic variables included age, sex, educational status, socioeconomic status (classified according to the Modified Kuppuswamy Scale) [12], marital status, and family type. Clinical variables included primary kidney disease, presence of diabetes mellitus and systemic hypertension, body mass index (BMI), hemodialysis schedule (once, twice, or thrice weekly), duration of hemodialysis, presence of arteriovenous (AV) fistula at dialysis initiation, plan for renal transplantation, and receipt of erythropoietin. Biochemical parameters included serum hemoglobin (g/dL), albumin (g/dL), ferritin (ng/mL), sodium (mEq/L), potassium (mEq/L), calcium (mg/dL), and high-sensitivity C-reactive protein (hs-CRP) (mg/L). Serum sodium, serum potassium, and serum calcium were recorded as dichotomous categories: sodium as below 135 mEq/L or 135 mEq/L and above, potassium as below 3.5 mEq/L or 3.5 mEq/L and above, and calcium as below 9 mg/dL or between 9 and 11 mg/dL. All biochemical measurements were those obtained as part of routine pre-dialysis care in the hospital laboratory.

Assessment tools

Every patient who satisfied the selection criteria underwent a clinical interview by a psychiatrist during which the International Classification of Diseases, 10th Revision, Diagnostic Criteria for Research (ICD-10-

DCR) criteria were applied [13]. Every participant was separately administered the Beck Depression Inventory-II (BDI-II) [14]. Depression was diagnosed using ICD10-DCR [13]. Severity of depressive episodes was evaluated using the BDI-II [14], a 21-item self-rating scale widely used in CKD and hemodialysis populations, with a cutoff score of ≥ 16 used to define depression in this study, consistent with similar studies in ESRD populations that recommend a higher BDI-II cutoff than the standard general-population threshold to improve diagnostic accuracy in this group [15,16]. As this diagnostic cutoff was derived from population-specific studies rather than the standard manual bands, scores of 14-15 - classified as mild depression in the original BDI-II manual - were included within the no-depression category in this study, and the mild band was correspondingly redefined as 16-19. Scores from 20 to 28 were categorized as moderate depression, and scores from 29 to 63 as severe depression, as per the inventory [14]. The licensed regional-language version of the BDI-II was used after obtaining permission from the Pearson Assessment Group.

Statistical analysis

Categorical variables were summarized as frequencies with corresponding percentages, and continuous variables were described using either the mean with standard deviation or the median with interquartile range based on their distribution. Normality of continuous variables was assessed using the Shapiro-Wilk test, and for regression models, the normality of residuals was additionally examined. Associations between depression status and categorical variables were analyzed using Pearson's chi-square test or Fisher's exact test as appropriate. Differences in continuous variables between the depressed and non-depressed groups were evaluated using the independent samples t-test when both groups satisfied normality assumptions, and the Mann-Whitney U test when either group violated them. The association between BDI-II scores and continuous biochemical variables was examined using Spearman's rank correlation coefficient due to the markedly non-normal distribution of the BDI-II scores. Variables showing significant associations with the BDI-II score in univariate analysis were included in a multiple linear regression model with the BDI-II score as the dependent variable, and the same predictors were entered into a binary logistic regression model with depression status as the dependent variable. A p-value < 0.05 was considered statistically significant. All analyses were performed using the open-source statistical software jamovi (version 2.7.33; The jamovi project, Sydney, Australia).

An overview of the study design is given in Figure 1

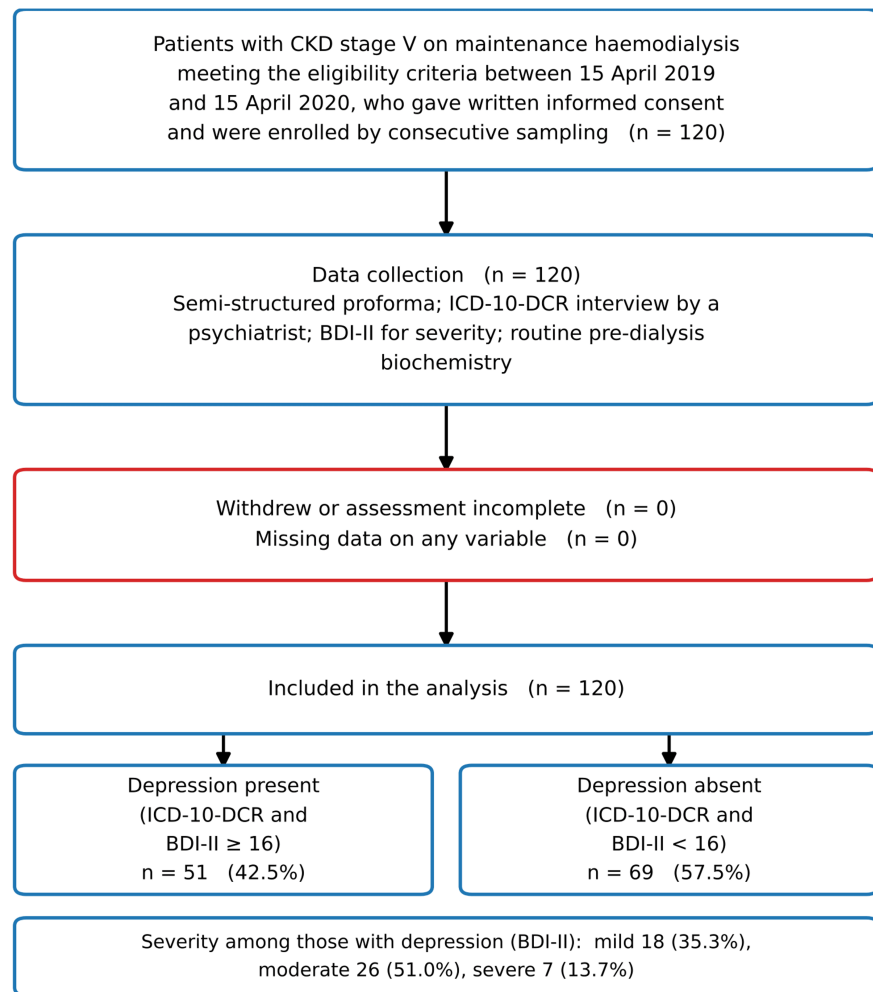


FIGURE 1: Overview of the study design

Results

Characteristics of the study population

A total of 120 patients with CKD undergoing maintenance hemodialysis were included in the study. The mean age was 50.2 ± 9.0 years, with a median of 51.5 years and a range of 22 to 74 years; 87 patients (72.5%) were male, and 33 (27.5%) were female. Diabetic nephropathy was the most common primary kidney disease, present in 70 patients (58.3%), and diabetes mellitus and systemic hypertension were present in 92 (76.7%) and 63 (52.5%) patients, respectively. Categorical variables are reported throughout as n (%). Continuous variables were tested for normality using the Shapiro-Wilk test and are reported as mean $\pm$ standard deviation together with the median and interquartile range, since hemoglobin, serum albumin, serum ferritin, hs-CRP, and the BDI-II score all departed significantly from normality.

