

Mild Cognitive Impairment in people undergoing Hemodialysis

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Abstract

Mild Cognitive Impairment (MCI) is a prevalent yet underexplored condition among individuals undergoing hemodialysis for chronic kidney disease (CKD), a condition affecting millions worldwide. MCI reflects an intermediate stage of cognitive impairment between normal cognitive aging and dementia, characterized by subtle deficits in memory, executive function, and attention. While its prevalence in CKD patients undergoing hemodialysis is estimated to be as high as 30-63%, it remains poorly understood in terms of its specific manifestations and contributing factors. This study examines the prevalence of MCI in a small group of individuals undergoing hemodialysis in renal units of Attica, Greece. The Montreal Cognitive Assessment (MoCA) was used to assess the cognitive performance of eight individuals, aged 55 to 87. Younger participants (ages 55-60) and those employed full-time scored highest (27-30), suggesting a protective effect of cognitive engagement. Trends indicated a negative association of age and dialysis duration with MoCA performance. With three participants (37.5%) scoring below the recognized MCI cutoff score, the results showed notable deficits, underscoring the prevalence of cognitive impairment in this demographic. Potential correlations between MCI, age, dialysis duration, and cognitive engagement are suggested by preliminary findings. These findings underscore the necessity of routine, culturally calibrated cognitive screening in nephrology settings and support integrating occupational therapy interventions to maintain functional independence and slow cognitive decline.

Keywords:Chronic Kidney Disease, Mild Cognitive Impairment, quality of life

JEL Classifications: I12, I30

Introduction

End-stage renal disease (ESRD) is a growing global health challenge, with an estimated 2.6 million people worldwide receiving renal replacement therapy, most commonly hemodialysis (Olczyk et al., 2022). While hemodialysis effectively replaces essential renal functions, it also exposes patients to physiological stresses, uremic toxin accumulation, fluctuating fluid and electrolyte balance, and intradialytic hypotension that collectively heighten the risk of cognitive decline (Drew et al., 2019; Juncos et al., 2017). Cognitive impairment in the hemodialysis population spans a spectrum from subtle deficits in attention and executive function to overt dementia, adversely affecting treatment adherence, daily functioning, and health-

related quality of life (Chang et al., 2020; Jesus et al., 2019; Voltarelli & Ruzzi-Pereira, 2021).

Mild Cognitive Impairment (MCI) occupies an intermediate clinical stage between age-associated cognitive changes and dementia. Characterized by measurable decrements, often in episodic memory, processing speed, and executive domains, that do not significantly compromise participation and functioning at basic activities of daily living, MCI nonetheless elevates the risk of progression to Alzheimer's disease and other dementias (Anderson, 2019; Lindbergh et al., 2016). In the general elderly population, MCI prevalence ranges from 10% to 20%; among hemodialysis patients, rates have been reported between 30% and 63%, roughly double those of age-matched community peers (Brodzki et al., 2019; Burns et al., 2017; Otobe et al., 2019). Such figures underscore the need for systematic screening and early intervention in dialysis settings.

The pathophysiology of cognitive impairment in ESRD is multifactorial. Uremic toxins, such as indoxyl sulfate and p-cresyl sulfate, cross the blood-brain barrier and disrupt neurotransmission, while microvascular disease, common in hypertensive and diabetic CKD patients, accelerates white-matter hyperintensities and small-vessel ischemia (Drew et al., 2019; Bugnicourt et al., 2013). Hemodialysis sessions themselves can transiently reduce cerebral perfusion, exacerbating neuronal vulnerability (Wolfgram, 2019). Additionally, inflammatory mediators, oxidative stress, and anemia further compound neurocognitive risk (Murphy et al., 2016; Tamura et al., 2016). Demographic factors such as older age, lower educational attainment, psychosocial variables, depression and social isolation, modulate this vulnerability, rendering cognitive trajectories highly heterogeneous across patients (Kelly & Rothwell, 2022; Viggiano et al., 2020).

