ORIGINAL RESEARCH

The Association of Frailty and Malnutrition With Dietary Intake and Gastrointestinal Symptoms in People With Kidney Failure: 2-Year Prospective Study

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Background: Frailty and malnutrition are both associated with worsening morbidity and mortality and become more prevalent in the elderly and as kidney function declines. Anorexia and reduced oral intake are common features of both frailty and malnutrition. However, there are sparse data evaluating the impact of other gastrointestinal (GI) symptoms, such as taste changes, on rates of frailty and malnutrition in people with kidney failure. The aim of this study is to describe the prevalence of frailty and malnutrition and their association with dietary intake and nutrition-related symptoms in people with kidney failure.

Methods: This observational study recruited people with kidney failure who were commencing Conservative Kidney Management or elderly people (aged > 75 years) newly commenced on dialysis from 3 renal units. Participants underwent assessments of frailty, nutritional status, dietary intake, and GI symptom burden when they attended clinic appointments, approximately every 6 months.

Results: Of the 85 participants, 57% were assessed as being frail and 33% were assessed as being malnourished. Participants assessed as frail reported more GI symptoms (3 vs. 2, $P < .001$) that were more severe (1.75 vs. 1.0, $P < .001$) compared to nonfrail participants. Being malnourished was associated with a 5 times higher chance of being frail (odds ratio 5.8; 95% confidence interval 1.5, 21.8; $P = .015$) and having more severe symptoms was associated with a 2 times higher chance (odds ratio 2.8; 95% CI 1.1, 7.0; $P = .026$) of being frail. In addition to experiencing more GI symptoms, that were more severe, participants who were malnourished consumed significantly less energy (1234 kcal vs. 1400 kcal, $P = .01$) and protein (51 g vs. 74 g, $P < .001$).

Conclusions: Frailty and malnutrition are common and are associated with a higher GI symptom burden and poorer dietary intake. Future research is needed to determine effective interventions targeting frailty and malnutrition, including nutrition-related symptoms and optimal protein intake.

Keywords: Kidney failure; conservative kidney management; frailty; malnutrition; diet

Introduction

CHRONIC KIDNEY DISEASE (CKD) is a progressive condition that is estimated to affect approximately 10% of the global population,[1] with a disproportionately higher rate of kidney failure in people aged more than 65 years.[2,3] Malnutrition and frailty are 2 clinical syndromes that become increasingly prevalent as people age and as CKD progresses.

Frailty is estimated to affect up to 60% of older people receiving dialysis, compared to just 11% of the general older adult population.[4] In CKD, frailty is an independent risk factor for falls, decreased quality of life, hospitalization, death, and progression to dialysis,[4,5] with functional decline common within the first 6 months of commencing dialysis.[6] The early identification, management, and prevention of frailty are crucial to maintaining quality of life.

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Financial Disclosure: The authors declare that they have no relevant financial interests.

Conflicts of Interest: Nothing to disclose.

Ethics Approval Statement: This study was approved by Human Research Ethics Committee [2019/ETH04797].

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1051-2276/$36.00

https://doi.org/10.1053/j.jrn.2023.10.006

There are numerous aspects to the development of frailty, including physical, nutritional, cognitive, medication, and sociodemographic factors.[5] In the elderly, general population, multicomponent interventions incorporating several of these facets have been most effective at managing and reversing frailty.[7] There are several frailty assessment tools, including subjective scales that require holistic assessment of an individual (e.g., Clinical Frailty Scale) and objective tools that assess the physical domains of frailty (e.g., Fried's Frailty Index).[4]

Malnutrition is also common in CKD, with the global prevalence estimated to be between 35% in CKD populations and 50% in kidney failure populations.[8] Malnutrition develops when there is an imbalance between nutritional requirements and intake which results in altered metabolism, impaired function, and loss of body mass[9] and in CKD is associated with reduced quality of life and increased rates of hospitalization and mortality.[10] There are several tools to assess nutritional status, with the Subjective Global Assessment (SGA) being recommended for use in CKD.[11] The SGA categorizes people as being well nourished, mildly to moderately malnourished, or severely malnourished.

