Frailty prevalence in Aotearoa New Zealand haemodialysis patients and its association with hospitalisations

Katherine Bloomfield, Zhenqiang Wu, Lai Chan, Janak R de Zoysa

ABSTRACT

AIMS: To use two frailty tools to assess frailty prevalence in a cohort of Aotearoa New Zealand haemodialysis (HD) patients and determine factors associated with frailty and frailty's association with adverse health outcomes.

METHODS: Frailty was measured using the Fried score and Edmonton Frail Scale (EFS) in HD patients dialysing at dependent or satellite clinic sites in Waitematā District Health Board, Auckland. Linear regression models were used to explore factors associated with frailty measurements. Logistic regression models were used to assess associations between frailty and mortality and hospitalisations.

RESULTS: 138 participants. Mean (SD) age: 61.5 (13.5) years. 70 females (51%). 51 (37%) were frail by Fried score. 51 (37%) were frail by EFS (overlap of 32 participants). Age, marital status, smoking status and albumin were independently associated with both measures of frailty. Medication number was additionally associated with Fried score. Pacific ethnicity and Charlson Comorbidity Index were associated with EFS score. After adjusting for covariables, only Fried frailty was associated with hospitalisations at six months.

CONCLUSIONS: Pacific ethnicity was independently associated with increased risk of EFS frailty. Fried frailty was associated with hospitalisations at six months. Given the paucity of literature on the New Zealand population, further work within these ethnic groups is warranted.

Frailty is a syndrome of reduced physiological reserve that increases the risk of adverse health outcomes, such as hospitalisation, increasing dependency, residential care placement and death.[1,2] Frailty occurs along a spectrum, with evidence of bi-directional fluctuations. Therefore, there is the potential to improve frailty status with appropriate management or intervention.[2] Frailty is a better predictor of mortality than age or comorbidities,[3] and in some conditions there is evidence of a superior ability to predict adverse outcomes compared to traditional risk models.[4,5]

Renal insufficiency potentially accelerates the ageing process. For example, rates of frailty are greater in patients with early-stage chronic kidney disease (CKD) than in those without.[6] This is likely to be due to disease-related and disease-associated conditions in patients with CKD, such as protein-energy wasting and inflammation, which is consistent with the idea of a shared or overlapping phenotype with the frailty syndrome.[7,8] Based on international studies, the prevalence of frailty in haemodialysis (HD) patients ranges widely. However, a systematic review reported a pooled prevalence of 34%.[9] There are no published reports of frailty prevalence within Aotearoa New Zealand CKD, dialysis or renal transplant populations. Higher rates of mortality, hospitalisations, increasing dependence and fractures have been reported in both frail non-dialysis CKD and dialysis patients, with evidence of increased falls, poor quality of life and vascular access failure also documented in the latter.[10–12] The risk of these

adverse outcomes increases with frailty severity.

There is a high, and increasing, incidence of renal replacement therapy (RRT) in patients aged 65–74 years (388 per million) and 75–84 years (242 per million) in Aotearoa New Zealand.[13] This is placing greater importance on the understanding of geriatric syndromes like frailty. Given the ageing population, different thresholds to initiate dialysis in older adults between countries and the ethnic diversity within Aotearoa New Zealand, it is important that we understand frailty within our own clinical context. Identification of frail individuals may assist with clinical decision-making, targeting at-risk individuals with appropriate intervention, such as exercise, dietary supplementation, de-prescribing and facilitating advance care planning, and potentially reducing adverse outcomes.

The aims of this study were to assess the prevalence of frailty in an Aotearoa New Zealand cohort of HD patients; to assess factors associated with frailty at baseline; to assess the association of frailty with hospitalisations at six months and mortality at one, two and three years; and to compare the overall predictive performance and discrimination of frailty measured by the Fried score and the Edmonton Frail Scale (EFS) for predicting the above healthcare outcomes.

Methods

This was a prospective study of frailty among HD patients at facility haemodialysis units in Waitematā District Health Board (WDHB) between August and December 2016. All patients were invited to participate in the study at the time of their dialysis session. Participants were assessed during dialysis session. Mobility measurements were taken either immediately before or after dialysis. Patients with acute kidney injury (AKI) not established on chronic dialysis or a diagnosis of significant cognitive impairment, and non-English speakers without the presence of an interpreter and those unwilling to participate, were excluded. Due to study constraints, home HD patients were not included.