Despite mounting evidence of high MCI prevalence in dialysis populations, research specific to the Greek context remains sparse. Greece operates a universal healthcare system that fully subsidizes hemodialysis, yet regional inequities in service availability and cultural factors, such as strong family involvement in elder care and attitudes toward cognitive aging, may uniquely shape cognitive outcomes and the feasibility of interventions (Nicholas et al., 2015). Furthermore, normative data for cognitive screening instruments must be adapted for language, education, and cultural norms. The Montreal Cognitive Assessment (MoCA) is validated internationally as a sensitive tool for MCI detection, outperforming the Mini-Mental State Examination (MMSE) in identifying mild deficits (Arevalo-Rodriguez et al., 2015; Ciesielska et al., 2016; Devenney & Hodges, 2016; Pinto et al. 2018). In Greece, Poptsi et al. (2019) established education-adjusted thresholds of 26/30 for ≥12 years of schooling and 23/30 for <12 years to optimize sensitivity and specificity.

Within this complex clinical picture, occupational therapy offers a unique and holistic perspective in addressing cognitive impairment in individuals undergoing hemodialysis. Emphasizing the interplay between cognitive function, daily activities, and psychosocial well-being, occupational therapists assess and address challenges in memory, executive function, and attention that interfere with treatment adherence and meaningful occupation (American Occupational Therapy Association, 2020; Anderton et al., 2015; Fang et al., 2020). Targeted interventions may include strategy training, environmental modifications, and support for engagement in everyday roles, yet few studies have examined the implementation of these interventions in nephrology settings (Schnell-Inderst et al., 2023; Stigen et al., 2022).

Although exploratory in nature, the findings have the potential to inform future research and clinical practice, emphasizing the need for early identification and targeted interventions for MCI in this population. Given the multifaceted nature of cognitive impairment in ESRD, a multidisciplinary approach is essential for comprehensive care. Collaboration among nephrologists, neurologists, occupational therapists, psychologists, and social workers can facilitate integrated assessment and management strategies (Abe et al., 2023; Goto, 2017). Establishing evidence-based pathways that include cognitive screening and rehabilitation may ultimately improve patient outcomes, adherence, and overall wellbeing (Baragar et al., 2023).

Study Objective

The primary objective of this study is to investigate the occurrence and profiles of mild cognitive impairment (MCI) in individuals with chronic kidney disease (CKD) undergoing hemodialysis. Secondary aims include the implications of cognitive status for occupational performance and psychosocial wellbeing.

Methods

Study Design

This cross-sectional study is conducted among adults diagnosed with chronic kidney disease (CKD) who are undergoing hemodialysis at nephrology departments of hospital units in Attica. Data collection includes a cognitive screening assessment designed to evaluate cognitive function of the participants.

Target Population

The study aims to recruit adults (both male and female) diagnosed with CKD at stages 4 and 5. Participants must be over 18 years of age and regularly attend dialysis sessions at hospital units in Attica. All participants receive an information leaflet detailing the study's objectives and procedures, and informed consent is obtained prior to their inclusion in the research. Participants must possess adequate oral and written communication skills in Greek. The study excludes individuals under 18 years of age, those with other cognitive disorders (such as intellectual disabilities), and individuals with severe motor, sensory, or perceptual impairments. This is to ensure the homogeneity of the sample (Guthrie et al., 2018).

Ethics

This study adheres to the principles outlined in the Declaration of Helsinki and relevant ethical guidelines for research involving human participants. All individuals invited to participate receive a detailed information leaflet explaining the study's objectives, procedures, potential risks, and benefits. Participants have the opportunity to ask questions and seek clarifications before providing their informed consent. Written consent is obtained from all participants prior to their inclusion in the study, ensuring their voluntary and informed participation. Participants can choose to withdraw from the study at any given time. Ethical approval for this cross-sectional study was granted by the Research Ethics Committee of the University of West Attica, Athens, Greece. The study protocol was thoroughly reviewed to ensure that it meets ethical standards for safeguarding the rights, dignity, and well-being of all participants.

