

ASSESSMENT OF COGNITIVE IMPAIRMENT AMONG PATIENTS UNDERGOING HEMODIALYSIS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Chronic kidney disease (CKD) is a progressive global health problem, and a significant proportion of patients with advanced disease require haemodialysis for survival. Patients undergoing haemodialysis are exposed to multiple complications, among which cognitive impairment is increasingly recognized. Though majority of the patients undergoing hemodialysis remain underdiagnosed for cognitive impairment. Thus, assessing the cognitive impairment among patients undergoing haemodialysis, and examining the potential relationship between cognitive impairment and various sociodemographic factors has become increasingly important.

Methods: A cross-sectional descriptive design was selected for this study which was conducted at the Dialysis Unit of xxx from 1st January 2026 to 30th January 2026. A non-probability convenience sampling technique was used to select 150 patients undergoing hemodialysis. A structured socio-demographic Proforma was used to gather socio-demographic data, and the Addenbrooke's Cognitive Examination III was used to assess the cognitive impairment in patients undergoing haemodialysis. The data collected were analysed using descriptive and inferential statistical methods.

Results: Of the 150 patients studied, 88% had cognitive impairment. The mean total cognitive score was 68.12 ± 11.97 , indicating a mild to severe level of cognitive impairment among patients undergoing hemodialysis. Cognitive level was negatively correlated with age and associated with educational qualification ($p < 0.05$).

Conclusion: The study concluded that the majority of patients undergoing haemodialysis exhibited some degree of cognitive impairment, while only a small proportion demonstrated a normal cognitive level. These findings emphasise the importance of early identification and regular cognitive assessment among patients undergoing haemodialysis.

KEYWORDS: Cognitive dysfunction; Renal Dialysis; Renal Insufficiency, chronic; Dialysis.

INTRODUCTION

Chronic Kidney Disease (CKD) is a persistent, disabling health condition that is progressive in nature. Worldwide increase in the prevalence of CKD is alarming, which has engulfed up to 10 % of adults globally. It is assumed to become the 5th most common cause of mortality by 2040 ¹. CKD is a condition marked by the gradual decline of kidney function, which can eventually lead to the need for renal replacement therapies (RRT) like dialysis or kidney transplantation ².

Patients diagnosed with CKD are often asymptomatic in the early stages, with symptoms typically becoming apparent only in stages IV and V. Some of the symptoms include nausea, vomiting, loss of appetite, fatigue, weakness, oliguria, sleep disturbance and cognitive impairment ³. Cognitive impairment is associated with kidney disease, and the prevalence of cognitive impairment increases with declining kidney function ⁴.

Cognitive impairment is highly prevalent among individuals with CKD, particularly those receiving dialysis therapy. Several factors contribute to cognitive decline in these patients, including metabolic abnormalities associated with kidney failure, cerebrovascular disease, chronic inflammation, and vascular dysfunction. Evidence from neuroimaging and epidemiological studies suggests that vascular pathology may be a major contributing mechanism underlying cognitive dysfunction in dialysis patients⁵. Patients undergoing haemodialysis have been reported to experience more severe cognitive impairment compared to those receiving peritoneal dialysis. This difference is thought to be associated with the intermittent nature of haemodialysis and the hemodynamic instability occurring during dialysis sessions, which may increase the risk of cerebral ischemia and subsequent neuronal injury⁶. The same study has indicated that silent cerebral infarctions occur up to nine times more frequently in dialysis patients than in the general population, significantly increasing the risk of dementia. Additionally, dialysis patients are more susceptible to white matter disease and subcortical vascular deficits, which commonly present with impaired executive functioning⁶.

Several risk factors have been associated with cognitive impairment in CKD patients, including advanced age, declining renal function, uremia, cerebrovascular disease, depression, and metabolic disturbances. Patients with end stage renal disease demonstrate a higher prevalence of stroke, silent brain infarcts, white matter lesions, ventricular enlargement, and hippocampal atrophy, all of which are strongly associated with cognitive decline and dementia ⁷.

Cognitive decline increases the risk of hospital admission, diminishes quality of life, and is associated with an increased risk of mortality. Patients undergoing renal replacement therapy, whether haemodialysis or peritoneal dialysis, also

exhibited impaired cognitive function. Early diagnosis of cognitive impairment in patients undergoing renal replacement therapy is often missed. Unfortunately, screening for cognitive impairment is not yet a routine test, and there is no standard cognitive test⁸. This may guide the decision-maker to develop a better plan in order to improve the quality of the patient's life. Thus, the study aims to evaluate the presence and extent of cognitive impairment, and to examine the potential relationship between cognitive impairment and various sociodemographic factors among patients undergoing haemodialysis at xxx.

