

Cognitive Impairment in Patients with Chronic Kidney Disease; A Study from Egypt

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ABSTRACT

Background: Patients with chronic kidney disease (CKD) often have cognitive impairment, an issue that is frequently overlooked.

Objective: To determine the prevalence and patterns of cognitive impairment among CKD patients and to evaluate its association with demographic and clinical factors in a tertiary care setting of Egypt.

Methodology: A descriptive cross-sectional study was conducted at the Department of Nephrology, Alexandria University, El-Shatby, Alexandria, Egypt, from January to December 2023. The study included 384 adult patients with CKD in all stages (I–V). Individuals taking neuropsychiatric drugs and those with underlying neurological or psychiatric conditions were not included. The Montreal Cognitive Assessment (MoCA) was used to evaluate cognitive function. Age, gender, educational attainment, stage of chronic kidney disease, comorbidities (diabetes, hypertension), and length of sickness were among the demographic and clinical information gathered. SPSS v26 was used for data analysis. Chi-square was used to evaluate for associations between study variables and cognitive impairment, with $p < 0.05$ being regarded as statistically significant.

Results: Out of 384 CKD patients, 198 (51.56%) had cognitive impairment: 128 (33.33%) mild, 58 (15.10%) moderate, and 12 (3.13%) severe. Cognitive impairment was significantly associated with older age, advanced CKD stage, and comorbidities. Among patients aged >60 , 117 (80.69%) had impairment, compared to only 4 (9.52%) in the 18–30 age group ($p < 0.001$). Impairment was present in 87 (78.38%) patients in CKD stage V vs. 11 (15.49%) in stages I–II ($p < 0.001$). It was also more common among those with hypertension (174/294, 59.18%, $p = 0.002$), diabetes mellitus (124/204, 60.78%, $p < 0.001$), and longer disease duration (>3 years: 116/192, 60.42%, $p = 0.032$).

Conclusion: Cognitive impairment is prevalent in CKD patients and strongly associated with age, disease severity, and comorbidities, highlighting the need for routine cognitive screening in nephrology care.

Keywords: Chronic Kidney Disease, Cognitive Impairment, Montreal Cognitive Assessment, Hypertension, Diabetes Mellitus, Cross-Sectional Study

INTRODUCTION

Chronic kidney disease (CKD), which is a degenerative illness marked by a progressive decrease of kidney function over time, is often brought on by underlying medical conditions such hypertension and diabetes mellitus [1,2]. A number of systemic repercussions, such as cardiovascular disease, anemia, mineral and bone abnormalities, and most significantly, cognitive impairment, are linked to chronic kidney disease (CKD) in addition to renal-specific issues [3]. Concern about the neurological effects of CKD, particularly with respect to cognitive health, is growing as its prevalence rises worldwide [4,5].

Deficits in a number of areas, including memory, attention, executive function, and psychomotor speed, are included in cognitive impairment [6]. These deficiencies may be made worse in people with chronic kidney disease (CKD) by a confluence of uremic toxins, oxidative stress, chronic inflammation, anemia, and vascular alterations, all of which impair cerebral perfusion and neuronal function [7,8]. Furthermore, because of its gradual start and overlap with symptoms of sadness and tiredness, which are already common in this group, cognitive impairment in CKD patients is often underdiagnosed, especially in the early stages [9,10]. According to new research, cognitive impairment may start in the early stages of chronic kidney disease (CKD) and become worse as renal failure progresses. Affected persons' functional independence and quality of life are negatively impacted by this trajectory, which may also make it more difficult for them to follow complicated treatment plans, which might eventually have an impact on clinical results [11]. Routine cognitive screening is still not a regular procedure in nephrology treatment, despite this, particularly in locations with minimal resources where knowledge and diagnostic ability may be restricted.

For prompt identification and management, it is essential to comprehend the incidence and trends of cognitive impairment in

CKD patients. Determining related clinical and demographic characteristics may also help guide focused tactics to slow cognitive deterioration in this susceptible group.

Research Objective

To determine the prevalence and patterns of cognitive impairment among patients with chronic kidney disease and to evaluate its association with demographic and clinical parameters in a tertiary care setting.

