Received: 14 January 2021 | Revised: 26 May 2021 | Accepted: 23 June 2021

DOI: 10.1111/jorc.12393

ORIGINAL RESEARCH

Journal of Renal Care EDTNA/ERCA WILEY

A cross-sectional study exploring cognitive impairment in kidney failure

Pauline Nicholas MAS[1,2] | Theresa Green PhD[3,4] | Louise Purtell PhD[1,5,6] | Ann Bonner PhD[1,5,6]

[1]Kidney Health Service, Metro North Hospital and Health Service, Brisbane, Australia

[2]School of Nursing, Queensland University of Technology, Brisbane, Australia

[3]Surgical Treatment and Rehabilitation Service, Metro North Hospital and Health Service, Brisbane, Australia

[4]School of Nursing, University of Queensland, Brisbane, Australia

[5]Chronic Kidney Disease Centre for Research Excellence, University of Queensland, Brisbane, Australia

[6]School of Nursing and Midwifery, Griffith University, Brisbane, Australia

Correspondence

Pauline Nicholas, Kidney Health Service, Metro North Hospital and Health Service, Butterfield St, Herston, 4029 QLD, Australia.
Email: Pauline.Nicholas@health.qld.gov.au

Abstract

Background: Little is known of the prevalence or associated factors of cognitive impairment in people with kidney failure. Assessment of cognition is necessary to inform comprehension of healthcare information, aptitude for dialysis modality and informed decision making.

Objectives: This study sought to determine the prevalence and factors associated with cognitive impairment in people with kidney failure.

Design: Prospective cross-sectional.

Participants: Participants ($n = 222$) with chronic kidney disease grade 5 (CKD G5) including those not treated with dialysis, those undertaking dialysis independently or in a facility (CKD 5D), and those with a kidney transplant (CKD 5T).

Measurements: Data were collected using the Montreal Cognitive Assessment tool, the Hospital Anxiety and Depression Scale (only the depression subscale), and a demographic questionnaire. Type of kidney disease and comorbidities were extracted from participants' hospital records.

Results: Participants were 61 ± 13.63 years old; most were male (61.26%), and diabetes was the primary cause of kidney disease (34%). Prevalence of cognitive impairment was 34% although it was significantly higher for those in CKD G5 compared with other groups. A number of factors were found to be associated with cognitive impairment including, age, diabetes, hypertension, education, haemoglobin, albumin, parathyroid hormone, CKD G5, and length of time on treatment.

Conclusions: Cognitive impairment in kidney failure is common and it has significant implications for informed decision making and treatment choices. Routine assessment of cognitive function is an important part of clinical practice.

KEYWORDS

cognitive impairment, end stage kidney disease, kidney failure, kidney replacement therapy, Montreal Cognitive Assessment

INTRODUCTION

Cognitive impairment, a loss of mental function (American Psychiatric Association, 2013), is a growing concern globally due to more people living longer and the increasing prevalence of diabetes and hypertension related vascular dementia (Prince et al., 2016). Cognitive impairment impacts people managing their activities of daily living and understanding complex health needs (Volpi et al., 2017). Chronic kidney disease (CKD) is also increasing globally due chronic diseases which are similarly responsible for vascular cognitive impairment (Koye et al., 2018). Several studies suggest that cognitive impairment occurs frequently in people with kidney failure (Kurella et al., 2004; Murray, 2008). However, the extent and characterization of this impairment and how it relates to different kidney replacement therapy (KRT) modalities is still poorly understood.

Chronic kidney disease (CKD) is classified into five grades (new nomenclature) with kidney failure (CKD grade 5 [CKD G5] previously termed end stage kidney disease) occurring when kidney function has deteriorated to an estimated glomerular filtration rate (eGFR) < 15 ml/min/1.73^2 (Levey et al., 2020). At this level of kidney function, treatment options are either conservative management or KRT. It has been reported that the prevalence of cognitive impairment in those with CKD G5 could be three times higher than that of similar age populations without kidney disease (Tamura & Yaffe, 2011), with one study suggesting that 87% of people undertaking haemodialysis have some level of diminished cognitive function (Murray, 2008). This level of previously underappreciated cognitive impairment may be one explanation for the challenges people with kidney failure face adhering to the complex diet, medication, and dialysis treatment regimens (Yu et al., 2016). In addition, patient selection of the appropriate treatment modality for CKD G5 (i.e., to have KRT or not) is ideally a collaboration between the patient, their significant others, and the multidisciplinary kidney healthcare team for informed decision making (Wainstein et al., 2018). This level of decision making requires the patient to have a reasonable degree of cognition to understand the risk and benefits of undertaking KRT or opting for conservative management. Decision aids are recommended to support the patient to understand options for healthcare pathways and plans (Brown et al., 2019; Stacey et al., 2017). However, including a cognitive assessment as part of the informed decision making process would be beneficial in identifying the capacity to provided informed consent and to also match individuals with an appropriate treatment option or learning style.