MATERIALS AND METHODS

Study Design

The study design chosen for the present study was a descriptive, cross-sectional, quantitative research design.

Ethical Approval

Ethical approval for the study was obtained from the Institutional Ethics Committee (Reference No.: EC-25/130-PG-RINER, Date: 08/10/2025), which adheres to the Declaration of Helsinki.

Informed Consent

All participants provided written informed consent to participate in the study for educational and research purpose.

Sample Size Calculation

A non-probability convenience sampling technique based on the predefined selection criteria was employed to select samples. The sample size was determined based on the previous study findings, which revealed that the prevalence of cognitive impairment among patients undergoing haemodialysis was 92%⁹. In the present study, expecting similar results with 95% confidence level and 5% absolute precision, the study requires 113 samples, which is rounded off to 150.

$$n = z^2 * p * q / d^2$$

Inclusion and Exclusion Criteria

The study included patients diagnosed with CKD who had been undergoing haemodialysis for at least three months and were aged between 18 and 70 years. Patients undergoing haemodialysis with a prior diagnosis of severe mental health disorders that could interfere with cognitive assessment and introduce bias into the outcome measures were excluded from the study.

Data collection

This study was conducted over a period of one month from 1st January 2026 to 30th January 2026 at a tertiary care hospital. The data were collected by interviewing the patient's undergoing haemodialysis and by accessing patients' clinical files. Socio-demographic and clinical variables were age, gender, educational level, duration since CKD diagnosis, duration of dialysis treatment, frequency of dialysis sessions per week, presence of comorbidities, height, weight, body mass index (BMI), type of diet, average hours of sleep, and smoking history. The cognitive impairment was assessed by interviewing the patient using Addenbrooke's cognitive examination-III.

The Addenbrooke's Cognitive Examination-III is a standardised and validated tool for cognitive assessment. The internal consistency of the English and Kannada versions of ACE-III has been reported as good (Cronbach's alpha > 0.93); inter-rater reliability and test-retest reliability have also been found to be high (Cronbach's alpha > 0.99)¹⁰. In addition, the tool has demonstrated good construct and criterion validity, with sensitivity ranging from 0.86 to 1.00 and specificity ranging from 0.83 to 0.93¹¹. For the present study, ACE-III scores were interpreted as follows: scores of 88 and above were considered normal cognitive function, scores between 83 and 87 were considered inconclusive, and scores 82 and less were considered as abnormal. For descriptive analysis, abnormal scores were further subdivided into mild impairment (69-82), moderate impairment (60-68) and severe impairment (<60)¹².

Outcome measures

The primary outcome of the study was to assess cognitive impairment among patients undergoing regular haemodialysis. The secondary outcome was to examine the relationship between cognitive function and selected socio-demographic variables.

Statistical analysis

Data obtained from patients undergoing haemodialysis were analysed using SPSS version 27. Descriptive statistics were used to determine the frequency and percentage distribution of socio-demographic variables and cognitive impairment levels among the participants. Mean and standard deviation were calculated to describe the cognitive scores of patients undergoing haemodialysis.

Karl Pearson's correlation coefficient and Spearman's rank correlation coefficient were used to assess the relationship between cognitive function and selected socio-demographic variables. Pearson's correlation was used for normally distributed variables and Spearman's correlation was used for non-normally distributed variables. The Chi-square test and Fisher's exact test were employed to determine the association between cognitive impairment and selected socio-demographic variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

BASELINE characteristics

Among the 150 patients undergoing haemodialysis, the majority were aged 60–70 years (50%) and were male (66%). Most participants had attained secondary-level education (39%). Regarding clinical characteristics, 54% had been diagnosed with CKD for 2–5 years, and 61.3% had been receiving haemodialysis for the same duration. The majority of patients underwent dialysis three times per week (76.0%). Hypertension (83%) and diabetes mellitus (60.0%) were the most common comorbidities. Most participants followed a non-vegetarian diet (83%), while BMI distribution showed an

equal proportion of normal weight and obesity class I (27% each). In addition, 39% reported sleeping 7–8 hours per day, and 85% were non-smokers. These findings are presented in Table 1.