Instruments

Montreal Cognitive Assessment (MoCA). The MoCA cognitive assessment scale is a psychometric tool for assessing cognitive function, designed for the detection of Mild Cognitive Impairment and early dementia (Nasreddine et al., 2005). It has been translated and standardized to the Greek population (Nasreddine et al., 2005; Poptsi et al., 2019). It includes 11 items that assess cognitive functions such as visuospatial abilities, naming, short-term memory, attention, language and orientation (Nasreddine et al., 2005). Visuospatial abilities are assessed by drawing tasks, specifically by copying a cube and a clock (5 points). Naming of animals through identifying pictures (e.g., lion, rhinoceros and camel) tests the ability to recall and label objects (3 points). Short-term memory tests involve the recall with a 5-minute delay of a learned list of 5 words (5 points). Attention skills are assessed using a test of maintaining attention (tapping detection; 1 point) and a serial subtraction test (3 points) of digits backwards (1 point each) and identifying target letters in a sequence (1 point). Tasks involving sentence repetition and word fluency, such as listing words beginning with a specific letter are used to assess language deficits (5 points). Finally, spatial/temporal orientation is assessed with 6 short questions about the date, location, and time (6 points). In the original validation, a MoCA score of 26/30 or below was used to indicate possible MCI, with reported sensitivity and specificity around 90% and 87%, respectively (Nasreddine et al., 2005). However, recent research suggests that optimal cutoff scores may differ. Greek normative data indicate that the cutoff may range from 23 to 26 depending on educational attainment. For example, Poptsi et al. (2019) found cutoffs of 23 for individuals with low education and 26 for higher education levels. A meta-analysis by Carson et al. (2017) also supports using a cutoff of 23/30 to maximize diagnostic accuracy and reduce false positives. In our analysis, we adjust the MoCA score by +1 for participants with less than 12 years of education, as per standard guidelines.

Results

This study represents a preliminary investigation involving eight participants with chronic kidney disease undergoing hemodialysis. The findings are part of an exploratory study informing the broader scope of a PhD thesis, which aims to include approximately 90 participants.

Summary of Findings

There were eight participants aged 55–87 years ($M = 69.37$, $SD = 12.51$), the majority of whom were married (87.5%) and retired (75%). Two participants (25%) were employed full-time (see Table 1). All participants were male. The distances traveled to dialysis centers ranged from 5 to 30 km ($M = 9.75$, $SD = 8.29$). The duration of hemodialysis spanned from 2 to 17 years ($M = 7.12$, $SD = 4.64$). MoCA scores ranged from 23 to 30 ($M = 26.13$, $SD = 2.75$). Based on education-adjusted cutoffs, three participants (37.5%) were classified as having Mild Cognitive Impairment (MCI). Specifically, one participant aged 85 with a university degree scored 23; another aged 78, a high school graduate, scored 24; and one aged 87, also with high school education, scored 23. An additional participant (P2), aged 68 with a university degree, scored 25 and was considered a possible case of MCI. Although this technically meets criteria for MCI, the result was interpreted cautiously given the borderline score, absence of known cognitive complaints or functional impairment, and preserved performance across most cognitive domains. Therefore, this case was categorized as a “possible MCI,” acknowledging the limitations of single-point screening thresholds. All other participants, who held university degrees, scored within the normal cognitive range.