Prevalence and severity of depression

Depression was identified in 51 of 120 patients, yielding an overall prevalence of 42.5% (95% confidence interval 34.0-51.4%). Among the 51 patients with depression, 26 (51.0%) had moderate depressive episodes, 18 (35.3%) had mild depressive episodes, and 7 (13.7%) had severe depressive episodes. Expressed as a proportion of the whole study population, 33 patients (27.5%) had depression of at least moderate severity. The mean BDI-II score for the whole sample was 17.25 ± 6.59 , with a median of 15 (interquartile range 13 to 20) and an observed range of 8 to 38.

Depression and Sociodemographic Variables

Among sociodemographic variables (Table 1), depression showed a statistically significant association only with socioeconomic status, the prevalence being highest in the upper lower class at 54.4% compared with 28.6% in the lower middle class and 35.7% in the lowerclass ($\chi^2 = 6.601$, $df = 2$, $p = 0.037$); the association

was not, however, a graded one, and the chi-square test for linear trend across the classes was not significant ($\chi^2 = 0.357$, $df = 1$, $p = 0.550$). No significant association was found between depression and age, gender, educational status, family type, or marital status. The prevalence of depression was numerically higher in men than in women, at 46.0% against 33.3%, but this difference did not reach statistical significance ($\chi^2 = 1.565$, $df = 1$, $p = 0.211$).

Variable	Total, n (%)	Depressed (n = 51), n (%)	Non-depressed (n = 69), n (%)	χ^2 (df)	p-value
Age (years)				0.340 (2)	0.844
45 and below	29 (24.2)	11 (37.9)	18 (62.1)	-	-
46-55	62 (51.7)	27 (43.5)	35 (56.5)		
Above 55	29 (24.2)	13 (44.8)	16 (55.2)		
Gender				1.565 (1)	0.211
Male	87 (72.5)	40 (46.0)	47 (54.0)	-	-
Female	33 (27.5)	11 (33.3)	22 (66.7)		
Educational status				2.085 (2)	0.353
Higher secondary and above	36 (30.0)	17 (47.2)	19 (52.8)	-	-
High school	55 (45.8)	25 (45.5)	30 (54.5)		
Middle school and below	29 (24.2)	9 (31.0)	20 (69.0)		
Socioeconomic status				6.601 (2)	0.037*
Lower middle	35 (29.2)	10 (28.6)	25 (71.4)	-	-
Upper lower	57 (47.5)	31 (54.4)	26 (45.6)		
Lower	28 (23.3)	10 (35.7)	18 (64.3)		
Family type				1.156 (2)	0.561
Nuclear	54 (45.0)	24 (44.4)	30 (55.6)	-	-
Joint	55 (45.8)	21 (38.2)	34 (61.8)		
Extended	11 (9.2)	6 (54.5)	5 (45.5)		
Marital status				0.015 (1)	0.904
Married	84 (70.0)	36 (42.9)	48 (57.1)	-	-
Widowed, divorced or unmarried	36 (30.0)	15 (41.7)	21 (58.3)		

TABLE 1: Association between depression and sociodemographic variables (N = 120)

χ^2 : Pearson chi-square test; (df): degrees of freedom; $p < 0.05$ considered statistically significant (*).

Percentages in the total column are of the whole sample; percentages in the depressed and non-depressed columns are row percentages calculated on the total in that category.

Depression and Clinical Variables

Among clinical variables (Table 2), depression showed a statistically significant association with low BMI, with 56.9% of underweight patients affected compared with 35.6% of those of normal weight and 10.0% of overweight patients ($\chi^2 = 9.779$, $df = 2$, $p = 0.008$); the chi-square test for linear trend was also significant ($\chi^2 = 9.657$, $df = 1$, $p = 0.002$), confirming a graded relationship. A significant association was also observed with shorter duration of hemodialysis: patients on dialysis for less than 12 months had the highest prevalence of depression at 66.7%, which declined progressively with longer dialysis duration to 27.3% among those on dialysis for more than 36 months ($\chi^2 = 11.013$, $df = 3$, $p = 0.012$; test for linear trend $\chi^2 = 9.695$, $df = 1$, $p = 0.002$). The strongest association observed among the clinical variables was with erythropoietin therapy: depression was present in 40 of the 61 patients receiving erythropoietin (65.6%) compared with 11 of the 59 who were not (18.6%), giving $\chi^2 = 27.030$, $df = 1$, $p < 0.001$ and an odds ratio of 8.31 (95% confidence interval

3.58 to 19.28).

Clinical variable	Total, n (%)	Depressed (n = 51), n (%)	Non-depressed (n = 69), n (%)	χ^2 (df)	p-value
Primary kidney disease				3.004 (3)	0.391
Diabetic nephropathy	70 (58.3)	34 (48.6)	36 (51.4)	-	-
Ischemic renal failure	27 (22.5)	9 (33.3)	18 (66.7)		
Chronic glomerulonephritis	19 (15.8)	6 (31.6)	13 (68.4)		
Adult polycystic kidney disease	4 (3.3)	2 (50.0)	2 (50.0)		
Diabetes mellitus				1.603 (1)	0.205
Present	92 (76.7)	42 (45.7)	50 (54.3)	-	-
Absent	28 (23.3)	9 (32.1)	19 (67.9)		
Systemic hypertension				0.677 (1)	0.411
Present	63 (52.5)	29 (46.0)	34 (54.0)	-	-
Absent	57 (47.5)	22 (38.6)	35 (61.4)		
Body mass index (kg/m ²)				9.779 (2)	0.008*
Underweight (below 18.5)	51 (42.5)	29 (56.9)	22 (43.1)	-	-
Normal weight (18.5–24.9)	59 (49.2)	21 (35.6)	38 (64.4)		
Overweight (25 and above)	10 (8.3)	1 (10.0)	9 (90.0)		
AV fistula at initiation				0.274 (1)	0.600
Present	36 (30.0)	14 (38.9)	22 (61.1)	-	-
Absent	84 (70.0)	37 (44.0)	47 (56.0)		
Plan for renal transplantation				0.882 (1)	0.348
Yes	67 (55.8)	31 (46.3)	36 (53.7)	-	-
No	53 (44.2)	20 (37.7)	33 (62.3)		
Hemodialysis schedule				0.136 (1)	0.712
Twice weekly or less	47 (39.2)	19 (40.4)	28 (59.6)	-	-
Thrice weekly	73 (60.8)	32 (43.8)	41 (56.2)		
Duration of hemodialysis				11.013 (3)	0.012*
Less than 12 months	30 (25.0)	20 (66.7)	10 (33.3)	-	-
13–24 months	33 (27.5)	14 (42.4)	19 (57.6)		
25–36 months	35 (29.2)	11 (31.4)	24 (68.6)		
More than 36 months	22 (18.3)	6 (27.3)	16 (72.7)		
Erythropoietin therapy				27.030 (1)	<0.001*
Receiving	61 (50.8)	40 (65.6)	21 (34.4)	-	-
Not receiving	59 (49.2)	11 (18.6)	48 (81.4)		