LITERATURE REVIEW

The global prevalence of cognitive impairment in the general population is estimated to be between 3% and 7% (Prince et al., 2016), whereas the prevalence of cognitive impairment for people with CKD has been reported to be between 16% and 87% (Murray, 2008; Tamura & Yaffe, 2011), which is three to 12 times greater than the global prevalence. Most of the understanding of cognitive impairment from these studies was in the CKD G5D group who were treated by haemodialysis, and since then several studies have provided detailed comparisons of cognition between CKD groups and general populations (e.g., the systematic review by O'Lone et al., 2016) or improvements in cognition post kidney transplantation (Joshee et al., 2018). Recently, Nöhre et al. (2019) reported a prevalence of 15.6% cognitive impairment in those with a kidney transplant, and in another systematic review, Shea et al. (2019) reported a pooled prevalence rate of 28.7% of cognitive impairment for those receiving PD. Only Lambert et al. (2017) has explored the prevalence of cognitive impairment across four groups of patients with CKD G4 and G5 finding that 16.7% in CKD G4 and G5, 48% of undertaking PD, 55.6% undertaking HD were cognitively impaired.

Older age, chronic diseases and depression are all common factors for impaired cognition in the general population (Buscemi et al., 2017). These factors are also common in the CKD population. For example, in Australia, one-third of people commencing KRT are over the age of 70, with diabetes and hypertension the leading causes of kidney disease, and up to 31% will have additional comorbidities including cardiovascular and lung disease (ANZDATA, 2019). Depression has also been reported to occur up to three times more frequently in those with CKD than in the general population (Shirazian et al., 2017). In addition, people with kidney failure will have other risks for impaired cognition such as vascular disease, chronic inflammation, uraemia, and oxidative stress (Elias et al., 2016). Other factors that may increase the risk of cognitive impairment in this population are decreased vitamin D, hyperparathyroidism, albuminuria, hypoalbuminaemia, and anaemia (Drew et al., 2019). When undertaking haemodialysis (HD) acute fluid volume and electrolyte fluctuations, increased frequency of intradialytic hypotension, cerebral oedema, and hypoperfusion during the HD treatment itself all increase the likelihood of cognitive impairment (McIntyre & Goldsmith, 2015). While peritoneal dialysis (PD) does not have the same acute fluid and electrolyte shifts as HD, impaired cognition is believed to be related to chronic inflammation caused by prolonged exposure to intraperitoneal glucose (Li et al., 2017). Cognition seems to improve following kidney transplantation suggesting that some components of cognitive impairment in kidney failure may be reversible although the improvement is not usually to the same level as earlier stages of CKD (Joshee et al., 2018).

Considering the complexity for self-management of CKD, especially in those undertaking either HD or PD at home, it is important for clinicians to understand that some patients may be cognitively impaired. This will have relevance for clinicians providing education at various points along a patient's kidney journey as well as when assessing whether a patient has an aptitude for a specific treatment modality (e.g., home HD). This study therefore sought to measure the prevalence of impaired cognition in people with kidney failure, to identify associated factors for cognitive impairment, and examine differences in cognitive domains between these in CKD G5 (conservative care) or receiving KRT.

MATERIALS AND METHODS

Design

This was a cross sectional study and adhered to the STROBE guidelines.

Setting and study participants

This study was undertaken at a major Australian metropolitan kidney health service providing comprehensive healthcare to people with CKD G3b to G5 including conservative management, KRT, and post kidney transplantation care. Participants were recruited between January and July 2019 using convenience sampling at outpatient clinics as well as from the HD facilities (i.e., in-centre and satellite units). Inclusion criteria included those diagnosed with CKD G5 (eGFR < 15 mls/min/1.73^2 with or without KRT), ≥18 years of age, and willing to participate in this study while those who had a documented medical diagnosis of cognitive impairment were excluded due to ethical challenges and logistical barriers for valid consent. In this study participants were classified into five groups: those in CKD G5 and not undertaking KRT; receiving supported HD in a facility; undertaking HD at home; undertaking PD; and those with a functioning kidney transplant.

Data collection

Data were collected using a demographic questionnaire, clinical record review, and two self-reported instruments used to screen for cognitive function and for depression. The self-reported demographic characteristics collected were age, gender, years of education, language, employment status, living arrangements, and smoking status. Clinical information extracted from hospital records included primary cause of kidney disease, comorbidities (used to calculate Charlson Comorbidity Index; Charlson et al., 1994) and recent blood pathology results (vitamin D, C-reactive protein, parathyroid hormone [PTH], sodium, potassium, phosphate, calcium [corrected], albumin, urea, creatinine, haemoglobin and iron studies). In addition, dialysis-related information (time on current treatment, dry weight, interdialytic weight gain, and treatment hours) was also extracted from the hospital records for those on either HD, home HD (HHD) or PD, using the results closest to the date of cognitive assessment.

Montreal Cognitive Assessment

The Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005), an extensively validated screening and clinical assessment tool in CKD (Amatneeks & Hamdan, 2019), was used to assess participants for cognitive impairment. The MoCA is a one page, 30-point test that assesses several cognitive domains including executive function, visuospatial function, complex attention, language, memory recall and abstract thinking. The cut-off score for mild cognitive impairment was initially set at less than 26/30; however, a score less than 24 has been reported to demonstrate better sensitivity (0.99) for mild cognitive impairment while specificity (0.74) is similar to the previous cut-off score. The MoCA has good reliability (Cronbach alpha 0.73–0.85) reported (Carson et al., 2018).

Each of the cognitive domains (visuospatial function, executive function, delayed memory, complex attention, language and orientation) have been validated individually and demonstrate an overall good fit between the subtests and the overall scores, as well as a high validity to identify those people at risk of mild cognitive impairment (Freitas et al., 2015). For this study a deficit was defined by a less than perfect score for each cognitive domain. The ability to review the cognitive domains separately identifies areas of strength or weakness which can be used to cognitively profile an individual. The principal investigator was certified to conduct the cognitive assessment using the MoCA and the test was conducted at outpatient clinic appointments or during the first hour of a haemodialysis treatment session.

Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS), a self-reported rapid screening assessment instrument for anxiety and depression (Snaith, 2002), was used routinely at sites where this study was conducted and was used to collect data for depression. The scoring system of the HADS uses a Likert scale of 0–3 for each item in the depression subscale. A score of 7–10 for the specific depression questions denotes mild depression, with 11–14 showing moderate depression and 15–21 signifying significant depression (Stern, 2014).

Sample size

The sample size was calculated using Cochran's formula (1977) to achieve a power of 90% with a 0.05 level of significance and an incidence of cognitive impairment in kidney failure between 25% and 87% (O'Lone et al., 2016; Lambert et al., 2017). Determining similarities between studies to establish sample size was difficult due to the number of different assessment tools and study methods used therefore a middle of the range percentage was applied for the calculation (Bartlett et al., 2001). This study required 270 participants.

Data analysis

Data analyses were undertaken using IBM SPSS V23.0 (IBM Corp, 2017), commencing with descriptive statistics for demographic characteristics, clinical characteristics, and mean or median scores for the MoCA. One participant declined to complete the HADS and

was not included in the overall assessment for this variable. There was 5% missing data for haemoglobin and albumin (not different across groups) and these participants were not included in the data analysis for associations between these variables and the MoCA scores. Categorical variables were presented as numbers and percentages with continuous variables expressed as either mean and standard deviation or median and interquartile range for non-normally distributed data. Chi-square tests for categorical variables and t-tests for continuous data were performed to establish the prevalence of cognitive impairment between groups, statistical significance, and relationships between variables and the MoCA scores. Post hoc testing was performed following the one-way analysis of variance for the standard error of the differences between the two means of groups for MoCA, cognitive domains, and depression scores using Dunn's procedure with a Bonferroni correction (Dunn, 1961) for multiple comparisons and adjusted *p*-values to establish where the actual significant difference was present. Hierarchical regression analysis was undertaken to explore predictors for the MoCA score with variables chosen based on the univariate analysis which were significant (Table S1) and presented as an odds ratio (OR) with 95% confidence intervals (CI). A *p* value of <.05 was considered significant. The regression analysis steps are provided in Table S3.

Ethical considerations

This study conformed with the Australian good clinical practice principles and approval was obtained from the Human Research Ethics (deidentified for review). All participants received verbal and written information and voluntarily provided consent before commencing the study. Low MoCA or high HADS—Depression scores were reported to their treating clinician.

RESULTS

A total of 222 participants were recruited (Figure 1): CKD G5 ($n = 32$), HD (facility; $n = 76$), HHD ($n = 33$), PD ($n = 43$), and kidney transplantation ($n = 38$). The mean age for the overall group was 61 ± 13.63 years and 136 (61.26%) were male. The mean years of education was 10.53 ± 1.39. Diabetes was identified in the clinical records as the cause of CKD in 34% of participants ($n = 75$) while the median overall Charlson comorbidity score was 5.00 (95% CI, 4.90–5.41). The median time on KRT was 27 months (95% CI, 38.57–57.54; see Table 1).

Assessment of cognition and depression

Table two provides the MoCA and cognitive domain scores between groups. The median MoCA score was 26.00 (95% CI, 24.26–25.32) with the CKD G5 group having the lowest score (23.00; 95% CI, 21.79–25.02) and the HHD group the highest (28.00; 95% CI, 26.26–27.95). The overall cognitive impairment prevalence was 34% (total sample) and the proportions across groups were 53% (CKD G5), 44% (HD [facility]), 12% (HHD), 37% (PD) and 16% (kidney