Table 1. Sociodemographic Characteristics of Participants

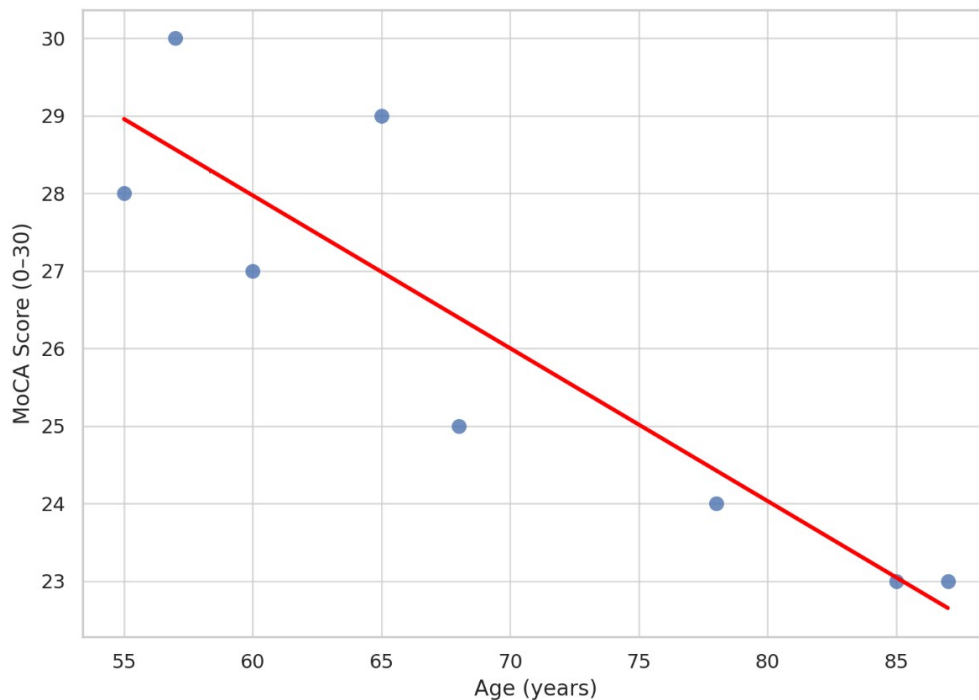
Participant	<i>Age</i>	<i>Gender</i>	<i>Marital Status</i>	<i>Education Level</i>	<i>Employment</i>	<i>Years on Dialysis</i>	<i>Distance to Dialysis center (km)</i>	<i>MoCA Score</i>	<i>MCI Classification</i>
<i>P1</i>	57	Male	Married	University degree	Full-time	7	30	30	Normal
<i>P2</i>	68	Male	Not Married	University degree	Retired	9	9	25	Possible MCI
<i>P3</i>	78	Male	Married	High school	Retired	3	8	24	MCI (adjusted cutoff)
<i>P4</i>	85	Male	Married	University degree	Retired	2	5	23	MCI (adjusted cutoff)
<i>P5</i>	87	Male	Married	High school	Retired	17	7	23	MCI (adjusted cutoff)
<i>P6</i>	60	Male	Married	University degree	Full-time	5	8	27	Normal
<i>P7</i>	55	Male	Married	University degree	Retired	6	5	28	Normal
<i>P8</i>	65	Male	Married	University degree	Retired	8	6	29	Normal

Relationship between age and MoCA scores

Although the sample size is small, a potential negative trend is observed, suggesting that increased age may be associated with lower cognitive performance. Older participants (e.g., aged 85 and 87) demonstrated lower MoCA scores (25 and 23, respectively), whereas the youngest participant (aged 57) obtained a full score of 30/30. Figure 1 presents this trend through a scatterplot, illustrating an inverse relationship between participant age and MoCA scores. While not statistically tested due to the limited sample

size, the visual trend suggests a potential age-related decline in cognitive function.

Figure 1. Scatterplot of Age Versus MoCA Score in Patients with CKD on Hemodialysis



Impact of Dialysis Duration

The relationship between dialysis duration and cognitive performance did not present a clear or consistent pattern. While the participant with the longest duration on dialysis (17 years; age 87) had one of the lowest MoCA scores (23), other participants with similar durations (e.g., 8-9 years) performed within the normal cognitive range. Conversely, some individuals with relatively short dialysis histories (2-3 years) also showed signs of cognitive impairment.

Distance to Dialysis Center

The average distance from participants' residences to the dialysis center was 9.75 km (SD = 8.29). Interestingly, the participant living farther from the dialysis center (30 km) demonstrated preserved cognitive performance (MoCA score of 30), suggesting that, in this small sample, longer distance alone did not appear to be linked to reduced cognitive performance. However, further analysis with a larger cohort is needed to explore this relationship comprehensively.

Marital and Employment Status

Most participants were married (75%), and two were employed full-time (25%). One employed participant demonstrated the highest MoCA score (30/30), potentially highlighting the role of cognitive engagement in preserving function. Retired participants showed a broader range of scores (23-29), underscoring the variability within this subgroup.