TABLE 2: Clinical characteristics of the study population and their relation to depression (N = 120)

kg: kilograms; m²: square meter; χ^2 : Pearson chi-square test; (df): degrees of freedom. p < 0.05 is considered statistically significant (*).

For primary kidney disease, two of the eight cells had expected counts below five; a collapsed three-category analysis combining adult polycystic kidney disease with chronic glomerulonephritis gave $\chi^2 = 2.545$, df = 2, p = 0.280, with the same conclusion. Only three patients were dialysed once weekly, and

the once- and twice-weekly categories were therefore combined before testing. All expected counts exceeded five for the analysis of erythropoietin therapy.

Depression and Biochemical Variables

Among the categorical biochemical variables (Table 3), depression was significantly associated with hyponatremia and with hypocalcemia. Depression was present in 62.0% of patients with a serum sodium below 135 mEq/L compared with 28.6% of those with a normal sodium ($\chi^2 = 13.337$, $df = 1$, $p < 0.001$), and in 55.7% of those with a serum calcium below 9 mg/dL compared with 28.8% of those with a normal calcium ($\chi^2 = 8.897$, $df = 1$, $p = 0.003$).

Variable	Total, n (%)	Depressed (n = 51), n (%)	Non-depressed (n = 69), n (%)	χ^2 (df)	p-value
Serum sodium				13.337 (1)	<0.001*
Hyponatremia (below 135 mEq/L)	50 (41.7)	31 (62.0)	19 (38.0)	-	-
Normal (135 mEq/L and above)	70 (58.3)	20 (28.6)	50 (71.4)	-	-
Serum potassium				2.214 (1)	0.137
Hypokalemia (below 3.5 mEq/L)	11 (9.2)	7 (63.6)	4 (36.4)	-	-
Normal (3.5 mEq/L and above)	109 (90.8)	44 (40.4)	65 (59.6)	-	-
Serum calcium				8.897 (1)	0.003*
Hypocalcemia (below 9 mg/dL)	61 (50.8)	34 (55.7)	27 (44.3)	-	-
Normal (9-11 mg/dL)	59 (49.2)	17 (28.8)	42 (71.2)	-	-

TABLE 3: Categorical biochemical parameters and their relation to depression (N = 120)

χ^2 : Pearson chi-square test; df: degrees of freedom.

For serum potassium, one expected count was below five, and Fisher’s exact test gave $p = 0.201$, with the same conclusion. $p < 0.05$ is considered statistically significant (*).

Among the continuous biochemical variables (Table 4), patients with depression had a significantly lower mean hemoglobin and serum albumin and a significantly higher mean hs-CRP than those without depression. Serum ferritin did not differ significantly between the two groups.

Variable	Depressed (n = 51): mean ± SD; median (IQR)	Non-depressed (n = 69): mean ± SD; median (IQR)	t (df)	p-value
Hemoglobin (g/dL)	8.83 ± 0.47; 8.80 (8.60-9.20)	9.34 ± 0.48; 9.30 (9.10-9.60)	5.722 (118)	<0.001*
Serum albumin (g/dL)	2.86 ± 0.24; 2.80 (2.70-3.00)	3.01 ± 0.17; 3.00 (2.90-3.10)	4.002 (118)	<0.001*
Serum ferritin (ng/mL)	850.39 ± 134.91; 864.70 (764.30-956.85)	832.88 ± 111.22; 864.00 (754.80-932.50)	0.778 (118)	0.438
hs-CRP (mg/L)	3.80 ± 0.70; 3.70 (3.35-4.20)	3.46 ± 0.60; 3.40 (3.10-3.80)	2.877 (118)	0.005*

TABLE 4: Continuous biochemical parameters and their relation to depression (N = 120)

g: grams; ng: nanograms; mg: milligrams; dL: deciliter; mL: milliliter; L: liter; t: independent samples t test; df: degrees of freedom; p < 0.05 considered statistically significant (*).

Because the Shapiro-Wilk test rejected normality for all four variables, the Mann-Whitney U test was applied as a check and gave U = 793.5, p < 0.001 for hemoglobin; U = 1072.0, p < 0.001 for serum albumin; U = 1830.5, p = 0.708 for serum ferritin; and U = 2248.0, p = 0.009 for high-sensitivity C-reactive protein (hs-CRP), agreeing with the t tests in every case.

Comparison of BDI-II score across variable categories

The mean BDI-II score did not differ significantly across categories of sociodemographic variables (Table 5) for age, gender, educational status, socioeconomic status, marital status, and family status.