Frailty was assessed with the simplified Fried score[14,15] and EFS[16] (see Appendix) by one of two assessors. Scoring was calculated by one assessor. Fried score (range 0–5) was calculated by counting the presence of the following items: weight loss, exhaustion, low walking speed, low grip strength and physical inactivity (using self-reported abbreviated items).[15] "Frail" was defined as a Fried score ≥ 3, "pre-frail" as a score of 1–2 and "non-frail" as a score of 0.

The EFS (range from 0–17) assesses the following nine domains: cognition, general health status, functional independence, social support, medication usage, nutrition, mood, continence, functional performance. "Frail" was defined as an EFS ≥8, "vulnerable" as an EFS of 6–7 and "fit" as an EFS of 0–5.

The following characteristics were documented from participants and hospital records at baseline: age, gender, ethnicity, marital status, residence (home, aged residential care), smoking status, medications, comorbidities (with calculation of Charlson Comorbidity Index (CCI)),[17] renal diagnosis, haemoglobin (Hb), albumin, Kt/V and duration of time since starting dialysis. Electronic hospital records were interrogated for the outcomes in the follow-up period (primary outcome: mortality at three years; secondary outcomes: hospitalisations at six months and mortality at one year).

Univariable and multivariable linear regression models with mean difference (MD) and 95% confidence intervals (CIs) were performed to assess factors associated with baseline frailty measurements. Associations between frailty and outcomes were explored using univariable and multivariable logistic regression models to estimate odds ratios (ORs) and 95% CIs. The discriminative ability of two frailty tools for predicting outcomes (hospitalisations or mortality) were assessed using the areas under the curve (AUC) and associated c-statistics, with a value of 0.5 indicating random prediction and a value of 1 indicating perfect prediction. The overall model performance of frailty tools was reported by Nagelkerke's R^2, with higher values indicating better model performance for predicting outcomes. All analyses were performed with SAS version 9.4. A two-sided $p<0.05$ was considered statistically significant.

Ethical approval was received from Northern B Health and Disability Ethics Committee 15/NTB/114/AM01. Written, informed consent was obtained from all participants.

Results

During the study period, 232 patients were undergoing HD at WDHB. Of these, 54 were home HD patients and were not approached. One hundred and seventy-eight patients were dialysing at either the dependent or the satellite sites during the study period. Eight participants received dialysis at both sites during the study period; these were only assessed once in the satellite setting. Figure 1 shows recruitment process.

One hundred patients received dialysis at satellite sites: one was excluded due to cognitive impairment and two declined to participate, leaving 97 patients. Seventy-eight patients dialysed at the dependent site only during the study period. Five were excluded due to language constraints. Seventy-three were approached to participate: 32 declined (43.8%), leaving 41 assessed. One hundred and thirty-eight patients participated in total. Mean (SD) age was 61.5 (13.5) years, and 70 (50.7%) were female. Other demographic details can be seen in Tables 1 and 2.

Frailty prevalence and associated factors

Twenty-five (18.1%) were non-frail, 62 (44.9%) were pre-frail and 51 (37.0%) were frail by the Fried score. In comparison, 39 (28.2%) were fit, 48 (34.8%) were vulnerable to frailty and 51 (37.1%) were frail by EFS. Within each category of frailty, overlap between the two methods was 13 (9.4%) non-frail, 26 (18.9%) pre-frail (Fried) or vulnerable (EFS) and 32 (23.2%) frail. Tables 1 and 2 show univariable and multivariable associations of baseline factors with each frailty tool. On multivariable analysis, both tools showed higher frailty scores independently associated with increasing age and decreasing albumin. Being an ex-smoker was associated with decreased frailty scores compared with current smoking. Both tools showed significant associations with marital status: compared to married and partner patients, patients who were divorced, widowed or separated had a lower Fried score, and patients who were single had an increased EFS. Additionally, Fried score was independently and significantly associated with the number of medications. A higher EFS was additionally associated with Pacific ethnicity and a higher CCI.

Association of frailty categories and outcomes

Fried category was significantly associated with one-, two- and three-year mortality and six-month hospitalisations in univariable analysis ($p<0.01$). After adjustment for co-variables, only the association with six-month hospitalisations remained (pre-frail vs non-frail, OR=3.29, 95%CI=1.01–10.74; frail vs non-frail, OR=7.31, 95% CI=1.80–29.74) (Table 3).