To target interventions, identification of specific factors that may contribute to the development of frailty and malnutrition is needed. A common feature in the development of both frailty and malnutrition is reduced oral intake. In CKD, reduced oral intake and anorexia are common, with approximately 50% of people with kidney failure reporting a poor appetite.[12] Some emerging data in kidney failure populations, managed conservatively (i.e., nondialysis) and on dialysis, indicated that other gastrointestinal (GI) symptoms are also associated with malnutrition.[12] However, the impact of other GI symptoms, such as nausea and taste changes, is poorly described particularly in relation to frailty and malnutrition in elderly people with kidney failure. The aim of this research is to describe the prevalence of frailty and malnutrition in elderly people with kidney failure and to determine if there is any association between frailty and dietary intake and GI symptoms.

Methods

Study Design

This was a prospective, observational study with 2 years of follow-up. Written and informed consent was obtained from all participants before enrollment into the study.

Study Setting

The study was conducted at 3 renal units that serve socioeconomically and culturally diverse populations. This was a pragmatic study with data collected during clinic appointments by dietitians. Recruitment commenced in July 2018 and due to COVID-19 pandemic physical distancing requirements limiting in-person consultation, recruitment was ceased in September 2020.

Participants

Patients were eligible if they were commencing Conservative Kidney Management (CKM) (i.e., nondialysis, medical management for kidney failure) or if they were aged 75 years or more and commencing dialysis. People were excluded if they were withdrawing from dialysis, being acutely palliated (i.e., in the terminal phase of life as per clinician assessment), currently hospitalized, or were acutely unwell. People who met eligibility criteria were recruited at their initial CKM appointment or within 3 months of commencing dialysis. Participants continued to receive usual dietary counseling, including oral nutrition support when indicated.

Outcomes

Frailty was assessed using the Fried's Frailty Index (FFI).[13] The FFI assesses frailty against 5 domains: shrinking (unintentional weight loss), weakness, slowness, exhaustion, and low physical activity. Assessment criteria for each of these domains are outlined in Supplementary File 1. As has been done in previous studies, some of the assessment criteria were modified to reduce burden to participants and improve ease of collection. Patients were classified as frail if they met 3 or more of the criteria.

Nutritional status was assessed using the 7-point SGA.[14] Participants were classified as well-nourished if they were scored ≥ 6 and were classified as malnourished if they were scored ≤ 5.

Dietary intake was assessed using a 24-hour multiple pass structured dietary recall.[15] Protein and energy intake was quantified using a dietary calculator that was developed for this study. Dietary intake data were collected within 2 weeks of the frailty and malnutrition assessment being completed.

Gastrointestinal symptoms were assessed using the iPOS-Renal. Participants were asked to rate the presence and severity of symptoms (anorexia, nausea, vomiting, dry/sore mouth, constipation, and diarrhea) experienced in the past week using a 5-point Likert scale. The presence and severity of taste alterations were also assessed using the same 5-point Likert scale. Symptom severity scores were calculated by adding together the scores for each GI symptom and dividing by the total number of GI symptoms reported by an individual. For example, a patient reports having moderate (score of 2) anorexia and slight (score of 1) taste changes would equate to a score of 3 divided by 2 (number of symptoms), giving a symptom severity score of 1.5.

Biochemical results were extracted from electronic medical records if they had been collected within 4 weeks of frailty and malnutrition assessment.

Statistics

Based on assumed rates of frailty of 42% in CKD and 67% in dialysis populations, a sample size of 60 participants in

each cohort (CKM and dialysis) was determined to be needed to detect a between-group difference in the rate of frailty with 80% power with an alpha 0.05. Statistical analysis was performed using R and SPSS (v28.0.0.0). Variables are presented as means and standard deviations or else median (interquartile range) for non-normally distributed data. Variables with a normal distribution were compared between groups using Student's *t*-test or Mann-Whitney test for non-normally distributed variables. The chi-square test was used to compare categorical variables. A logistic regression analysis to investigate predictors of frailty was conducted. A significance level of < 0.05 was used.

Results

A total of 85 patients were recruited into the study. Sixty (70%) participants were receiving CKM and 25 (30%) had been commenced on dialysis. The dialysis cohort were predominantly receiving peritoneal dialysis (n = 23, 92%). Recruitment into the dialysis cohort was ceased early due to slower recruitment of the dialysis cohort and the impact from COVID-19. The mean age of the total cohort was 80 years, 62% were male (n = 53), 35% of participants were born in Australia (n = 30), and 66% (n = 56) reported their primary language as English (Table 1). Overall, 48 participants (56%) were assessed as frail and 28 participants (33%) were malnourished. Participants had an average of 2 GI symptoms and median symptom severity score of 1.3, indicating symptoms to be slight to moderate in severity. There was no correlation between dietary protein intake and serum albumin (r 0.18, $P = .11$) or serum urea (r 0.19, $P = .08$).