Variable	Category	n (%)	Mean ± SD	Median (IQR)	Test statistic (df)	p-value
Age (years)	45 and below	29 (24.2)	16.76 ± 5.87	14 (13-19)	F = 1.652 (2, 117)	0.196
	46-55	62 (51.7)	16.58 ± 5.97	15 (12-20)		
	Above 55	29 (24.2)	19.17 ± 8.22	15 (14-24)		
Gender	Male	87 (72.5)	17.63 ± 6.66	15 (13-22)	t = 1.032 (118)	0.304
	Female	33 (27.5)	16.24 ± 6.40	14 (12-19)		
Educational status	Higher secondary and above	36 (30.0)	16.81 ± 5.02	15 (13-19)	F = 0.547 (2, 117)	0.580
	High school	55 (45.8)	17.93 ± 7.10	15 (13-23)		
	Middle school and below	29 (24.2)	16.52 ± 7.35	14 (12-19)		
Socioeconomic status	Lower middle	35 (29.2)	15.57 ± 5.14	14 (13-16)	F = 1.911 (2, 117)	0.153
	Upper lower	57 (47.5)	18.32 ± 6.84	16 (13-24)		
	Lower	28 (23.3)	17.18 ± 7.43	14 (13-21)		
Marital status	Married	84 (70.0)	17.20 ± 6.65	15 (13-20)	t = -0.120 (118)	0.904
	Widowed, divorced or unmarried	36 (30.0)	17.36 ± 6.54	14 (13-19)		
Family type	Nuclear	54 (45.0)	16.52 ± 5.62	14 (13-19)	F = 0.912 (2, 117)	0.405
	Joint	55 (45.8)	17.56 ± 7.09	15 (13-23)		
	Extended	11 (9.2)	19.27 ± 8.38	16 (14-24)		

TABLE 5: Comparison of BDI-II score across sociodemographic variables (N = 120)

Among the clinical variables, the mean BDI-II score differed significantly across categories of BMI, duration of hemodialysis, and erythropoietin therapy (Table 6, all p < 0.05). The gradient across BMI was stepwise, the

mean score falling from 18.71 ± 6.70 in underweight patients through 16.68 ± 6.70 in those of normal weight to 13.20 ± 1.93 in the overweight ($F = 3.496$, $df = 2$ and 117 , $p = 0.034$), and the gradient across dialysis vintage was likewise stepwise, from 20.07 ± 6.09 in the first year to 14.41 ± 1.89 beyond three years ($F = 3.685$, $df = 3$ and 116 , $p = 0.014$). The largest single difference was that associated with erythropoietin therapy, with patients receiving it scoring 19.92 ± 7.12 against 14.49 ± 4.63 in those who were not ($t = 4.931$, $df = 118$, $p < 0.001$).

Variable	Category	n (%)	Mean $\pm$ SD	Median (IQR)	Test statistic (df)	p-value
Primary kidney disease	Diabetic nephropathy	70 (58.3)	17.37 ± 6.29	15 (12-22)	$F = 0.512$ (3, 116)	0.675
	Ischemic renal failure	27 (22.5)	16.44 ± 6.22	14 (13-19)		
	Chronic glomerulonephritis	19 (15.8)	17.21 ± 7.25	14 (13-18)		
	Adult polycystic kidney disease	4 (3.3)	20.75 ± 11.84	16 (13-24)		
Diabetes mellitus	Present	92 (76.7)	17.55 ± 6.53	15 (13-22)	$t = 0.916$ (118)	0.361
	Absent	28 (23.3)	16.25 ± 6.82	14 (13-17)		
Systemic hypertension	Present	63 (52.5)	17.89 ± 7.13	15 (14-21)	$t = 1.118$ (118)	0.266
	Absent	57 (47.5)	16.54 ± 5.92	14 (12-20)		
AV fistula at initiation	Present	36 (30.0)	16.86 ± 7.04	14 (12-20)	$t = -0.422$ (118)	0.674
	Absent	84 (70.0)	17.42 ± 6.43	15 (13-20)		
Hemodialysis schedule	Twice weekly or less	47 (39.2)	17.11 ± 6.71	14 (13-19)	$t = -0.191$ (118)	0.849
	Thrice weekly	73 (60.8)	17.34 ± 6.56	15 (13-22)		
Body mass index (kg/m ²)	Underweight (below 18.5)	51 (42.5)	18.71 ± 6.70	18 (14-24)	$F = 3.496$ (2, 117)	0.034*
	Normal weight (18.5-24.9)	59 (49.2)	16.68 ± 6.70	14 (13-18)		
	Overweight (25 and above)	10 (8.3)	13.20 ± 1.93	14 (12-14)		
Plan for transplantation	Yes	67 (55.8)	18.21 ± 7.52	15 (13-24)	$t = 1.809$ (118)	0.073
	No	53 (44.2)	16.04 ± 4.99	14 (13-16)		
Duration of hemodialysis	Less than 12 months	30 (25.0)	20.07 ± 6.09	20 (14-26)	$F = 3.685$ (3, 116)	0.014*
	13-24 months	33 (27.5)	17.58 ± 7.60	14 (12-22)		
	25-36 months	35 (29.2)	16.31 ± 7.11	14 (13-16)		
	More than 36 months	22 (18.3)	14.41 ± 1.89	14 (13-16)		
Erythropoietin therapy	Receiving	61 (50.8)	19.92 ± 7.12	19 (14-25)	$t = 4.931$ (118)	<0.001*
	Not receiving	59 (49.2)	14.49 ± 4.63	14 (12-15)		

TABLE 6: Comparison of BDI-II score across clinical variables (N = 120)

kg: kilograms; m²: square meter; t: independent samples t test; F: one-way analysis of variance; df: degrees of freedom

Because the BDI-II score departed from normality, the Kruskal-Wallis test was applied as a check and gave $H = 8.294$, $df = 2$, $p = 0.016$ for body mass index and $H = 9.940$, $df = 3$, $p = 0.019$ for duration of hemodialysis, agreeing with the analysis of variance.

Because the BDI-II score departed from normality, the Mann-Whitney U test was applied as a check and gave $U = 2712.0$, $p < 0.001$ for erythropoietin therapy, agreeing with the t test.

$p < 0.05$ is considered statistically significant (*).

Among the categorical biochemical variables (Table 7), the mean BDI-II score differed significantly across categories of serum sodium and serum calcium.

Variable	Category	n (%)	Mean ± SD	Median (IQR)	Test statistic (df)	p-value
Serum sodium	Below 135 mEq/L	50 (41.7)	20.16 ± 7.76	19 (14-26)	t = 4.391 (118)	<0.001*
	135 mEq/L and above	70 (58.3)	15.17 ± 4.65	14 (13-16)		
Serum potassium	Below 3.5 mEq/L	11 (9.2)	18.82 ± 5.60	19 (14-24)	t = 0.827 (118)	0.410
	3.5 mEq/L and above	109 (90.8)	17.09 ± 6.68	15 (13-20)		
Serum calcium	Below 9 mg/dL	61 (50.8)	19.18 ± 7.12	18 (13-24)	t = 3.405 (118)	0.001*
	9-11 mg/dL	59 (49.2)	15.25 ± 5.36	14 (13-16)		

TABLE 7: Comparison of BDI-II score across categorical biochemical variables

mEq: milliequivalent; L: liter; mg: milligrams; dL: deciliter; t: independent samples t test; df: degrees of freedom; p < 0.05 is considered statistically significant (*).