Table 1- Frequency and percentage distribution of socio-demographic variables in patients undergoing haemodialysis

(n=150)

SL.NO	SOCIO-DEMOGRAPHIC DATA	FREQUENCY	PERCENTAGE
1.	Age in years		
	18-24 years (Youth)	1	0.7
	25-44 years (Young adult)	18	12.0
	45-59 years (Middle age)	56	37.3
	60-70 years (Elderly)	75	50.0
2.	Gender		
	Male	99	66
	Female	51	34
3.	Educational Qualification		
	No formal schooling	1	0.7
	Primary education	32	21.3
	Secondary education	58	38.7
	Diploma	17	11.3
	Undergraduate education	31	20.7
	Postgraduate education	11	7.3
	Any other	-	-
4	Time since Chronic Kidney Disease Diagnosis		
	≤1 year	23	15.3
	2-5 years	81	54.0
	6-9 years	20	13.3
	≥10 years	26	17.3
5	Years of dialysis treatment		
	≤1year	33	22.0
	2-5 years	92	61.3
	6-9 years	15	10
	≥10 years	10	6.7
6	Frequency of dialysis sessions per week		
	1	1	0.7
	2	29	19.3
	3	114	76.0
	4	6	4.0
7	Other health conditions		
	i. DM		
	Yes	90	60.0
	No	60.0	40.0
	ii. HTN		
	Yes	124	82.7
	No	26	17.3

	iii. Thyroid (Hypothyroidism and Hyperthyroidism)		
	Yes	16	10.7
	No	134	89.3
	iv. Other		
	Yes	10	6.7
	No	140	93.3
9.	Type of diet		
	Vegetarian	25	16.7
	Non- Vegetarian	125	83.3
11.	BMI (kg/m2)		
	≤18.5 (Underweight)	16	10.7
	18.5-22.9 (Normal)	41	27.3
	23-24.9 (Overweight)	33	22.0
	25-29.9 (Obese I)	40	26.7
	≥30 (Obese II)	20	13.3
12.	Average hours of sleep		
	≤4 hours	18	12.0
	5-6 hours	51	34.0
	7-8 hours	59	39.3
	≥8 hours	22	14.7
13.	History smoking		
	Yes, (past smoker)	23	15.3
	Yes, (present smoker)	-	-
	No	127	84.7

Primary outcomes

The study findings revealed that among the 150 participants, 7.3% had normal cognitive function, 4.7% had inconclusive cognitive status, and 88% had cognitive impairment. Among those with impairment, 40% had mild impairment, 35% had moderate impairment, and 25% had severe impairment (Table 2).

Table 2- Frequency and percentage distribution of cognitive level and its domains among patients undergoing haemodialysis

(n=150)				
Sl.no	Cognitive Level	Score	Frequency	Percentage
1.	Normal	88-100	11	7.3
2.	Inconclusive	83-87	7	4.7
3.	Impaired	≤82	132	88
	i. Mild impairment	69-82	53	40.1
	ii. Moderate impairment	60-68	46	34.84
	iii. Severe impairment	≤60	33	25.06

The mean total cognitive score was 68.12 ± 11.97 , indicating mild to severe cognitive impairment among patients undergoing haemodialysis (Table 3).

Table 3- Mean and Standard Deviation of cognitive level
(n=150)

Cognitive Level	Minimum score	Maximum score	Mean	Standard deviation
	21	95	68.12	11.966

Domain-wise analysis showed that fluency, visuospatial ability and memory were the most affected cognitive domains, whereas attention was relatively better preserved (Table 4).

Table 4- Frequency and percentage distribution of the domains of Addenbrooke's Cognitive Examination-III in patients undergoing haemodialysis

Sl.No	Scores for each cognitive domain	Frequency	Percentage	Minimum score	Maximum score	Mean	Standard Deviation
	ATTENTION (Total score- 0 to 18)						
1.	0-11	2	1.3	5	18	13.91	2.33
2.	7-12	34	22.7				
3.	13-18	114	76.0				
	MEMORY (Total score- 0 to 26)						
1.	0-9	2	1.3	8	26	18.27	4.96
2.	10-18	72	48.0				
3.	19-26	76	50.7				
	FLUENCY (Total score- 0 to 14)						
1.	0-5	78	52.0	1	12	5.66	2.069
2.	6-10	70	46.7				
3.	11-14	2	1.3				
	LANGUAGE (Total score- 0 to 26)						
1.	0-9	5	3.3	6	26	19.03	4.153
2.	10-18	53	35.3				
3.	19-26	92	61.3				
	VISUOSPATIAL (Total score- 0 to 16)						
1.	0-5	5	3.3	1	16	11.19	2.96
2.	6-10	53	35.3				
3.	11-16	92	61.3				

(n=150)

Secondary Outcomes

With respect to socio-demographic variables, a weak negative correlation was observed between cognitive function and age ($r = -0.252$, $p = 0.0002$) (Figure 1). A statistically significant association was also found between cognitive function and educational qualification ($p < 0.05$) (Table 5).