EFS category was significantly associated with risk of hospitalisation at six-months ($p=0.01$) and mortality at three years ($p=0.02$) in univariable analysis. After adjustment for co-variables, these associations disappeared (Table 4).

Single Fried category had higher observed predictive performance (c-statistics & R^2) for primary and secondary outcomes compare to single EFS category (see Figure 2 and Table 5). However, this was not statistically significant between the two tools.

Discussion

This study is the first to report the prevalence of frailty in Aotearoa New Zealand HD patients. Thirty-seven percent of the cohort were identified as frail by both methods. Age and albumin were independently associated with Fried score and EFS. Importantly, we found Pacific people were independently associated with higher EFS. The latter is a new finding and warrants further investigation. In addition, after adjusting for covariables, Fried category was independently associated with the risk of six-month hospitalisations.

A wide range of prevalence of frailty (6–82%) has been reported in HD patients. In part, this largely relates to study population differences, including indications for dialysis, and methods used to measure frailty. The frailty prevalence in this Aotearoa New Zealand cohort is high but comparable to a recently reported pooled rate of 34%.[9] To put this in context, approx-

Figure 1: Patient recruitment.

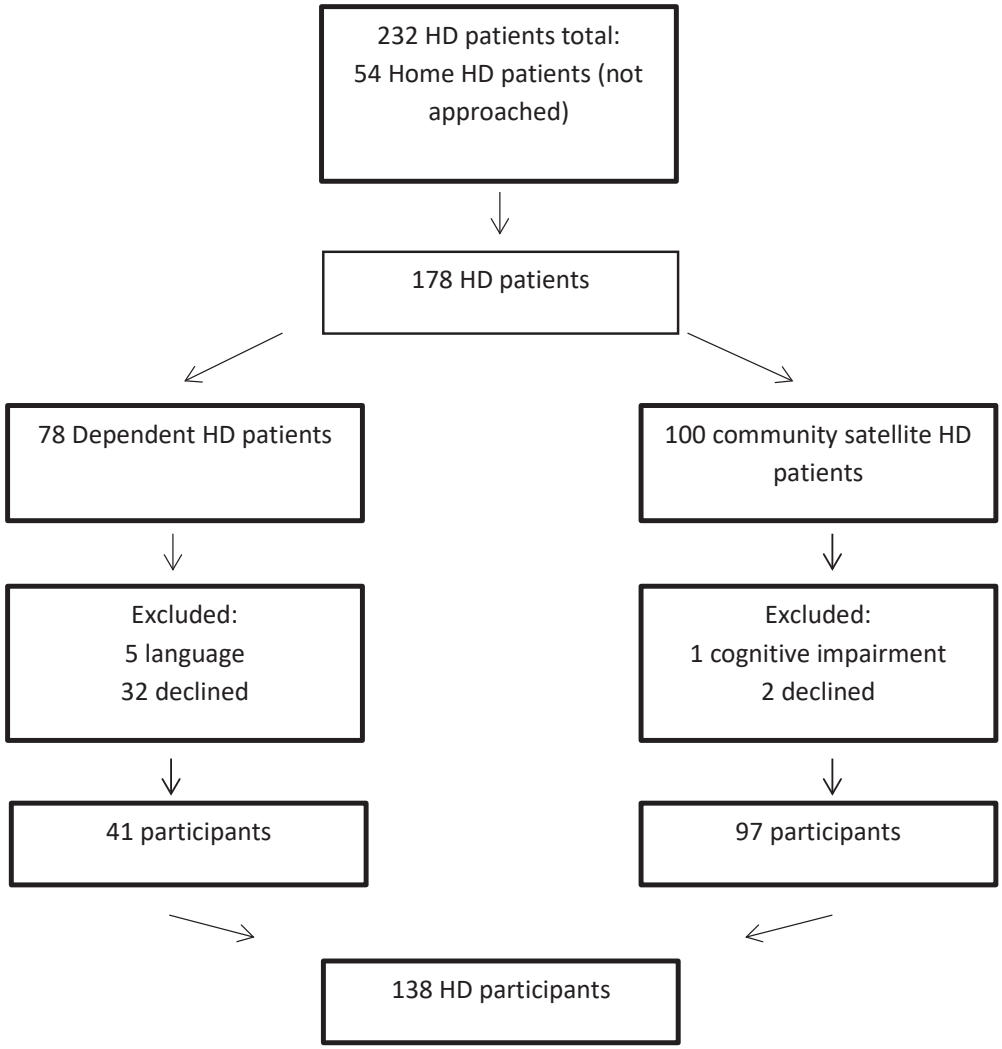

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Table 1: Univariate and multivariate association of baseline factors with Fried score.