Correlation of BDI-II Score With Continuous Variables

Pearson correlation analysis showed that the BDI-II score correlated significantly with hemoglobin (r = -0.408, 95% confidence interval -0.547 to -0.247, p < 0.001), with serum albumin (r = -0.294, 95% confidence interval -0.450 to -0.122, p = 0.001) and with hs-CRP (r = 0.181, 95% confidence interval 0.001 to 0.349, p = 0.048), but not with age (p = 0.094) or serum ferritin (p = 0.320), as shown in Table 8. Because the BDI-II score departed from normality, Spearman’s rank correlation was computed as a check and gave closely comparable coefficients with the same pattern of significance. The confidence interval for the correlation with hs-CRP has a lower bound of 0.001, so although the association attains conventional significance, it is compatible with an effect close to zero and should not be relied upon in isolation.

Variable	Pearson's r	95% confidence interval	p-value	Spearman's rho
Age (years)	0.154	-0.026 to 0.324	0.094	0.116 (p = 0.207)
High-sensitivity C-reactive protein (hs-CRP) (mg/L)	0.181	0.001 to 0.349	0.048*	0.187 (p = 0.041)
Serum ferritin (ng/mL)	0.092	-0.089 to 0.266	0.320	0.022 (p = 0.813)
Serum albumin (g/dL)	-0.294	-0.450 to -0.122	0.001*	-0.276 (p = 0.002)
Hemoglobin (g/dL)	-0.408	-0.547 to -0.247	<0.001*	-0.440 (p < 0.001)

TABLE 8: Correlation of BDI-II score with continuous variables (N = 120)

mg: milligrams; ng: nanograms; g: grams; L: liter; mL: milliliter; dL: deciliter

Two-tailed tests throughout. Confidence intervals for Pearson’s r were derived using Fisher’s z transformation.

p < 0.05 is considered statistically significant (*).

Multiple linear regression

Variables significantly associated with the BDI-II score on univariate analysis - BMI, duration of dialysis, serum sodium, serum calcium, serum albumin, and hemoglobin - were entered into a multiple linear regression model (Table 9). The model was statistically significant (F = 8.367, df = 6 and 113, p < 0.001), with R = 0.555, R² = 0.308 and adjusted R² = 0.271, explaining 30.8% of the variance in BDI-II scores. In multivariate analysis, serum sodium (B = -3.142, 95% confidence interval -5.386 to -0.898, β = -0.236, p = 0.006) and hemoglobin (B = -3.257, 95% confidence interval -5.330 to -1.185, β = -0.267, p = 0.002) remained independently associated with a higher BDI-II score. Since serum sodium and serum calcium were coded as 1 for the abnormal category and 2 for the normal category, the negative coefficients indicate that hyponatremia and hypocalcemia are associated with higher BDI-II scores; the negative coefficient for hemoglobin likewise indicates that a lower hemoglobin predicts a higher score.

Predictor variable	B	Std. error	95% confidence interval for B	Beta (β)	t (df)	p-value
Constant	65.559	10.791	44.180 to 86.938	-	6.075 (113)	<0.001*
Body mass index category	-0.679	0.896	-2.454 to 1.096	-0.065	-0.758 (113)	0.450
Duration of hemodialysis	-0.648	0.537	-1.711 to 0.415	-0.104	-1.208 (113)	0.230
Serum sodium category	-3.142	1.133	-5.386 to -0.898	-0.236	-2.774 (113)	0.006*
Serum calcium category	-1.613	1.138	-3.868 to 0.642	-0.123	-1.417 (113)	0.159
Serum albumin	-2.896	2.622	-8.090 to 2.298	-0.096	-1.105 (113)	0.272
Hemoglobin	-3.257	1.046	-5.330 to -1.185	-0.267	-3.114 (113)	0.002*

TABLE 9: Multiple linear regression analysis of predictors of BDI-II score (N = 120)

Model summary: $R = 0.555$, $R^2 = 0.308$, adjusted $R^2 = 0.271$, standard error of the estimate = 5.63, $F = 8.367$ with 6 and 113 degrees of freedom, $p < 0.001$. Dependent variable: BDI-II score. Body mass index was entered as its three ordered categories, duration of hemodialysis as its four ordered categories, and serum sodium and serum calcium as their two categories, coded 1 for the abnormal and 2 for the normal range. $p < 0.05$ was considered statistically significant (*).

Note on model specification: erythropoietin therapy and hs-CRP were also significantly associated with the BDI-II score on univariate analysis but are not included in this model. Erythropoietin therapy was excluded because it is prescribed on the basis of the hemoglobin concentration and is strongly collinear with it ($r = -0.722$); when it is entered alongside hemoglobin, the variance inflation factors of the two rise to 2.25 and 2.31, and neither retains significance, leaving serum sodium as the only independently significant. The result for hemoglobin reported above is therefore conditional on erythropoietin being excluded from the model. With erythropoietin excluded, all variance inflation factors lie between 1.18 and 1.23.

Binary logistic regression

Because the categorical diagnosis of depression rather than the continuous BDI-II score is the outcome of primary clinical interest, a binary logistic regression was fitted with the presence of depression as the dependent variable and the same six predictors as the linear model, so that the two analyses remain directly comparable (Table 10). The model was statistically significant, with a likelihood ratio chi-square of 50.068 on six degrees of freedom and $p < 0.001$.

Predictor variable	B	Std. error	Wald	Odds ratio	95% confidence interval	p-value
Constant	28.421	6.371	19.897	-	-	<0.001*
Body mass index category	-0.620	0.412	2.264	0.538	0.240 to 1.207	0.132
Duration of hemodialysis	-0.220	0.234	0.885	0.802	0.507 to 1.269	0.347
Serum sodium category	-0.937	0.481	3.803	0.392	0.153 to 1.005	0.051
Serum calcium category	-0.327	0.503	0.423	0.721	0.269 to 1.932	0.516
Serum albumin	-2.101	1.209	3.021	0.122	0.011 to 1.308	0.082
Hemoglobin	-2.103	0.594	12.528	0.122	0.038 to 0.391	<0.001*

TABLE 10: Binary logistic regression analysis with depression as the dependent variable (N = 120)

Model summary: likelihood ratio $\chi^2 = 50.068$, $df = 6$, $p < 0.001$; Cox and Snell $R^2 = 0.341$; Nagelkerke $R^2 = 0.458$; Hosmer-Lemeshow $\chi^2 = 10.383$, $df = 8$, $p = 0.239$; overall classification accuracy 79.2%, sensitivity 72.5%, specificity 84.1%. Dependent variable: presence of depression (1 = present, 0 = absent). Predictors are coded exactly as in Table 9, body mass index as its three ordered categories, duration of hemodialysis as its four ordered categories, and serum sodium and serum calcium as their two categories coded 1 for the abnormal and 2 for the normal range; an odds ratio below one therefore denotes lower odds of depression in the higher-coded, normal category. Wald = Wald chi-square statistic on 1 degree of freedom. $p < 0.05$ was considered statistically significant (*).