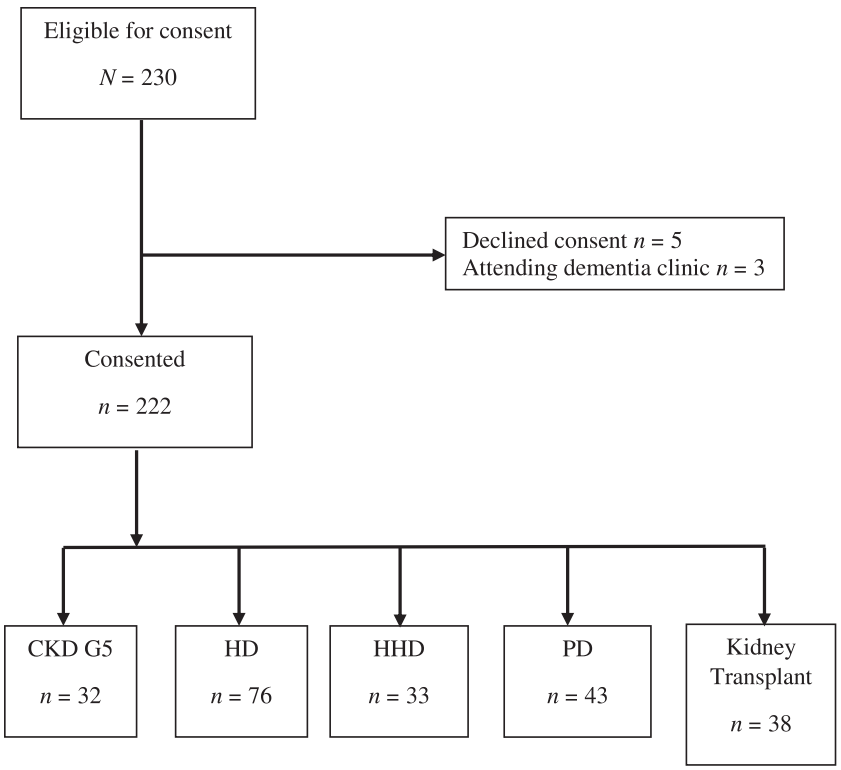

FIGURE 1 Recruitment flow diagram. Abbreviations: *n*, number; CKD G5, Chronic kidney disease grade 5 not receiving kidney replacement therapy; HD, haemodialysis; HHD, Home haemodialysis; PD, peritoneal dialysis

TABLE 1 Demographic characteristics

Variable	Value	Total population	CKD G5	PD	HD (facility)	HHD	Transplant	Significance p^*
Age	*M* ± *SD*	61.46 ± 13.63	61.19 ± 17.17	61.00 ± 16.16	66.11 ± 10.87	57.04 ± 10.74	56.74 ± 11.94	.01
Gender								.52
Men	*n* (%)	136 (61.26%)	17 (53.12%)	26 (60.46%)	44 (57.89%)	22 (66.66%)	27 (71.05%)	
Women	*n* (%)	86 (38.73%)	15 (46.87%)	17 (39.53%)	32 (42.10%)	11 (33.33%)	11 (28.94%)	
Number of people in household								.33
Living alone	*n* (%)	41 (18.60%)	3 (9.3%)	8 (18.60%)	19 (26.40%)	5 (15.15%)	6 (15.78%)	
With others	*n* (%)	177 (81.40%)	29 (90.7%)	35 (81.40%)	53 (73.60%)	28 (84.85%)	32(84.22%)	
Employment status								.01
Employed	*n* (%)	45 (20.50%)	8 (25.00%)	11 (25.60%)	2 (2.70%)	9 (27.30%)	15 (39.50%)	
Not employed	*n* (%)	21 (9.60%)	5 (15.60%)	3 (7.00%)	5 (6.80%)	6 (18.20%)	2 (5.30%)	
Retired	*n* (%)	104 (47.50%)	17(53.10%)	19 (44.20%)	43 (58.90%)	11 (33.30%)	14 (36.80%)	
Disability	*n* (%)	49 (22.40%)	2 (6.30%)	10 (23.30%)	23 (31.50%)	7 (21.20%)	7 (18.40%)	
Education								.13
Years	*M* ± *SD*	10.53 ± 1.39	10.44 ± 1.46	10.37 ± 1.51	10.26 ± 1.50	10.94 ± .93	10.92 ± 1.22	
Primary renal disease								.17
Diabetes	*n* (%)	75 (34.09%)	12 (38.70%)	15 (34.88%)	31 (41.33%)	12 (36.36%)	5 (13.15%)	
HTN	*n* (%)	24 (10.90%)	4 (12.90%)	5 (11.62%)	9 (12.00%)	1 (3.03%)	5 (13.15%)	
GN	*n* (%)	43 (19.54%)	7 (22.58%)	11 (25.58%)	12 (16.00%)	5 (15.15%)	8 (21.05%)	
Other	*n* (%)	78 (35.45%)	8 (25.80%)	12 (27.90%)	23 (30.66%)	15 (45.45%)	20 (52.63%)	
Time on KRT								
	Median	27.00		12.00	41.00	18.00	33.00	
	(95% CI)	(38.57–57.54)	-	(16.53–33.90)	(42.69–68.48)	(20.58–61.24)	(31.19–99.01)	
CCI								
	Median	5.00	6.00	6.00	4.00	5.00	4.00	
	(95% CI)	(4.90–5.41)	(4.35–5.83)	(5.69–6.39)	(3.99–5.22)	(4.31–5.51)	(3.54–4.98)	

Abbreviations: CCI, Charlson Comorbidity Index, time on modality (months); CI, confidence interval; GN, glomerulonephritis; HTN, hypertension; KRT, kidney replacement therapy; M, mean; Mdn, median; *n*, number; *SD*, standard deviation.

*χ^2 test statistic; $p < .05$.

transplantation). There were significant differences in cognitive domains between groups, with the HHD group performing better in visuospatial (deficits in 15%; $p < .01$) and executive function (deficits in 30%; $p < .01$) domains compared to all other groups. 75% of the participants in this study self-reported scores consistent with depression; this was reported more frequently in those < 65 years and in both HHD and PD groups (see Table 2).

Associated factors for cognitive impairment

Age between 40 and 65 years of age, >10 years of education, being currently employed, and haemoglobin and albumin levels within normal range were associated with a significantly higher MoCA score ($p < .05$), while older age, <10 years of education, being unemployed, hypertension, diabetes, and higher levels of PTH were associated with significantly lower MoCA scores ($p < .05$; see Table S1). Figure 2 presents the associated factors for MoCA scores consistent with cognitive impairment as an odds ratio. These were < 10 years of education (OR 4.51; 95% CI, 2.39–8.26), >65 years of age (OR 2.94; 95% CI, 1.65–5.24), hypertension (OR 1.95; 95% CI, 0.91–4.22) and CKD G5 (OR 2.51; 95% CI, 1.17–5.35). Among the groups undertaking KRT, longer times on treatment corresponded with an odds ratio of 2.11 (95% CI, 1.06–4.11) for cognitive impairment.