Variable	N (%) / mean (SD)	Univariate		Type 3 test	Multivariate		Type 3 test
		Coefficient (95%CI)	P value		Coefficient (95%CI)	P value	
Age (year)	61.5 (13.5)	0.04 (0.02, 0.05)	<0.001	<0.001	0.04 (0.02, 0.06)	<0.001	<0.001
Gender				0.18			0.24
Male	68 (49.3)	0			0		
Female	70 (50.7)	0.32 (-0.15, 0.79)	0.18		0.25 (-0.17, 0.68)	0.24	
Ethnic groups				0.64			0.18
European	45 (32.6)	0			0		
Māori	31 (22.4)	0.32 (-0.33, 0.98)	0.33		0.56 (-0.02, 1.14)	0.06	
Pacific peoples	51 (37.0)	-0.01 (-0.58, 0.56)	0.97		0.27 (-0.23, 0.77)	0.29	
Asian	11 (8.0)	-0.21 (-1.14, 0.73)	0.66		-0.22 (-1.00, 0.56)	0.58	
Marital status				0.10			0.06
Married/partner	89 (64.5)	0			0		
Divorced/widowed	20 (14.5)	-0.33 (-0.92, 0.26)	0.27		-0.60 (-1.09, -0.11)	0.02	
Single	29 (21.0)	-0.71 (-1.39, -0.03)	0.04		-0.07 (-0.75, 0.61)	0.84	
Smoking status				0.34			0.03
Never smoker	61 (44.2)	0			0		
Ex-smoker	62 (44.9)	0.48 (-0.32, 1.28)	0.23		-0.48 (-0.92, -0.05)	0.03	
Current smoker	15 (10.9)	-0.11 (-0.61, 0.39)	0.66		0.21 (-0.46, 0.88)	0.54	

Table 1: Univariate and multivariate association of baseline factors with Fried score (continued).

Variable	N (%) / mean (SD)	Univariate		Type 3 test	Multivariate		Type 3 test
		Coefficient (95%CI)	P value		Coefficient (95%CI)	P value	
Aetiology of ESKD				0.46			0.22
Diabetes	67 (48.6)	0			0		
Hypertension	12 (8.7)	0.34 (-0.53, 1.21)	0.44		0.76 (0.01, 1.50)	0.05	
Combination	7 (5.1)	-0.07 (-1.18, 1.03)	0.89		-0.15 (-1.06, 0.76)	0.74	
Other	52 (37.7)	-0.31 (-0.82, 0.21)	0.44		0.19 (-0.31, 0.69)	0.44	
Albumin	32.0 (4.7)	-0.13 (-0.17, -0.08)	<0.001	<0.001	-0.09 (-0.14, -0.05)	<0.001	<0.001
Haemoglobin	110.3 (13.1)	-0.02 (-0.04, -0.002)	0.03	0.03	-0.01 (-0.02, 0.01)	0.41	0.41
Kt/V	1.4 (0.2)	-0.49 (-1.56, 0.58)	0.37	0.37	-0.58 (-1.54, 0.37)	0.23	0.23
Log(months on dialysis)*	3.6 (1.1)	-0.11 (-0.32, 0.10)	0.29	0.29	-0.001 (-0.18, 0.18)	0.99	0.99
CCI	4.1 (1.4)	0.21 (0.05, 0.38)	0.01	0.01	0.07 (-0.11, 0.24)	0.46	0.46
No. of medications	11.8 (3.0)	0.17 (0.10, 0.25)	<0.001	<0.001	0.15 (0.09, 0.22)	<0.001	<0.001

*Natural logarithm of months on dialysis; number of medications was included as it's not a component of Fried score.

ESKD: End stage kidney disease. Combination: combination of diabetes and hypertension. CCI: Charlson Comorbidity Index.

Table 2: Univariate and multivariate association of baseline factors with EFS.