Note on model specification: as in Table 9, erythropoietin therapy was excluded on grounds of collinearity with hemoglobin. When it is added as a seventh variable, the association with the inventory score falls to $p = 0.243$ and that with the diagnosis to $p = 0.083$, neither retaining conventional significance. This is the expected consequence of collinearity rather than of instability in the data: erythropoietin is prescribed on the basis of the hemoglobin concentration, the two variables correlate at $r = -0.722$ in this sample, and their variance inflation factors rise to 2.31 and 2.25 when both are entered.

The adjusted odds ratio for erythropoietin therapy is 2.44 (95% confidence interval 0.65 to 9.18, $p = 0.187$), and that for hemoglobin becomes 0.26 (95% confidence interval 0.06 to 1.20, $p = 0.083$), neither reaching significance, while the overall fit is essentially unchanged (McFadden's pseudo $R^2 = 0.317$; classification accuracy = 80.8%).

Hemoglobin was the only variable independently associated with depression status. Because serum sodium and serum calcium were coded as 1 for the abnormal and 2 for the normal category, an odds ratio below one indicates that the normal category carries lower odds of depression; expressed in the more intuitive direction, each fall of 1 g/dL in hemoglobin multiplied the odds of depression by 8.20 (95% confidence interval 2.56 to 26.32, $p < 0.001$), and hyponatremia multiplied them by 2.55 (95% confidence interval 1.00 to 6.54), the latter falling marginally short of significance at $p = 0.051$. Serum albumin approached but did not attain significance ($p = 0.082$), and BMI category, duration of hemodialysis, and serum calcium category were not independently associated once the other variables were taken into account. The two multivariable models therefore point in the same direction: hemoglobin and serum sodium carry the signal, and the remaining nutritional and biochemical variables act through their correlation with these two rather than independently of them.

Discussion

The study of depression in patients with CKD offers researchers and clinicians a unique opportunity and considerable challenge in elucidating the pathophysiology of depression in this chronic condition. The opportunity arises from the increasing lifespan of these patients, made possible by dialysis and earlier detection of kidney disease. Multiple mechanisms have been proposed, arising from an interaction between biological and psychosocial factors.

The challenge arises because, as patients age, the number of comorbidities associated with CKD may increase, and these comorbidities could potentially hasten progression to ESRD. Diabetes and hypertension are common comorbidities seen in ESRD, and it is possible that the medications used to manage them may themselves be associated with depressive disorder in some patients. Depression in CKD may therefore arise, at least in part, from the intrinsic effects of kidney disease, its comorbidities, or medication side effects, making it difficult to isolate the contribution of kidney disease itself fully.

In univariate analysis, depression was significantly associated with socioeconomic class, with a low BMI, with a shorter duration of dialysis, with the receipt of erythropoietin, with hyponatremia and with hypocalcemia, and depressed patients had significantly lower hemoglobin and serum albumin and higher hs-CRP concentrations. When these variables were carried into multivariable models, however, the picture simplified considerably: hemoglobin was significantly associated with both the continuous score and the categorical diagnosis, serum sodium remained significantly associated with the continuous score only, and

the remaining associations were largely accounted for by their correlation with these two.

Sociodemographic and clinical profile

Most patients in this cohort were middle-aged. This likely reflects the rising prevalence of diabetes and hypertension in these age groups. The mean age was 50.2 ± 9.0 , consistent with the Indian CKD registry [17]. The male predominance also paralleled the registry. Most of the study subjects were married and had formal education up to high school. This reflects Kerala's educational development. Diabetic nephropathy was the leading cause of CKD, consistent with national trends and India's rising diabetes burden [17].

Prevalence of Depression

The prevalence of depressive episodes was 42.5%, with 51.0% moderate, 35.3% mild, and 13.7% severe. This was consistent with an Indian study by Shanmukham et al., in which approximately 41% of 92 patients screened positive for depression using the BDI-II [18]. This was more than the rate reported by Kumar et al., who reported a prevalence of 31.17% using DSM-5 clinical criteria in a North Indian cohort [19]. It was lower than Gupta et al., who reported a prevalence of 63.27% using DSM-5 for diagnosis of depression and MADRS for rating depression in the hemodialysis subgroup [20]. This variability across studies likely reflects differences in screening instruments, diagnostic thresholds, and population-specific psychosocial and healthcare-access factors.

Somatic symptoms of anorexia, sleep disturbance, and fatigue, which may coexist with the chronic disease symptoms of CKD, may lead to overestimation of depression diagnosis when using self-report scales [8]. Hence, when the conventional BDI-II cutoff of 14 and above is applied, it may overestimate depression in this population; however, in dialysis-dependent populations, this somatic-symptom overlap has led the literature to adopt higher screening thresholds to preserve diagnostic accuracy. A BDI-II cutoff of ≥ 16 has been consistently used and supported across multiple dialysis-population studies [15,16]. Hence, this cutoff was used in this study.

Sociodemographic Correlates

Among sociodemographic factors, depression showed a statistically significant association only with socioeconomic status ($p=0.037$). Rather than a consistent socioeconomic gradient, prevalence was disproportionately high in the upper-lower class (54.4%) relative to the lower-middle (28.6%) and lower (35.7%) classes - a non-linear pattern that may reflect specific financial burdens in this specific subgroup, such as the non-availability of free dialysis or disability benefits, or subgroup sample size variations may also be contributory. In contrast, age, gender, educational status, and family type were not significantly associated with depression in this study. The absence of significant association with these sociodemographic variables supports the hypothesis that depression in CKD is driven primarily by the intrinsic effects of kidney disease on brain function rather than by demographic vulnerability alone.

Findings from the literature have been mixed. Male gender and lower socioeconomic status were significantly associated with the diagnosis of major depressive disorder in a study by Kumar et al. [19], while age below 60 years, male gender, no treatment funding, education less than grade 12, and low monthly income were found to be significant factors affecting depression in a study by Ahlawat et al. [9]. Most persons with depression were married, and the largest proportion lived in nuclear families - closely mirroring the demographic composition of the overall study sample, consistent with the lack of significant association between depression and either marital status or family type in this cohort.