DISCUSSION

The results of this study showed that when assessed, one-third of the total CKD G5 group had indications of impaired cognition. The prevalence of suspected cognitive impairment was disproportionally higher in the CKD G5 (and not on dialysis), HD (facility), and PD groups; approximately 10 times higher than that of the estimated global prevalence (Prince et al., 2016). In the kidney transplantation

TABLE 2 Assessment of cognition and depression

Variable	Total population	CKD G5	HD (Facility)	HHD	PD	Transplant
MoCA						
n	218	32	72	33	43	38
Median	26.00	23.00	24.50	28.00	25.00	27.00
IQR	5	8	5	4	5	4
95% CI	24.23–25.32	21.79–25.02	22.62–24.57	26.23–27.95	23.06–25.69	25.59–27.62
Range	7–30	15–30	11–30	22–30	7–30	17–30
Significance *p**	.01					
Prevalence of CI	34%	53%	44%	12%	37%	16%
Cognitive domain deficits						
Executive function		50%	68%*	30%	45%	37%
Visuospatial		55%*	46%	15%	44%	40%
Attention		69%	61%	30%	58%	26%
Language		66%	74%	52%	52%	45%
Abstract		56%*	43%	3%	37%	21%
Memory		91%	94%*	79%	88%	76%
Depression						
n	216	32	70	33	43	38
Median	3.50	4.00	3.00	4.00	5.00	2.50
IQR	4	4	4	6	4	3
95% CI	3.91–4.79	3.71–5.66	3.36–5.09	3.52–5.94	4.06–6.03	2.25–4.06
Range	0–20	1–11	0–20	0–13	0–12	0–12
Significance *p**	.03					

Abbreviations: CI, confidence interval; CKD G5, chronic kidney disease grade 5; HD, haemodialysis; HHD, home haemodialysis; IQR, interquartile range; MoCA, Montreal Cognitive Assessment; *n*, number; PD, peritoneal dialysis.

*Kruskal-Wallis test; $p < .05$.

group, the prevalence of cognitive impairment was almost triple, and while the HHD group had the lowest level of cognitive impairment which is in line with them being of younger age, with fewer comorbidities and most years of education, they were still more than twice as likely to be cognitively impaired when compared with the estimated global prevalence (Prince et al., 2016).

In this study, over 50% of participants with kidney failure and not on dialysis had possible cognitive impairment when assessed by the MoCA. This is a higher prevalence than that reported by Lambert et al. (2017) who had included both CKD G4 and G5in the same group. Given the progressive decline in cognitive function relative to a reduction in eGFR (Feng et al., 2012), the inclusion of those with a higher eGFR by Lambert et al. (2017) may explain the lower prevalence of cognitive impairment. However, Lambert et al. (2017) also used the older MoCA cutoff score (<26) than the current recommendation of <24. In future studies using the MoCA, the new cutoff score ought to be used.

Older age and fewer years of education were found to be significantly associated with cognitive impairment. These results were similar to previous studies (Drew et al., 2019; Elias et al., 2016). While cognitive decline is considered part of normal ageing (Bettio et al., 2017), the majority of studies assessing cognition in kidney failure usually involve older people compared to the general population; thus, discerning whether impaired cognition is part of the ageing process or due to the effects of reduced kidney function is problematic. The recent systematic review by Brodski et al. (2019) reported that adults who were younger than 65 years with CKD were more cognitively impaired than those without CKD in the same age group, which shows that there are additional factors associated with cognition beyond age alone. Results from this study showed that the HHD and kidney transplantation groups had the highest proportion of individuals completing more than 10 years of education, with the HHD group also reporting the most with tertiary education. Education has been identified as a major factor for cognitive function (Lavrencic et al., 2018), with higher education suggested to be protective against cognitive decline (Cook & Fletcher, 2015) and to slow the progression of age-related cognitive changes. This study found that total years of education accounted for the most variation in MoCA score modelling, and education less than 10 years was significantly associated with lower cognitive scores. Low levels of education have also been associated with poor health literacy (Van der Heide et al., 2013), which highlights the need to utilise principles of health literacy when providing information or healthcare instructions. The fact that the HHD group were both