Variable	N (%) / mean (SD)	Univariate		Type 3 test	Multivariate		Type 3 test
		Coefficient (95%CI)	P value		Coefficient (95%CI)	P value	
Age (year)	61.5 (13.5)	0.05 (0.01, 0.08)	0.004	0.004	0.06 (0.03, 0.10)	<0.001	<0.001
Gender				0.01			0.10
Male	68 (49.3)	0			0		
Female	70 (50.7)	1.05 (0.23, 1.87)	0.01		0.67 (-0.13, 1.46)	0.10	
Ethnic groups				0.07			0.03
European	45 (32.6)	0			0		
Māori	31 (22.4)	1.00 (-0.13, 2.13)	0.08		0.55 (-0.49, 1.71)	0.27	
Pacific peoples	51 (37.0)	1.27 (0.27, 2.26)	0.01		1.37 (0.42, 2.32)	0.005	
Asian	11 (8.0)	0.30 (-1.34, 1.93)	0.72		0.05 (-1.43, 1.52)	0.27	
Marital status				0.90			0.07
Married/partner	89 (64.5)	0			0		
Divorced/widowed	20 (14.5)	0.16 (-0.90, 1.22)	0.77		0.02 (-0.90, 0.94)	0.96	
Single	29 (21.0)	-0.18 (-1.40, 1.05)	0.77		1.49 (0.20, 2.78)	0.02	
Smoking status				0.05			0.003
Never smoker	61 (44.2)	0			0		
Ex-smoker	62 (44.9)	-0.87 (-1.75, <0.01)	0.05		-1.23 (-2.05, -0.42)	0.003	
Current smoker	15 (10.9)	0.55 (-0.85, 1.95)	0.44		0.39 (-0.87, 1.65)	0.54	

Table 2: Univariate and multivariate association of baseline factors with EFS (continued).

Variable	N (%) / mean (SD)	Univariate		Type 3 test	Multivariate		Type 3 test
		Coefficient (95%CI)	P value		Coefficient (95%CI)	P value	
Aetiology of ESKD				0.004			0.32
Diabetes	67 (48.6)	0			0		
Hypertension	12 (8.7)	-0.87 (-2.36, 0.62)	0.25		-0.10 (-1.51, 1.31)	0.88	
Combination	7 (5.1)	-1.54 (-3.42, 0.35)	0.11		-1.50 (-3.21, 0.20)	0.08	
Other	52 (37.7)	-1.60 (-2.47, -0.72)	<0.001		-0.48 (-1.44, 0.45)	0.30	
Albumin	32.0 (4.7)	-0.16 (-0.25, -0.08)	<0.001	<0.001	-0.16 (-0.25, -0.07)	<0.001	<0.001
Haemoglobin	110.3 (13.1)	-0.01 (-0.04, 0.03)	0.74	0.74	0.01 (-0.02, 0.04)	0.60	0.60
Kt/V	1.4 (0.2)	-0.18 (-2.08, 1.71)	0.85	0.85	0.12 (-1.68, 1.91)	0.90	0.90
Log(months on dialysis) *	3.6 (1.1)	-0.03 (-0.40, 0.34)	0.86	0.86	-0.03 (-0.36, 0.30)	0.87	0.87
CCI	4.1 (1.4)	0.54 (0.25, 0.82)	<0.001	<0.001	0.43 (0.11, 0.75)	0.009	0.009

*Natural logarithm of months on dialysis; number of medications was not included as it's a component of EFS.

ESKD: End stage kidney disease. Combination: combination of diabetes and hypertension. CCI: Charlson Comorbidity Index.

Table 3: Risk of adverse outcome by Fried categories.

Outcome	Number of events by Fried categories			Unadjusted odds ratio (95%CI), p		Type 3 test	Adjusted* odds ratio (95%CI), p		Type 3 test
	0 (n=25)	1 (n=62)	2 (n=51)	1 vs 0	2 vs 0		1 vs 0	2 vs 0	
Primary outcome									
Mortality at three years	4 (16.0)	18 (29.0)	29 (56.9)	2.15 (0.65, 7.14), 0.21	6.92 (2.08, 23.07), 0.002	<0.001	2.47 (0.56, 10.95), 0.23	3.90 (0.78, 19.48), 0.10	0.25
Secondary outcome									
Mortality at two years	3 (12.0)	10 (16.1)	21 (41.2)	1.41 (0.35, 5.62), 0.24	5.13 (1.40, 19.39), 0.02	0.004	1.06 (0.23, 4.91), 0.94	2.19 (0.42, 11.49), 0.35	0.46
Mortality at one year	1 (4.0)	4 (6.5)	14 (27.5)	1.66 (0.18, 15.58), 0.66	9.08 (1.12, 73.62), 0.002	0.005	0.97 (0.08, 11.40), 0.98	2.52 (0.20, 32.43), 0.48	0.51
Hospitalisations at six months	7 (28.0)	34 (54.8)	40 (78.4)	3.12 (1.14, 8.54), 0.03	9.35 (3.12, 28.06), <0.001	<0.001	3.29 (1.01, 10.74), 0.05	7.31 (1.80, 29.74), 0.006	0.02

*Adjusted for age, gender, ethnicity, marital status, smoking status, aetiology of renal disease, albumin, haemoglobin, Kt/V, natural logarithm transformed months on dialysis.