Table 5-Relationship between cognitive level and selected sociodemographic variables (r =Karl Pearson's Correlation Coefficient, r^* = Spearman Correlation coefficient, χ^2 = Chi Square value, df = Degree of freedom) (n=150)

Sl. No.	Socio-demographic variables	Normal (88-100)	Inconclusive (83-87)	Mild Impairment (69-82)	Moderate impairment (60-68)	Severe impairment (≤ 60)	Correlation Coefficient	Chi-Square value χ^2 /Fisher's Exact Test	P - value
	Age						$r^* = -0.252$		0.0025
	18-24 years (Youth)	0	0	1	0	0			
	25-44 years (Young adult)	2	3	9	3	1			

	45-59 years (Middle age)	3	3	19	20	11			
	60-70 years (Elderly)	6	1	24	23	21			
	Gender						-	$\chi^2=3.424$ df=4	0.331 NS
	Male	6	3	34	34	22			
	Female	5	4	19	12	11			
	Educational qualification						-	$\chi^2=26.03$ df=1	<0.001 S
	No formal schooling	0	0	0	1	0			
	Primary education	0	0	6	11	15			
	Secondary education	0	1	24	21	12			
	Diploma	0	1	5	8	3			
	Undergraduate	6	3	16	4	2			
	Postgraduate	5	2	2	1	1			
	Time since Chronic Kidney Disease Diagnosis						$r^*=0.135$		0.098 NS
	≤1 year	0	2	6	8	7			
	2-5 years	6	3	29	25	18			
	6-9 years	4	1	6	4	5			
	≥10 years	1	1	12	9	3			
	Years of dialysis treatment						$r^*=0.123$		0.133 NS
	≤1 year	0	2	11	12	8			
	2-5 years	7	4	34	25	22			
	6-9 years	4	0	5	4	2			
	≥10 years	0	1	3	5	1			
	Frequency of dialysis sessions per week						$r^*=0.130$		0.112 NS
	1	0	0	0	1	0			
	2	1	1	13	7	7			
	3	9	4	37	38	26			
	4	1	2	3	0	0			
	Other health conditions								
	Hypertension						-	4.927	0.977 NS
	Yes	11	7	40	39	27			
	No	0	0	13	7	6			
	Diabetes Mellitus						-	$\chi^2=0.285$ df=4	0.593 NS
	Yes	8	3	30	30	19			
	No	3	4	23	16	14			

	Thyroid					-	1.618	0.761NS
	Yes	2	1	4	5			
	No	9	6	49	41			
	Other					-	4.254	0.215NS
	Yes	2	1	4	1			
	No	9	6	49	45			
	Type of Diet						$\chi^2=0.904$ df=4	0.342NS
	Vegetarian	3	3	8	6			
	Non-Vegetarian	8	4	45	40			
	Body Mass Index					r=-0.049		0.55NS
	≤18.5 (Under weight)	0	2	6	4			
	18.5-22.9 (Normal)	6	1	13	11			
	23-24.9 (Overweight)	1	1	12	7			
	25-29.9 (Obese I)	2	2	16	17			
	≥30 (Obese II)	2	1	6	7			
	Hours of sleep					r*=-0.011		0.891NS
	1	1	1	6	7			
	2	3	3	18	17			
	3	6	3	18	16			
	4	1	0	11	6			
	History of smoking						4.889	0.337NS
	Yes, (past smoker)	0	0	0	0			
	Yes, (present smoker)	3	1	9	3			
	No	8	6	44	43			

DISCUSSION

The present study aimed to assess cognitive impairment and its relationship with selected socio-demographic variables among patients undergoing haemodialysis using the Addenbrooke's Cognitive Examination-III. The findings are discussed in relation to existing literature. The results revealed a high burden of cognitive impairment in this population, highlighting the need for routine cognitive assessment as part of comprehensive dialysis care.

The present study was conducted in a xxx. The majority of participants were aged 60–70 years, predominantly male, and had been receiving haemodialysis for 2–5 years with thrice-weekly sessions. This demographic pattern reflects the established epidemiology of CKD, in which disease prevalence and severity increase with advancing age and longer disease duration. Furthermore, the predominance of thrice-weekly haemodialysis is consistent with the standard maintenance haemodialysis regimen practised globally. These findings suggest that the study sample is representative of the typical haemodialysis population, thereby supporting the generalizability of the results to similar clinical settings 13–15.