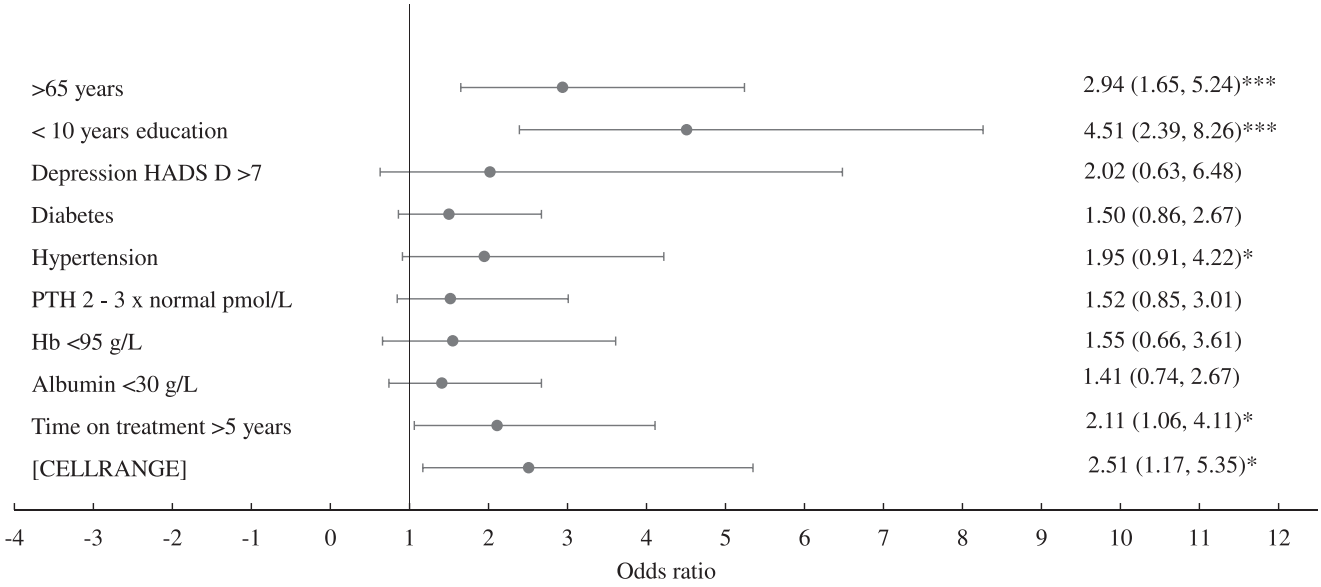

FIGURE 2 Associated factors for cognitive impairment. Abbreviations: HADS D, Hospital Anxiety and Depression Scale; PTH, parathyroid hormone; Hb, haemoglobin; CKD G5, Chronic kidney disease grade 5; *p*, * < .05 and *** < .001

younger (<65 years) and had more years of education could explain the lower prevalence of cognitive impairment in the HHD group.

Depression is a factor associated with cognitive impairment, particularly in older individuals (Calzon et al., 2018), although this study found no significant correlation between higher depression scores and lower MoCA scores. Despite this, depression was highest in the PD group in this study, which may be attributable to their older age and the known overwhelming fatigue experienced by those receiving PD (Bonner et al., 2010). Depression was also high in the HHD group, which could be due to this group being younger, and the detrimental effects of a chronic condition as well as the home treatment burden on social interactions and the ability to work (Ferro et al., 2017) which may explain the higher level of depression but not cognitive impairment seen in this group of patients.

Further examination of the MoCA and the individual cognitive domains which make up this assessment revealed some interesting trends. All groups demonstrated deficits in attention, language, and memory, which suggests they may find it difficult to follow routine healthcare related conversations, to remain focussed during lengthy or in-depth conversations, or to remember information given previously. The HHD group had the least deficits in all domains, especially the higher complex areas of executive function, visuospatial cognition, and abstract thinking. Whereas the HD (facility) group had the greatest deficits in all of these domains, with executive function being the worst.

It is important to acknowledge that the MoCA is a screening rather than a diagnostic tool and can only indicate impaired cognition. Despite the overall sample size being sufficient for this study, the individual group sizes were relatively small, and caution is required when inferring the prevalence of cognitive impairment. In addition, despite addressing possible confounders through assessing cognitive function by the same person, analysing between group differences, and using post hoc analysis to correct for multiple tests and outcomes, future studies should address the potential influence of confounders such as medications, length of time in CKD G5 and other comorbidities where possible. A further limitation is that the study was undertaken at a single site, which may limit the generalisability of the finding to other kidney failure populations.

Implications for clinical practice

Practice guidelines are not explicit about routine screening for cognitive impairment in the CKD population (Farrington et al., 2017). The ethical and legal principles of autonomy and consent are required for all healthcare treatments. As kidney function continues to deteriorate and more complex decisions about whether to opt for KRT or for conservative management are required, it is crucial that cognitive screening should occur. It is essential that members of the multidisciplinary kidney team know whether cognitive impairment is present, what cognitive domains might be affected, and to consider further diagnostic investigations that should be undertaken before treatment decision making is needed. For instance, as part of predialysis education, where a baseline assessment of cognitive function is undertaken to establish cognition and their cognitive profile. Cognitive assessment is not only to detect possible cognitive impairment but also to recognise the strengths and weaknesses in various cognitive domains. Cognitive assessment may also assist in supporting patients, their families, and the multidisciplinary team to identify the most appropriate KRT and the delivery of nurse-led

education and information. For example, a person with deficits in the cognitive domain of attention should be given information in short, intermittent periods rather than a lengthy discussion, and those with deficits in memory would benefit from repetition and hands on learning. Lastly, as cognition changes over time with increasing age, it is also recommended that cognitive assessment be undertaken regularly to identify changes from baseline. We recommend regular 6–12 monthly assessments despite limited evidence to inform clinicians about the frequency of cognitive assessment. By routinely repeating cognitive assessments, differences over time could be investigated for modifiable causes (e.g. anaemia, hyperparathyroidism, and hypoalbuminaemia), before moving onto more rigorous neuropsychological and/or radiological investigations of cognitive function.

CONCLUSION

This study found that over one-third of participants had impaired cognition. Older age, low levels of education, kidney failure without KRT and more than 5 years undertaking treatment are significantly associated with cognitive impairment. Results of this study indicate that it is important that baseline cognitive screening of overall cognition and for deficits in cognitive domains in the CKD population to establish the legal requirements for informed decision making and for determining the suitability for complex treatment options such as home haemodialysis (HHD). Routine cognitive assessments ought to be integrated into regular care to monitor for changes over time.