Clinical Correlates

Erythropoietin therapy showed significant association with depression in our study among the clinical variables. The prevalence of depression was markedly higher among patients receiving erythropoietin (40/61, 65.6%) than among those not receiving it (11/59, 18.6%; $\chi^2=27.030$, $df=1$, $p<0.001$). This association should be interpreted with caution, however, as erythropoietin is prescribed specifically to correct anemia and is therefore inherently linked to hemoglobin status; patients receiving erythropoietin are, by definition, those with lower or harder-to-correct hemoglobin levels. Consistent with this, we excluded erythropoietin from the multivariable regression models because of collinearity with hemoglobin. A Taiwanese nationwide cohort dataset supports this interpretation, showing no significant association between erythropoietin treatment and depression risk after appropriate adjustment for confounders (adjusted HR=0.98, 95% CI 0.92-1.04, $p=0.499$) [21].

The association with nutritional status - BMI and serum albumin - was among the clearest, with depression present in 56.9% of the underweight, 35.6% of those of normal weight, and 10.0% of the overweight, with a significant test for linear trend. This was consistent with Koo et al., who reported an association between depression and malnutrition in chronic hemodialysis patients [22]. This aligns with the broader literature linking the malnutrition-inflammation complex to poor patient-reported outcomes, with the analysis by Kalantar-Zadeh et al. in 2001 as the most cited [23]. The concordant finding for serum albumin, and its

inverse correlation with the BDI-II score of -0.294, reinforces the point; Dogan et al. in 2005 reported a correlation of -0.43 between the Hamilton depression score and serum albumin in hemodialysis patients [24]. A cross-sectional design cannot establish direction: depression reduces appetite and thereby lowers body mass and albumin, while wasting and its accompanying fatigue lower mood, and in practice the two almost certainly reinforce one another. Consistent with this reciprocity, neither BMI nor albumin retained independent significance in either multivariable model once hemoglobin was included.

Depressive symptoms were more strongly associated with dialysis duration under one year than with longer duration in our study, consistent with Elkheir et al., who found that patients on dialysis for less than one year had markedly higher rates of depression (66.7%) than those on dialysis for two to three years (21.6%) or more than three years (11.8%) [25]. The mean BDI-II scores of patients with dialysis duration <12 months were higher than those with duration >12 months. Dialysis is initially threatening to the patient, and in the first 12 months represents a major stressor - dependence on a machine, lifestyle restriction, and financial burden, often without insurance coverage - compounded by the peak severity of uremic biochemical derangement, which may contribute to the higher depression scores seen in this period. As hemodialysis continues, creatinine levels gradually improve, indicating better clearance of uremic waste. This may partially reverse the neurobiological changes caused by pre-dialysis uremia, so that depression scores may ease with longer duration on dialysis. Diabetes and hypertension did not significantly influence depression in this study, consistent with Gupta et al. [20]. However, patients planned for renal transplantation had higher depression scores, possibly reflecting more advanced disease and greater neurobiological derangement.

Biochemical Correlates

Hemoglobin emerged consistently associated with depression in this study across correlation ($r = -0.408$, $p < 0.001$), multiple linear regression ($\beta = -0.267$, $p = 0.002$), and logistic regression, where it was independently associated with categorical depression status (OR = 8.20 per 1 g/dL fall, 95% CI 2.56-26.32, $p < 0.001$). The mean hemoglobin was 9.12 ± 0.54 g/dL overall and was lower in depressed patients (8.83 ± 0.47 g/dL) than in those without depression (9.34 ± 0.48 g/dL). The mean hemoglobin fell well below KDIGO-recommended levels [26]. This finding is consistent with prior reports of a negative correlation between hemoglobin and depression severity in hemodialysis patients [19,24] and with evidence that anemia and hypoalbuminemia together warrant depression screening in this population [27]. The relationship is plausibly mediated by anemia-related impairment of cerebral oxygen delivery and metabolism, which is critical for neuronal function.

Serum sodium showed the next strongest association with depression severity in our study. Patients with hyponatremia (serum sodium below 135 mEq/L) had substantially higher BDI-II scores than those with normal sodium levels (mean 20.16 vs. 15.17, $t = 4.391$, $p < 0.001$), and this association continued to be significant in multiple linear regression ($\beta = -0.236$, $p = 0.006$) though it fell just short of conventional significance in the logistic regression model (OR = 2.55, 95% CI 1.00-6.54, $p = 0.051$). This is consistent with a Taiwanese study of 200 hemodialysis patients, which found significant associations between lower past-year serum sodium levels and depression symptoms after multivariate regression, with the relationship most pronounced in moderate to profound hyponatremia [28]. Rapid electrolyte shifts during hemodialysis may cause cerebral edema and neurological dysfunction, offering a plausible biological mechanism linking hyponatremia to mood disturbance.

Serum calcium was significantly associated with BDI-II score on bivariate analysis (mean 19.18 vs. 15.25, $p = 0.001$), consistent with univariate findings from Kumar et al. and Delgado-Domínguez et al., who similarly reported decreased serum calcium among the biochemical correlates of depression in hemodialysis patients [19,29]. However, serum calcium did not retain significance in either regression model in the present study (linear regression: $p = 0.159$; logistic regression: $p = 0.516$), suggesting that its univariate association is likely explained by shared variance with hemoglobin or sodium rather than reflecting an independent effect of calcium on mood. This is consistent with Delgado-Domínguez et al., who also did not retain calcium in their final multivariate depression model [29]. But this contrasts with Kumar et al., who found calcium remained independently significant after adjustment [19]. This discrepancy may reflect differences in sample size, population characteristics, or the specific covariates adjusted for across studies. Given the cross-sectional design and single serum measurement, no causal conclusions can be drawn regarding sodium or calcium in the present study.

In our study, hs-CRP correlated weakly and positively with BDI-II scores, with a confidence interval approaching zero; this is broadly consistent with a UK cohort study of 396 hemodialysis patients using BDI-II, which similarly found the CRP-depression association to be small, of uncertain clinical significance, and inconsistent across depression measures [30]. This weak and inconsistent association could potentially reflect the limited specificity of hs-CRP as a marker of chronic inflammation, since it may be elevated across many inflammatory states and CKD itself is considered a chronic inflammatory condition. As such, this finding can neither confirm nor rule out a possible role for neuroinflammation in the etiology of depression in CKD, and more specific inflammatory or neuroimaging biomarkers might be needed to explore this hypothesis further.