Table 4: Risk of adverse outcome by EFS categories.

Outcome	Number of events by EFS categories			Unadjusted odds ratio (95%CI), p		Type 3 test	Adjusted* odds ratio (95%CI), p		Type 3 test
	0 (n=39)	1 (n=48)	2 (n=51)	1 vs 0	2 vs 0		1 vs 0	2 vs 0	
Primary outcome									
Mortality at three years	8 (20.5)	17 (35.4)	26 (51.0)	2.13 (0.80, 5.64), 0.13	4.03 (1.56, 10.44), 0.004	0.01	1.32 (0.37, 4.62), 0.67	2.21 (0.60, 8.19), 0.23	0.47
Secondary outcome									
Mortality at two years	8 (20.5)	8 (16.7)	18 (35.3)	0.78 (0.26, 2.30), 0.65	2.11 (0.80, 5.57), 0.13	0.08	0.29 (0.07, 1.14), 0.08	0.85 (0.22, 3.25), 0.81	0.15
Mortality at one year	4 (10.3)	5 (10.4)	10 (19.6)	1.02 (0.25, 4.08), 0.98	2.13 (0.62, 7.41), 0.23	0.32	0.36 (0.06, 2.23), 0.27	0.57 (0.08, 4.01), 0.57	0.54
Hospitalisations at six months	18 (46.2)	25 (52.1)	38 (74.5)	1.27 (0.54, 2.96), 0.58	3.41 (1.40, 8.31), 0.007	0.02	1.00 (0.36, 2.82), 1.00	2.29 (0.72, 7.34), 0.16	0.28

*Adjusted for age, gender, ethnicity, marital status, smoking status, aetiology of renal disease, albumin, haemoglobin, Kt/V log(months on dialysis).

Figure 2: Primary outcome: mortality at three years.

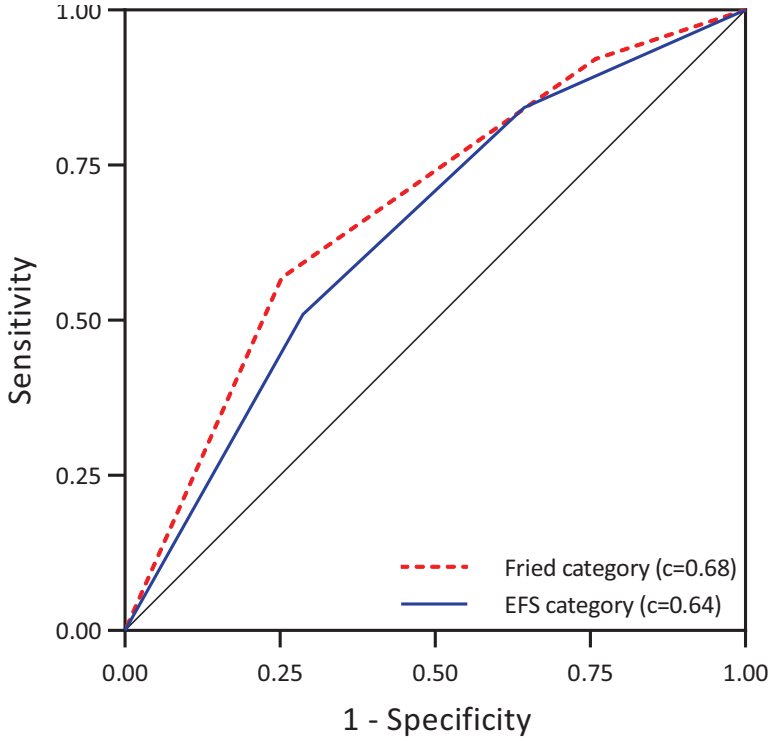

Table 5: C-statistic and pseudo-R2 estimates for mortality and hospitalisations.