ACKNOWLEDGMENTS

The authors thank all of the patients who participated in this study and the nursing staff for their support and cooperation to make this study happen.

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

AUTHOR CONTRIBUTIONS

Pauline Nicholas: *Principal author, conceived study, participated in design, coordination of research, drafted manuscript, read and approved final manuscript*. Theresa Green: *Supervised principal author, assisted with design and data analysis, helped to draft manuscript, read and approved the final manuscript*. Louise Purtell: *Supervised principal author, assisted with design and data analysis, helped to draft manuscript, read and approved the final manuscript*. Ann Bonner: *Senior author, supervised principal author, assisted with design and data analysis, helped to draft manuscript, read and approved the final manuscript*.

ORCID

Pauline Nicholas http://orcid.org/0000-0003-1104-9152
Ann Bonner http://orcid.org/0000-0001-9920-6743

REFERENCES

Amatneeks, T.M. & Hamdan, A.C. (2019) Montreal Cognitive Assessment for cognitive assessment in chronic kidney disease: A systematic review. *Brazilian Journal of Nephrology*, 41(1), 112–123.

American Psychiatric Association. (2013) *Diagnostic and statistical manual of mental disorders*, 5th edition. Washington, DC: American Psychiatric Association.

Bartlett, J., Kotrlik, J. & Higgins, C. (2001). Organizational research: Determining appropriate sample size in survey research. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.486.8295%26rep=rep1%26type=pdf

Bettio, L.E.B., Rajendran, L. & Gil-Mohapel, J. (2017) The effects of aging in the hippocampus and cognitive decline. *Neuroscience & Biobehavioral Reviews*, 79, 66–86.

Bonner, A., Wellard, S. & Caltabiano, M. (2010) The impact of fatigue on daily activity in people with chronic kidney disease. *Journal of Clinical Nursing*, 19(21-22), 3006–3015.

Brodski, J., Rossell, S.L., Castle, D.J. & Tan, E.J. (2019) A systematic review of cognitive impairments associated with kidney failure in adults before natural age-related changes. *Journal of the International Neuropsychological Society*, 25(1), 101–114.

Brown, L., Gardner, G. & Bonner, A. (2019) A randomized controlled trial testing a decision support intervention for older patients with advanced kidney disease. *Journal of Advanced Nursing*, 75(11), 3032–3044.

Buscemi, S., Di Pasquale, V., Buscemi, C., Piccoli, T. & Giordano, C. (2017) Factors associated with mild cognitive impairment in a population-based cohort. *European Journal of Internal Medicine*, 43, e20–e21.

Calzon, M.D., Garcia, M.G., Viloria, N., *et al*. (2018) Cognitive impairment, a mask of depression in elderly people. *European Psychiatry*, 48(S), S463–S463.

Carson, N., Leach, L. & Murphy, K.J. (2018) A re-examination of Montreal cognitive assessment (MoCA) cutoff scores. *International Journal of Geriatric Psychiatry*, 33(2), 379–388.

Charlson, M., Szatrowski, T.P., Peterson, J. & Gold, J. (1994) Validation of a combined comorbidity index. *Journal of Clinical Epidemiology*, 47(11), 1245–1251.

Cochran, W.G. (1977) *Sampling techniques*, 3rd edition. New York: Wiley.

Cook, C.J. & Fletcher, J.M. (2015) Can education rescue genetic liability for cognitive decline? *Social Science & Medicine*, 127, 159–170.

Drew, D.A., Weiner, D.E. & Sarnak, M.J. (2019) Cognitive impairment in CKD: Pathophysiology, management, and prevention. *American Journal of Kidney Diseases*, 74(6), 782–790.

Dunn, O.J. (1961) Multiple comparisons among means. *Journal of the American Statistical Association*, 56, 52–64.

Elias, M.F., Torres, R.V. & Davey, A. (2016) Albuminuria and cognitive performance: New evidence for consideration of a risk factor precursor model from the Maastricht Study. *American Journal of Kidney Diseases*, 69(2), 163–165.

Farrington, K., Covic, A., Nistor, I., *et al*. (2017) Clinical Practice Guideline on management of older patients with chronic kidney disease stage 3b or higher (eGFR < 45 mL/min/1.73 m2): A summary document from the European Renal Best Practice Group. *Nephrology, Dialysis Transplantation*, 32(1), 9–16.

Feng, L., Yap, K.B., Yeoh, L.Y. & Ng, T.P. (2012) Kidney function and cognitive and functional decline in elderly adults: Findings from Singapore longitudinal aging study. *Journal of the American Geriatrics Society*, 60(7), 1208–1214.

Ferro, M.A., Rhodes, A.E., Kimber, M., *et al*. (2017) Suicidal behaviour among adolescents and young adults with self-reported chronic illness. *The Canadian Journal of Psychiatry*, 62(12), 845–853.

Freitas, S., Prieto, G., Simões, M.R. & Santana, I. (2015) Scaling cognitive domains of the Montreal Cognitive Assessment: An analysis using the partial credit model. *Archives of Clinical Neuropsychology*, 30(5), 435–447.

Joshee, P., Wood, A.G., Wood, E.R. & Grunfeld, E.A. (2018) Meta-analysis of cognitive functioning in patients following kidney transplantation. *Nephrology Dialysis Transplantation*, 33(7), 1268–1277.