The findings revealed a high prevalence of cognitive impairment among haemodialysis patients, with 88% of participants demonstrating some degree of impairment. Among them, 35.3% had mild impairment, 30.7% had moderate impairment, and 22% had severe impairment. These findings are consistent with previous studies reporting prevalence rates ranging from 58% to over 90% among haemodialysis patients 16–18. The high prevalence observed may be attributed to the combined effects of uraemic toxin accumulation, chronic inflammation, vascular disease, oxidative stress, anaemia, and

haemodynamic fluctuations associated with regular haemodialysis. These factors contribute to cerebral hypoperfusion, white matter injury and progressive neuro-cognitive decline^{19–21}.

In the present study, domain-wise analysis revealed that fluency, visuospatial ability and memory were the most affected cognitive domains, whereas attention was relatively better preserved. These findings are consistent with previous studies reporting significant impairment in immediate recall memory and verbal fluency among patients undergoing haemodialysis^{7,18,22,23}. Memory deficits may result due to structural and functional changes in those regions of the brain involved in learning and recall²⁴. Reduced verbal fluency may reflect executive dysfunction related to cerebrovascular disease and impaired frontal lobe function^{25,26}. The decline in visuospatial ability among patients undergoing haemodialysis is due to cerebrovascular injury and white matter damage. These structural brain changes disrupt frontal–parietal neural pathways involved in visuospatial processing, resulting in impaired visual construction and spatial orientation abilities²⁷.

The relative preservation of attention observed in this study reflects that certain cognitive domains may be affected earlier than others during the course of disease progression²⁸.

Regarding the correlation with socio-demographic variables, the present study found a weak negative correlation between age and cognitive function, indicating increased cognitive decline with advancing age. Participants aged 60–70 years demonstrated the highest level of cognitive impairment, predominantly in the mild category. These findings are supported by previous studies reporting a significant negative association between age and cognitive performance^{18,29}. This finding may be attributed to age-related cognitive decline, along with structural and functional changes in the cerebral vasculature, which can reduce cerebral perfusion and adversely affect cognitive functioning³⁰.

A statistically significant association was also observed between educational qualification and cognitive function. Participants with higher educational status demonstrated better cognitive performance, suggesting a protective effect of education on cognitive functioning. Similar findings have been reported in previous studies, which have demonstrated a positive association between education level and cognitive outcomes in haemodialysis patients^{18,29}.

The use of the Addenbrooke's Cognitive Examination-III, a standardised cognitive assessment tool, is a key strength of the study as it provides an objective evaluation of cognitive impairment among patients undergoing haemodialysis. Additionally, the exclusion of participants with pre-existing severe psychiatric conditions improved the internal validity and reliability of the study results.

This study had certain limitations. As the study adopted a cross-sectional design, changes in cognitive function over time could not be assessed. Biochemical investigations and diagnostic tests, such as serum creatinine, blood urea nitrogen, Kt/V (hemodialysis adequacy) or other laboratory investigations, were not performed due to high cost and feasibility constraints among patients undergoing hemodialysis. In addition, the study was conducted in a single tertiary care hospital, which may introduce selection bias and limit external validity.

Based on the findings of the present study, it is recommended that future research be conducted in multiple clinical settings to improve the generalizability of the results. Interventional studies are also warranted to evaluate the effectiveness of cognitive training, counselling, and supportive therapies in improving cognitive function among patients undergoing haemodialysis. Routine cognitive screening in dialysis units is recommended to facilitate early identification and timely management of cognitive impairment. Furthermore, health education programs for patients and caregivers should be implemented to enhance awareness of cognitive health, improve treatment adherence, and promote appropriate lifestyle modifications. Future studies should also explore the feasibility and effectiveness of implementing routine cognitive screening protocols in dialysis units and their impact on patient outcomes.

Main Points

- In this study, cognitive impairment is widely prevalent among patients undergoing hemodialysis, with 88% of the patients having mild to severe level of cognitive impairment.
- The relationship between age and cognitive level has shown a negative correlation with each other, indicating increased cognitive decline with advancing age. A statistically significant association was also observed between educational qualification and cognitive function, suggesting a protective effect of education on cognitive functioning.
- In the present study, domain-wise analysis revealed that fluency, visuospatial ability and memory were the most affected cognitive domains, whereas attention was relatively better preserved.
- Early identification of cognitive impairment through routine cognitive screening is essential for improving patient outcomes, enhancing treatment adherence, and maintaining quality of life. Periodic cognitive assessment may facilitate early intervention and support the development of individualised care strategies for patients undergoing haemodialysis.
- As this was a cross-sectional study with a relatively limited sample size, casual interpretation can not be done; however recognizing the levels of impairment in various domains has allowed in identifying the specific areas of cognitive difficulty that could improve the cognitive outcomes in this population. Thus, it provides a basis for further research.

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