Outcome	Fried category		EFS category		C-statistics between two tools (95%CI), p	
	C	R^2	C	R^2		
Primary outcome						
Mortality at three years	0.68 (0.60, 0.77)	0.11	0.64 (0.55, 0.73)	0.06	0.04 (-0.06, 0.14)	0.46
Secondary outcome						
Mortality at two years	0.67 (0.58, 0.77)	0.08	0.62 (0.51, 0.72)	0.04	0.06 (-0.06, 0.17)	0.34
Mortality at one year	0.72 (0.61, 0.83)	0.09	0.59 (0.46, 0.73)	0.02	0.13 (-0.01, 0.27)	0.07
Hospitalisations at six months	0.70 (0.61, 0.78)	0.13	0.63 (0.54, 0.72)	0.06	0.06 (-0.03, 0.16)	0.21

imately 10% of community-dwelling adults >65 years are thought to be frail based on international data.[2] WDHB serves over half a million people, with people 65-years old and older expected to make up 20% of the total population by 2034.[18] WDHB is also the district health board with the highest life expectancy in Aotearoa New Zealand at 85.1 years.[18] The trend of older adults starting RRT in Aotearoa New Zealand has plateaued.[19] Similarly, the number of comorbid conditions that Aotearoa New Zealand patients are starting RRT with has also appeared to have stabilised since the start of the decade.[19]

Although the concept of frailty is accepted, there is no consensus with regard to its operationalisation,[1] with multiple frailty tools in existence. The Fried, or phenotypic, model has been widely used in research, is based on physical measure of frailty[14] and has been the most commonly used tool to assess HD populations. Studies supplementing physical measures of grip strength and gait speed for self-reported questionnaires have found over estimation of frailty, which likely accounts for some of this variation.[20] In contrast, the EFS addresses the multidimensional nature of frailty, with domains including mobility, functional independence, social support and quality of life, among others. It is less studied in this population. In the largest EFS-HD study, with a Spanish cohort of 277 patients (median age 65 years), approximately 30% were frail and frailty was associated with increased hospitalisations and mortality.[21] Other smaller studies report prevalence rates of 38–46%.[22–23]

Despite both tools reporting the same prevalence of 37%, they appear to be assessing differing aspects of the syndrome of frailty and identifying different participants, highlighting these tools are likely measuring different dimensions of frailty. There are few studies comparing Fried to EFS in HD patients,[23,24] and to the best of our knowledge, this is the largest. The Fried method has been shown to correlate with sarcopenia, likely due to the physical measurements within this tool.[25] It is possible that ethnic-specific differences in muscularity may explain why no differences in frailty were seen between ethnicities with the Fried method.[26] A small study assessing sarcopenia in liver transplant candidates in Hawai'i demonstrated the presence of ethnic differences with less sarcopenia found in the "Hawaiian and other Pacific people" group, which is consistent with this hypothesis.[27] Although the Fried tool was associated with hospitalisations in this study, there are disadvantages with its use clinically. As well as requiring specific equipment, the categorical Fried tool does not provide a range of severity in scoring. Given the high prevalence of frailty in the HD population, a tool providing a greater range of frailty severity, or one that is continuous, is likely to be more useful. Larger future studies in this population could include other frailty screening tools, such as the Clinical Frailty Scale or the five-point FRAIL scale, which are clinically user-friendly and show promise in this area.[22]

There are marked variations in end stage kidney disease in Aotearoa New Zealand based on ethnicity, with Pacific people having the highest rate (494 per million population (pmp)), compared to Māori (244 pmp) Asian (65 pmp) and European/Other ethnicities (72 pmp). Of concern, the rates in Pacific people are steadily growing while the mean age of Pacific people starting RRT is younger than other ethnic groups.[19] Thus the finding that Pacific people were at increased risk of EFS is an important one. There are very few publications reporting objective measures of frailty in Māori or Pacific people, and in non-CKD studies only.[28,29] This is again particularly relevant considering the wider health inequities present for Māori and Pacific people in Aotearoa New Zealand, and these differences should be explored further in a larger study. Unlike (non-CKD) publications that find Māori[28,29] and Pacific people [29] are more likely to be frail with multi-dimensional frailty assessments, we found no significant association in this cohort, which perhaps reflects the small cohort. Non-white ethnicity is associated with frailty in HD populations internationally.[30]