Koye, D.N., Magliano, D.J., Nelson, R.G. & Pavkov, M.E. (2018) The global epidemiology of diabetes and kidney disease. *Advances in Chronic Kidney Disease*, 25(2), 121–132.

Kurella, M., Chertow, G.M., Luan, J. & Yaffe, K. (2004) Cognitive impairment in chronic kidney disease. *Journal of the American Geriatrics Society*, 52(11), 1863–1869.

Lambert, K., Mullan, J., Mansfield, K. & Lonergan, M. (2017) Comparison of the extent and pattern of cognitive impairment among predialysis, dialysis and transplant patients: A cross-sectional study from Australia. *Nephrology*, 22(11), 899–906.

Lavrencic, L.M., Richardson, C., Harrison, S.L., *et al.* (2018) Is there a link between cognitive reserve and cognitive function in the oldest-old? *The Journals of Gerontology: Series A*, 73(4), 499–505.

Levey, A.S., Eckardt, K.U., Dorman, N.M., Christiansen, S.L., *et al.* (2020) Nomenclature for kidney function and disease: Executive summary from a KDIGO consensus conference. *Nature Reviews. Nephrology*, 16(8), 427–428.

Li, P.K.-T., Ng, J.K.-C. & Mcintyre, C.W. (2017) Inflammation and peritoneal dialysis. *Seminars in Nephrology*, 37(1), 54–65.

McIntyre, C.W. & Goldsmith, D.J. (2015) Ischemic brain injury in hemodialysis patients: Which is more dangerous, hypertension or intradialytic hypotension? *Kidney International*, 87(6), 1109–1115.

Murray, A.M. (2008) Cognitive impairment in the aging dialysis and chronic kidney disease populations: An occult burden. *Advances in Chronic Kidney Disease*, 15(2), 123–132.

Nasreddine, Z.S., Phillips, N.A., Bédirian, V., *et al.* (2005) The Montreal cognitive assessment MoCA: A brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society*, 53(4), 695–699.

Nöhre, M., Bauer-Hohmann, M., Klewitz, F., *et al.* (2019) Prevalence and correlates of cognitive impairment in kidney transplant patients using the Dem Tect—Results of a KTx360 substudy. *Frontiers in Psychiatry*, 10.

O'Lone, E., Connors, M., Masson, P., *et al.* (2016) Cognition in people with end-stage kidney disease treated with hemodialysis: A systematic review and meta-analysis. *American Journal of Kidney Diseases*, 67(6), 925–935.

Prince, M., Ali, G.-C., Guerchet, M., Prina, A.M., Albanese, E. & Wu, Y.T. (2016) Recent global trends in the prevalence and incidence of dementia, and survival with dementia. *Alzheimer's Research & Therapy*, 8(1), 23.

Shea, Y.F., Lee, M.C., Mok, M.M., Chan, F.H. & Chan, T.M. (2019) Prevalence of cognitive impairment among peritoneal dialysis patients: A systematic review and meta-analysis. *Clinical and Experimental Nephrology*, 23(10), 1221–1234.

Shirazian, S., Grant, C.D., Aina, O., Mattana, J., Khorassani, F. & Ricardo, A.C. (2017) Depression in chronic kidney disease and end-stage renal disease: Similarities and differences in diagnosis, epidemiology, and management. *Kidney International Reports*, 2(1), 94–107.

Snaith, R. (2002) The hospital anxiety and depression scale. *Journal of Psychosomatic Research*, 52(5), 401–401.

Stacey, D., Légaré, F., Lewis, K., *et al.* (2017) Decision aids for people facing health treatment or screening decisions. *The Cochrane Database of Systematic Reviews*, 4, CD001431.

Stern, A.F. (2014) The hospital anxiety and depression scale. *Occupational Medicine*, 64(5), 393–394.

Tamura, M.K. & Yaffe, K. (2011) Dementia and cognitive impairment in ESRD: Diagnostic and therapeutic strategies. *Kidney International*, 79(1), 14–22.

Van der Heide, I., Wang, J., Droomers, M., Spreeuwenberg, P., Rademakers, J. & Uiters, E. (2013) The relationship between health, education and health literacy: Results from the Dutch adult literacy and life skills survey. *Journal of Health Communication*, 18(Supp), 172–184.

Volpi, L., Pagni, C., Radicchi, C., *et al.* (2017) Detecting cognitive impairment at the early stages: The challenge of first line assessment. *Journal of the Neurological Sciences*, 377, 12–18.

Wainstein, M., Menzies, A.R., Brennan, F.P. & Brown, M.A. (2018) The legal doctrine of informed consent and renal dialysis—Do patients really consent? *Journal of Law and Medicine*, 25(4), 1008.

Yu, Z.L., Lee, V.Y.W., Kang, A.W.C., *et al.* (2016) Rates of intentional and unintentional nonadherence to peritoneal dialysis regimes and associated factors. *PLOS One*, 11(2), e0149784.

AUTHOR BIOGRAPHY

Pauline Nicholas has 25 years nephrology nursing experience and she is currently the Nurse Unit Manager of the Home and Independent Dialysis Service. Pauline completed her Masters of Applied Science (Research) in 2020.

SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

How to cite this article: Nicholas, P., Green, T., Purtell, L. & Bonner, A. (2021) A cross-sectional study exploring cognitive impairment in kidney failure. *Journal of Renal Care*, 1–9. https://doi.org/10.1111/jorc.12393