Table 2. Participant scores of Montreal Cognitive Assessment

Participant	Visuospatial/ Executive (5)	Naming (3)	Attention (6)	Language (3)	Abstraction (2)	Delayed Recall (5)	Orientation (6)	Total Score (30)
P1	5	3	6	3	2	5	6	30
P2	5	3	6	2	2	5	6	25
P3	5	3	5	1	1	3	6	24
P4	2	2	6	1	1	5	6	23
P5	4	3	5	2	1	3	5	23
P6	5	3	5	3	2	4	5	27
P7	5	3	6	3	2	4	5	28
P8	5	3	6	3	2	5	5	29

Performance across Cognitive Domains**Visuospatial/Executive Function**

The scores for visuospatial/executive function ranged from 2 to 5/5. Most participants performed at the upper end of the scale, with scores of 4 or 5, which is consistent with normative expectations in healthy adults. Participant 4 exhibited the lowest score (2/5).

Memory and Delayed Recall

Delayed recall varied from 3 to 5 out of 5, with most participants demonstrating moderate to high performance. The lowest score (3/5) was observed in Participants 3 and 5.

Attention and Language

Attention was relatively preserved across participants (scores ranging from 5/6 to 6/6) which are considered within the normal range based on normative MoCA data. Language performance ranged from 1 to 3 out of 3, with most participants scoring at the upper end. Participant 3 and Participant 4 scored lowest (1/3), suggesting possible difficulties in verbal fluency or expressive language.

Abstraction and Executive Function

Abstraction scores ranged from 1 to 2 out of 2. Three participants (3, 4, and 5) scored 1/2, indicating potential difficulties with abstract reasoning.

Discussion

This preliminary study aimed to explore the cognitive profile of individuals undergoing hemodialysis using the Montreal Cognitive Assessment (MoCA). The variability in MoCA scores highlights the heterogeneity of cognitive performance among individuals undergoing hemodialysis. The findings support existing evidence that both age and educational attainment are critical factors in cognitive performance among individuals undergoing hemodialysis (Floria et al., 2022). Based on education-adjusted cutoffs, three participants (37.5%) were classified as having Mild Cognitive Impairment (MCI), and one additional participant was considered a possible MCI case. These findings are consistent with previous literature like the prospective cohort study of Karakizlis et al. 2021 and the cross-sectional study of Pei et al. 2018, who found that 75% and 61% of people undergoing hemodialysis exhibited mild to severe cognitive impairment, suggesting that MCI is prevalent in a high percentage of people with CKD, potentially due to a combination of vascular, metabolic, and uremic factors. Age showed a negative association with MoCA performance (van Deudekom et al., 2020; van Zwieten et al., 2018).

Analysis of domain-specific performance revealed several notable patterns. In the visuospatial/executive domain, most participants performed well, scoring 4 or 5 out of 5, with the exception of one individual who scored 2. This lower score may reflect impairments in visual construction and executive functioning—skills often compromised in populations with cerebrovascular pathology (Bugnicourt et al., 2013). Delayed recall was generally preserved across the sample. Most participants scored 4 or 5 out of 5, while two individuals scored 3, indicating subtle retrieval difficulties. This mild reduction may be attributed to normal variability in aging or early episodic memory changes, which are particularly relevant in CKD due to uremic effects on hippocampal and prefrontal function (Murray et al., 2016). Attention scores were high and relatively uniform (5-6 out of 6), suggesting preserved attentional capacity in most participants. In contrast, language performance showed slightly more variability, with two participants scoring 1 out of 3, possibly reflecting expressive language difficulties or reduced verbal fluency—domains known to be sensitive to processing speed and cognitive slowing, particularly in CKD populations. Abstraction, a subdomain of executive function, showed reduced scores (1/2) in three participants. While the difference is subtle, reduced performance in this domain may reflect early executive dysfunction, particularly among individuals with multiple vascular risk factors such as hypertension and diabetes (Etgen et al., 2012).

Interestingly, the relationship between dialysis duration and cognitive performance did not follow a clear pattern. One participant with 17 years of dialysis had a MoCA score below the MCI cutoff, while others with shorter durations (5-9 years) performed within the normal cognitive range. Conversely, cognitive impairment was also present in a participant with only two years on dialysis. This variability suggests that dialysis duration alone may not be a strong predictor of cognitive status. Rather, age, educational background, and comorbidities may interact in complex ways to influence cognitive trajectories in this population.