Several other demographic and clinical factors previously known to be associated with frailty were also identified in this study: age, smoking status, number of medications, hypoalbuminaemia and comorbidities.[30] Contrary to other studies, we did not find an association with haemoglobin or gender (despite female gender

showing strong associations in HD-frailty and general frailty literature). Interestingly, both tools found marital status significantly associated with frailty, although not in the same direction. We are unaware of other HD-frailty studies reporting significant associations with marital status, and the cause of these findings is unclear. This suggests wider social characteristics may influence frailty. Other factors identified in previous studies associated with frailty status include unemployment, lower education, certain comorbidities, such as cardiovascular disease and depression, and testosterone levels.[30]

The relationship between frailty and outcomes is less clear in this study in comparison to the HD-frailty literature. Many studies have shown frailty is associated with falls, vascular access outcomes, hospitalisations and mortality.[30] After adjusting for confounders, only the Fried category was associated with adverse outcomes, in terms of six-month hospitalisation rate. This possibly relates to small study numbers. However this could reflect other factors in the Aotearoa New Zealand population that have not previously been interrogated. Particular differences may be due to the ethnic groups in this study, or they could reflect differing practices of patient selection for dialysis between countries. Most frailty studies do not report severity of frailty, and perhaps participants in our studies are less frail than others, which may influence results. Assessing whether the same adverse health effects are seen with frailty in a larger study in this population is required.

There are several limitations to this study, including small overall numbers. Despite good recruitment from community dialysis centres, 35% of those dialysing as inpatients declined participation. This likely caused under-representation of frailty in the total group and has possibly influenced outcome data. It is probable some of these patients declined due to acuity of medical illness or being newly initiated to dialysis. It should also be noted that results do not reflect overall HD population, as we elected not to include those on home-HD, who are possibly less frail. This decision was made due to potential difficulties recruiting this group in the short study time-period available. To reduce the burden of questions on patients undergoing dialysis, we used a simplified Fried tool rather than the formal and time-consuming methods measures used in original Fried study. Measurements were taken at the time of dialysis and recent evidence suggests this may also affect results in comparison to interdialytic measurements.[31] Other than specified outcomes, we did not study hospital notes of participants from baseline. Frailty is known to be dynamic; fluctuations and improvements are possible. It is possible that further appropriate management of patients, such as receiving kidney transplant, improved frailty levels and affected outcome data.

Despite these limitations, this study reports important findings of HD frailty in Aotearoa New Zealand and includes ethnic populations not previously studied in CKD-frailty before. Overall, similar rates of frailty were detected by both EFS and Fried measurements, with Fried category independently associated with six-month hospitalisations. Frailty measurements allow the identification of individuals who may warrant further clinical attention: for example physiotherapist or dietician input for exercise and nutrition components of frailty management, or clinical pharmacist input for deprescribing options.[1] Importantly, as frailty measurement identifies those at risk of adverse health outcomes, such recognition potentially enhances open communication between health providers, patients and whānau about the potential risks and benefits of any significant health intervention, such as surgery or advance care planning discussions. Recognising frailty allows us to advise patients who may have poor outcomes if they were to start dialysis and aid discussions in whether continuing RRT is appropriate. Therefore, further frailty work in the Aotearoa New Zealand dialysis populations is required, ideally including all dialysis modalities, pre-dialysis patients and more specifically longitudinal measurement of frailty in incident dialysis patients.

Competing interests:
Nil.
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Author information:
Katherine Bloomfield: Senior Lecturer/Geriatrician; Department of Medicine, University of Auckland, Auckland, Aotearoa New Zealand; Waitematā District Health Board, Auckland, Aotearoa New Zealand.
Zhenqiang Wu: Statistician/Research Fellow; Department of Medicine, University of Auckland, Auckland, Aotearoa New Zealand.
Lai Chan: Renal Physician; Waikato District Health Board, Hamilton, Aotearoa New Zealand.
Janak R de Zoysa: Associate Professor/Renal Physician; Department of Medicine, University of Auckland, Auckland, Aotearoa New Zealand; Waitematā District Health Board, Auckland, Aotearoa New Zealand.
Corresponding author:
Dr Katherine Bloomfield, Waitematā Clinical Campus, North Shore Hospital, PO Box 93 503, Takapuna, Auckland 0740, Aotearoa New Zealand, +64 9 4868920/42414 (phone), +64 9 4427166 (fax)
katherine.bloomfield@waitematadhb.govt.nz

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