METHODOLOGY

Study Design and Setting: This descriptive cross-sectional study was conducted at the Department of Nephrology, Alexandria University, El-Shatby, Alexandria, Egypt, over a period of one year, from January 2023 to December 2023.

Inclusion and Exclusion Criteria: Participants in the study were to be at least 18 years old, diagnosed with CKD at any stage (I–V), and enrolled in the nephrology outpatient or inpatient departments.

Patients who were unable or unable to participate in the cognitive evaluation, had a history of neurological or psychiatric diseases (such as dementia, stroke, or schizophrenia), were currently using neuropsychiatric drugs, or had acute renal damage were also excluded.

Sample Size: A sample size of 384 was calculated using the formula for estimating a proportion in a cross-sectional study: $n = Z^2 \cdot p \cdot (1-p) / d^2$, where $Z = 1.96$ (for 95% confidence level), $p = 0.5$ (assumed prevalence of cognitive impairment in CKD patients), and $d = 0.05$ (margin of error). Substituting these values, the required sample size was determined to be 384.

Data Collection: A standardized proforma was used to record sociodemographic and clinical information, such as age, gender, educational attainment, stage of chronic kidney disease, comorbid diseases (such as diabetes or hypertension), and length of illness. A validated screening instrument, such as the Mini-Mental State Examination (MMSE) or Montreal Cognitive Assessment (MoCA), was used to evaluate cognitive function. Trained staff members delivered the test in the patient's chosen language.

Statistical Analysis: SPSS version 26.0 was used to input and analyze the data. Demographic and clinical features were summed together using descriptive statistics (mean, standard deviation, frequencies, and percentages). Cognitive impairment prevalence was computed. The chi-square test was used where

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applicable to examine correlations between cognitive impairment and factors such age, stage of chronic kidney disease, and comorbidities. P-values less than 0.05 were regarded as statistically significant.

Ethical Approval: The Institutional Review Board (IRB) granted ethical clearance for the research. Prior to enrollment, all individuals provided written informed consent. Throughout the research, participant data confidentiality and anonymity were rigorously maintained.

RESULTS

The sociodemographic details of 384 CKD patients are shown in Table 1. 42 patients (10.94%) were between the ages of 18 and 30, 76 patients (19.79%) were between the ages of 31 and 45, 121 patients (31.51%) were between the ages of 46 and 60, and the biggest group, 145 patients (37.76%), were above 60. There were 162 patients (42.19%) who were female and 222 patients (57.81%) who were male. Ninety patients (23.44%) had graduated or finished postgraduate studies, 104 patients (27.08%) were illiterate, 88 patients (22.92%) had elementary education, and 102 patients (26.56%) had secondary education.

Table 1: Sociodemographic Characteristics of CKD Patients (n=384)

Variable	Categories	Frequency (n)	Percentage (%)
Age Group (years)	18–30	42	10.94
	31–45	76	19.79
	46–60	121	31.51
	>60	145	37.76
Gender	Male	222	57.81
	Female	162	42.19
Educational Status	Illiterate	104	27.08
	Primary	88	22.92
	Secondary	102	26.56
	Graduate/Postgraduate	90	23.44

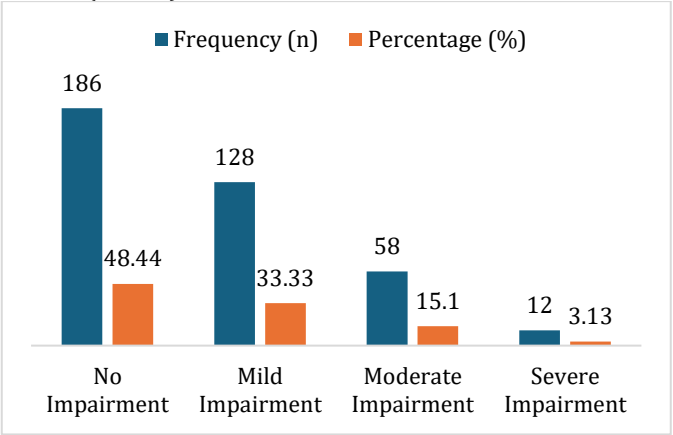
The clinical profiles of the same 384 individuals are compiled in Table 2. The distribution of CKD stages was as follows: 111 patients (28.91%) were in stage V (end-stage renal disease), 107 patients (27.87%) were in stage IV, 95 patients (24.73%) were in stage III, and 71 patients (18.49%) were in stages I–II. 204 patients (53.13%) had diabetes mellitus, while 294 patients (76.56%) had hypertension. 68 patients (17.71%) had been sick for less than a year, 124 patients (32.29%) for one to three years, and half of the patients, 192 (50.00%), had been unwell for more than three years.