Given that CKD is a multisystem disorder, these findings warrant cautious interpretation. Of the different variables examined in relation to the prevalence of depression in patients with CKD, biochemical parameters intrinsic to CKD pathophysiology emerged as the strongest correlates in this study. However, the role of psychosocial factors cannot be ignored, as evidenced by previous studies. Depression in CKD may therefore best exemplify the biopsychosocial nature of the disorder, and its high, likely under-recognized prevalence in hemodialysis populations underscores the need for routine screening as part of standard renal care.

Limitations

Our study has several limitations. The relatively small sample size and single-center design may limit the generalizability of our findings. The cross-sectional study design might have limited our ability to identify the fluctuating course of depression in a chronic condition like CKD. The study design helped to determine only associations between variables, not causal relationships.

Conclusions

Our study found a high prevalence of depression (42.5%, 95% confidence interval 34.0 to 51.4) among patients with CKD undergoing maintenance hemodialysis, with nearly two-thirds of the affected patients having depression of at least moderate severity. Among the sociodemographic, clinical, and biochemical variables examined, hemoglobin and serum sodium were the variables most consistently associated with depression after adjustment for the others, and the pattern of the two associations appeared to differ: hemoglobin was more closely associated with whether a patient met the criteria for depression, and serum sodium with the severity of depressive symptoms among those who did. The study was cross-sectional, and the associations present at a single point in time do not establish that either variable causes, precedes, or predicts depression. Within these limits, our findings may nonetheless assist clinicians in identifying the patients in whom screening for depression is likely to have the highest yield, and they support the case for incorporating such screening into routine dialysis care, given how frequently depression went unrecognized in this population. Further studies, preferably longitudinal and multicentric, are required to determine whether the biochemical variables identified here have any value as early markers of depression in CKD, whether correcting them influences mood, and whether the treatment of depression reduces morbidity and mortality in this condition.

Appendices

Appendix

Patient No: _____

PROFORMA

I DETAILS OF THE PATIENT

A. Age:

B. Address:

C. Gender:

D. Height:

E. Weight:

II SOCIODEMOGRAPHIC DATA

A. AGE GROUP:

1. 18-25	☒
2. 26-35	☒
3. 36-45	☒
4. 46-55	☒
5. 56-65	☒
6. >65	☒

B. RELIGION:

- | | |
|--------------|-------------------------------------|
| 1. Hindu | ☒ |
| 2. Muslim | ☒ |
| 3. Christian | ☒ |
| 4. Others | ☒ |

C. EDUCATIONAL STATUS:

- | | |
|---|-------------------------------------|
| 1. Profession or honors | ☒ |
| 2. Graduate or postgraduate | ☒ |
| 3. Intermediate or post-high school diploma | ☒ |
| 4. High school certificate | ☒ |
| 5. Middle school certificate | ☒ |
| 6. Primary school certificate | ☒ |
| 7. Literate | ☒ |

D. OCCUPATION OF HEAD OF FAMILY:

- | | |
|-------------------------|-------------------------------------|
| 1. Profession | ☒ |
| 2. Semi-professional | ☒ |
| 3. Clerical, Shop-owner | ☒ |
| 4. Skilled worker | ☒ |
| 5. Semi-skilled worker | ☒ |
| 6. Unskilled worker | ☒ |
| 7. Unemployed | ☒ |

E. INCOME (in INR):

- | | |
|------------------|-------------------------------------|
| 1. >41,430 | ☒ |
| 2. 20,715-41,429 | ☒ |
| 3. 15,536-20,714 | ☒ |
| 4. 10,357-15,535 | ☒ |
| 5. 6,214-10,356 | ☒ |
| 6. 2,092-6,213 | ☒ |
| 7. <2,091 | ☒ |

F. TYPE OF FAMILY:

- | | |
|------------|-------------------------------------|
| 1. Nuclear | ☒ |
| 2. Joint | ☒ |

3. Extended ☒

G. MARITAL STATUS:

1. Married, living together ☒

2. Married, living separately ☒

3. Divorced ☒

4. Widow/widower ☒

5. Unmarried ☒

6. Cohabitation ☒

III CLINICAL DATA

A. PRIMARY KIDNEY DISEASE:

B. DIABETES: YES / NO

C. HYPERTENSION: YES / NO

D. BMI:

E. DURATION OF DIALYSIS:

F. TIME BETWEEN DIAGNOSIS AND INITIATION OF DIALYSIS:

F. PRESENCE OF AV FISTULA AT TIME OF DIAGNOSIS:

G. PLAN FOR TRANSPLANT: YES / NO

H. SCHEDULE OF DIALYSIS:

☒ ONCE WEEKLY ☒ TWICE WEEKLY ☒ THRICE WEEKLY

I. RECEIPT OF ERYTHROPOIETIN:

IV BIOCHEMICAL PARAMETERS

1. Blood Routine

Hb:

TC:

DC:

ESR:

RBC:

PLATELET:

2. Urine Routine

Albumin:

Sugar:

Deposits:

3. Liver Function Tests

Total Bilirubin:

Direct Bilirubin:

SGOT:

SGPT:

ALP:

Total Protein:

Albumin:

Globulin:

4. Renal Function Tests

Blood Urea:

Serum Creatinine:

5. Serum Electrolytes

S. Na+:

S. K+:

V Other Investigations

hs-CRP:

Ca:

Uric Acid:

S. PTH:

S. Ferritin:

Transferrin saturation:

Hematocrit:

VI: Depression (ICD-10-DCR)-Yes/No

VII BDI-II Score:

VII SOCIOECONOMIC STATUS:

- | | |
|-----------------------|-------------------------------------|
| 1. Upper class | ☒ |
| 2. Upper middle class | ☒ |
| 3. Lower middle class | ☒ |
| 4. Upper lower class | ☒ |
| 5. Lower class | ☒ |

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Abeer Abdul Rezak Parayil, Varghese Punnoose, Sandeep Alex

Acquisition, analysis, or interpretation of data: Abeer Abdul Rezak Parayil, Varghese Punnoose

Drafting of the manuscript: Abeer Abdul Rezak Parayil, Varghese Punnoose, Sandeep Alex

Critical review of the manuscript for important intellectual content: Varghese Punnoose, Sandeep Alex

Supervision: Varghese Punnoose, Sandeep Alex

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee, Government TD Medical College, Alappuzha issued approval EC/10/17. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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