Overall, these findings reinforce the importance of routine cognitive screening in people undergoing hemodialysis. The MoCA proved useful in identifying domain-specific deficits, particularly in executive function and memory. Occupational therapists can play a vital role in interpreting these results and designing individualized interventions aimed at maintaining

functional independence and quality of life. Further studies with larger samples are warranted to clarify the contributions of clinical and sociodemographic variables to cognitive outcomes in this vulnerable group.

The findings underscore the potential role of occupational therapy in addressing MCI in patients undergoing hemodialysis. The multidimensional nature of MCI observed in this study, affecting domains such as visuospatial/executive function, memory, and abstraction, aligns with findings from prior research that associate CKD with vascular, metabolic, and inflammatory mechanisms (Bugnicourt et al., 2013; Tamura et al., 2017). These domain-specific impairments have practical implications for occupational therapy and patient care, emphasizing the need for tailored interventions to address cognitive challenges and support functional independence.

Occupational therapists have a central role in supporting cognitive health in this population. In the area of visuospatial and executive function, therapists can implement cognitive training using tasks such as visual sequencing, spatial navigation practice, and real-world simulations like map reading or managing a medication planner. For memory impairments, interventions may include the use of external memory aids (e.g., calendars, alarms), structured recall training, and spaced retrieval techniques. For attention-related challenges, although minimal in this sample, therapists can use strategies such as task segmentation, environmental simplification, and verbal cueing to improve sustained attention. In cases of language deficits, including reduced fluency or expressive difficulties, occupational therapists may collaborate with speech therapists and also adapt written and visual communication tools to optimize understanding. Abstraction and conceptual reasoning skills may be enhanced through problem-solving exercises, categorization tasks, and activities that require flexible thinking.

While this study did not test OT interventions, the identified impairments underscore the value of occupational therapy as a future avenue. OT practitioners could design and evaluate cognitive training programs, adaptive strategies for daily activities, and psychosocial support to enhance both cognitive and functional outcomes. Subsequent research should pilot OT based interventions and measure their effects on MoCA performance, treatment adherence, and quality of life.

Limitations and future studies

This study has several notable strengths and limitations. A key strength lies in its role as a preliminary exploration of mild cognitive impairment (MCI) in individuals undergoing hemodialysis, providing foundational data for future research and contributing to an underexplored area. The use of the Montreal Cognitive Assessment (MoCA) as a standardized tool enhances the reliability of cognitive assessments and facilitates comparisons with existing literature. Furthermore, the study emphasizes the practical implications of cognitive findings, particularly within the field of occupational therapy, by linking cognitive outcomes to functional and psychosocial domains.

However, the study also has important limitations. The small sample size, consisting of only eight participants, significantly restricts the generalizability of the findings, rendering them exploratory in nature. Additionally, the cross-sectional design does not allow for causal inferences or the assessment of changes in cognitive function over time. The regional

focus, with participants drawn exclusively from dialysis centers in Attica, reduces the applicability of the findings to broader or more diverse populations. Lastly, potential sampling bias may have arisen from recruiting participants from specific centers, further limiting the representativeness of the sample.

Conclusions

This study underscores the significant cognitive burden experienced by individuals with chronic kidney disease (CKD), particularly in the form of mild cognitive impairment (MCI). MCI remains a critical yet frequently underrecognized complication, with implications for daily functioning, treatment adherence, and overall quality of life. Cognitive impairment in CKD reflects a multifactorial interplay of vascular, metabolic, and uremic mechanisms, often compounded by aging and comorbid conditions. The complexity of identifying and managing MCI in this population highlights the need for systematic cognitive screening as part of routine nephrology care. A holistic, person-centered approach is required—one that not only addresses the medical management of CKD but also integrates functional, psychological, and social support. Occupational therapy can play a key role in bridging the gap between diagnosis and meaningful intervention. Despite growing recognition of MCI in CKD, clinical progress is limited by the heterogeneity of cognitive profiles and the absence of standardized assessment and intervention pathways. There is an urgent need for further research to clarify the trajectory and underlying mechanisms of cognitive decline in CKD and to evaluate the impact of targeted, interdisciplinary interventions. Advancing this knowledge will be critical to improving both clinical outcomes and quality of life for individuals navigating the dual challenges of kidney disease and cognitive impairment.

Conflict of interest/Disclosure statement

The authors have no conflict of interest to report

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None

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