Table 2: Clinical Profile of CKD Patients (n = 384)

Variable	Categories	Frequency (n)	Percentage (%)
CKD Stage	Stage I–II	71	18.49
	Stage III	95	24.73
	Stage IV	107	27.87
	Stage V (ESRD)	111	28.91
Hypertension	Present	294	76.56
	Absent	90	23.44
Diabetes Mellitus	Present	204	53.13
	Absent	180	46.88
Duration of Illness	<1 year	68	17.71
	1–3 years	124	32.29
	>3 years	192	50.00

The Montreal Cognitive Assessment (MoCA) tool's assessment of cognitive impairment status is shown in figure 1. Of the 384 patients with chronic kidney disease, 186 (48.44%) had no cognitive impairment, 128 (33.33%) had mild impairment, 58 (15.10%) had moderate impairment, and 12 (3.13%) had severe impairment.

Figure 1: Prevalence and Severity of Cognitive Impairment in CKD Patients (n = 384)



The distribution of cognitive impairment across 384 CKD patients across a number of clinical and demographic factors is shown in Table 3. Elderly patients had a considerably greater rate of cognitive impairment: 4 out of 42 patients (9.52%) were between the ages of 18 and 30, 26 out of 76 patients (34.21%) were between the ages of 31 and 45, 51 out of 121 patients (42.15%) were between the ages of 46 and 60, and 117 out of 145 patients (80.69%) were above the age of 60 ($p < 0.001$). Of patients with CKD, 11 out of 71 (15.49%) had cognitive impairment in Stage I–II, 37 out of 95 (38.95%) in Stage III, 63 out of 107 (58.88%) in Stage IV, and 87 out of 111 (78.38%) in Stage V ($p < 0.001$). Of the 294 individuals with hypertension, 174 (59.18%) had cognitive impairment, whereas 24 out of 90 (26.67%) did not have hypertension ($p = 0.002$). Of the 204 patients with diabetes mellitus, 124 (60.78%) had cognitive impairment, whereas 74 of 180 (41.11%) did not have diabetes ($p < 0.001$). In terms of disease length, 64 of 124 patients (51.61%) with 1–3 years and 116 of 192 patients (60.42%) with >3 years had impairment, whereas 18 of 68 patients (26.47%) with <1 year had impairment ($p = 0.032$).

Table 3: Association Between Cognitive Impairment and Clinical/Demographic Variables (n=384)

Variable	Category	No Cognitive Impairment (n = 186)	Cognitive Impairment (n = 198)	p-value
Age Group (years)	18–30	38 (90.48%)	4 (9.52%)	<0.001*
	31–45	50 (65.79%)	26 (34.21%)	
	46–60	70 (57.85%)	51 (42.15%)	
	>60	28 (19.31%)	117 (80.69%)	
CKD Stage	Stage I–II	60 (84.51%)	11 (15.49%)	<0.001*
	Stage III	58 (61.05%)	37 (38.95%)	
	Stage IV	44 (41.12%)	63 (58.88%)	
	Stage V (ESRD)	24 (21.62%)	87 (78.38%)	
Hypertension	Present	120 (40.82%)	174 (59.18%)	0.002*
	Absent	66 (73.33%)	24 (26.67%)	
Diabetes Mellitus	Present	80 (39.22%)	124 (60.78%)	<0.001*
	Absent	106 (58.89%)	74 (41.11%)	
Duration of Illness	<1 year	50 (73.53%)	18 (26.47%)	0.032*
	1–3 years	60 (48.39%)	64 (51.61%)	
	>3 years	76 (39.58%)	116 (60.42%)	

DISCUSSION

According to the current research, individuals with chronic kidney disease (CKD) bear a heavy burden of cognitive impairment. According to the Montreal Cognitive Assessment (MoCA), 33.33% of individuals had mild cognitive impairment, 15.10% had moderate cognitive impairment, and 3.13% had severe cognitive impairment, representing about 51.56% of the participants. This prevalence is significantly greater than that found in earlier research, which used similar neuropsychological tests to find cognitive impairment in about 36% of patients with chronic

kidney disease (CKD), underscoring the pervasiveness of cognitive decline in this population [12].

Our research found a high correlation between age and cognitive impairment, with 80.7% of patients over 60 exhibiting cognitive abnormalities compared to just 9.52% in the 18–30 age range ($p < 0.001$). This age-related tendency is consistent with other research that showed that cumulative vascular and neuronal insults worsen cognitive deterioration in CKD as people age [13,14]. Additionally, age-related cerebrovascular changes and comorbidities may exacerbate the cognitive susceptibility of older CKD patients, indicating the need for focused cognitive surveillance in geriatric CKD populations.

Cognitive impairment and CKD stage were significantly correlated. According to our findings, cognitive impairment was present in 78.38% of patients at stage V (ESRD), compared to 15.49% in stages I–II ($p < 0.001$). This gradient supports earlier research that showed a steady loss in cognitive performance as kidney function deteriorated, most likely due to uremic toxin buildup and vascular damage [15]. Early identification and care before advanced stages of the illness are crucial, as shown by the effect of CKD severity on cognition.

In our sample, cognitive impairment was also substantially correlated with frequent comorbidities in chronic kidney disease (CKD): diabetes mellitus (60.88% vs. 41.11%) and hypertension (59.18% vs. 26.67%, $p = 0.002$ and <0.001 , respectively). These findings are in accordance with earlier research that shown that vascular risk factors, such as diabetes and hypertension, worsen cognitive impairment in chronic kidney disease (CKD) by means of pathways involving chronic inflammation and microvascular damage [16]. In order to possibly prevent cognitive decline, our results emphasize the need for strict control of these comorbidities.

Cognitive impairment was more common in patients who had been unwell for more than three years (60.42%) than in those who had been diagnosed less than a year earlier (26.47%), suggesting that the course of CKD had a cumulative impact on cognitive function. Similar findings were reported in earlier research, indicating that systemic inflammation and extended exposure to the uremic milieu may be factors in the slow decline of neurocognition [17].

In conclusion, our research supports the complex etiology of cognitive impairment in chronic kidney disease (CKD), where age, stage of CKD, diabetes, hypertension, and length of illness are important factors. These results support the increasing body of nephrology literature that emphasizes the critical necessity for integrated cognitive screening and management procedures in the treatment of chronic kidney disease.

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Study Strengths and Limitations

The results of this research are more reliable and broadly applicable in a tertiary care context because of the comparatively high sample size of 384 CKD patients. The cognitive evaluation method is made more rigorous by using a validated cognitive assessment instrument (MoCA) that is given by qualified staff in the patients' chosen languages. Furthermore, the research thoroughly investigated a number of clinical and demographic characteristics, enabling a thorough examination of the variables linked to cognitive impairment. Nevertheless, it has drawbacks, such as a cross-sectional design that limits the ability to draw conclusions about the causes of cognitive deterioration over time. External validity to other populations or healthcare contexts may be limited by the study's single-center design. Furthermore, unmeasured variables that might affect cognitive results, such as depression, dietary issues, and socioeconomic status, were not taken into account. The reasons behind cognitive decline in CKD would be further clarified by future longitudinal investigations that include neuroimaging and biomarker analysis.

CONCLUSION

According to the research, cognitive impairment is quite prevalent in CKD patients, and its severity rises with age, CKD stage, and length of illness. In this group, comorbid diabetes and hypertension also have a major role in cognitive impairments. In order to enhance patient outcomes and quality of life, our results highlight the vital need of frequent cognitive screening and integrated treatment techniques in nephrology care. In CKD patients, early detection and focused therapies that address modifiable risk factors may help lessen cognitive decline and the functional deficits that go along with it.

Authors' Contribution

AA: Concept & study design, data collection and drafting of the manuscript.
 AIN: Data entry, statistical analysis, interpretation of the results.
 ZAS: Manuscript editing and critical revision of the manuscript.
 All authors approved the final version of the manuscript to be published.

Conflict of Interest

The authors declared no conflict of interest.

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Data Availability

Data is available with authors and can be provided on request

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