Treatment Modality (Conservative Management vs. Dialysis)

Participant characteristics were similar between the 2 cohorts, except people in the dialysis cohort had significantly lower serum albumin of 32 g/L compared to 35 g/L in CKM ($P = .015$). Participants commencing dialysis also had higher serum creatinine 567 mmol/L and lower estimated glomerular filtration rate (eGFR) of 7 mL/min/1.73 m^2, compared to CKM with serum creatinine 397 mmol/L and eGFR of 12 mL/min/1.73 m^2. People commencing dialysis also had higher rates of cardiovascular disease (80% vs. 53%) but lower rates of congestive cardiac failure (0% vs. 25%).

The rate of frailty for the total cohort was 56% (n = 48), with no difference between CKM and dialysis cohorts (Table 2). People receiving CKM and dialysis had similar rates of unintentional weight loss, weakness, exhaustion, and slow walking (Table 2). Low physical activity was more prevalent in CKM, 92% versus 64% in the dialysis cohort ($P = .003$). Weakness and low physical activity levels were the most frequently assessed criteria as meeting frailty cut-offs in both cohorts. While not significantly different, slow walking speed and exhaustion were more commonly noted in the CKM cohort. There was no difference in rates of malnutrition, presence, and severity of GI symptoms or dietary intake between those receiving CKM and dialysis (Table 2).

Table 1. Baseline Participant Characteristics Total Cohort (n = 85)

Sex, Male n (%)	53 (62%)
Age mean (SD)	80.7 (10.6)
Primary language, English n (%)	56 (66%)
Country of Birth, Australia n (%)	30 (35%)
Comorbidities, n (%)	
Total number (mean, SD)	4.7 (2.5)
Diabetes	46 (54%)
Cardiovascular disease	52 (61%)
Congestive Cardiac Failure	15 (18%)
Biochemistry mean (SD)	
Urea*	24.6 (19.8-29.8)
Creatinine*	426 (304-525)
eGFR*	9.5 (7-13.8)
Bicarbonate	22.8 (3.8)
Albumin	33.6 (5.7)
Potassium	4.6 (0.7)
Phosphate	1.62 (0.38)
Hemoglobin	107.2 (16.1)
Frailty status n (%)	
Frail	48 (56%)
Weight loss	31 (36%)
Weakness	66 (78%)
Slow walking	19 (22%)
Exhaustion	36 (42%)
Low physical activity	71 (84%)
Nutritional status n (%)	
Malnourished	28 (33%)
Gastrointestinal symptoms n (%)	
Anorexia	41 (48%)
Nausea	14 (16%)
Vomiting	6 (7%)
Dry/sore mouth	56 (66%)
Taste changes	30 (35%)
Constipation	29 (34%)
Diarrhea	9 (11%)
Number of symptoms*	2.0 (1-3)
Severity of symptoms median (IQR)	
Overall symptom severity*	1.3 (1-2)
Anorexia	2 (1-3)
Nausea	1 (1-1.75)
Vomiting	1 (1-2.25)
Dry/Sore Mouth	1 (1-2)
Taste changes	1 (1-2)
Constipation	2 (1-2)
Diarrhea	1 (1-2)

eGFR, estimated glomerular filtration rate; IQR, interquartile range; SD, standard deviation.
*Data presented as median (IQR).

Frailty

In the total cohort, those who were assessed as frail (n = 48, 56%) were significantly more likely to be malnourished, 50% versus 10% in people who were not frail

Table 2. Outcomes by Treatment Modality: CKM Versus Dialysis

Variables	Conservative (n = 60)	Dialysis (n = 25)	*P* Value
Age mean (SD)	80.9 (12.5)	80.2 (3.3)	.09
Sex, male n (%)	36 (60%)	17 (68%)	.49
Primary language, English n (%)	39 (65%)	17 (68%)	.79
Country of Birth, Australia n (%)	25 (42%)	5 (20%)	.06
Comorbidities n (%)	4.5 (2.7)	5.1 (2)	.32
Nutritional status n (%)			
Malnourished	23 (38%)	5 (20%)	.10
Frailty status n (%)			
Frail	37 (62%)	11 (44%)	.18
Unintentional weight loss	22 (37%)	9 (36%)	1.0
Weakness	48 (80%)	18 (72%)	.54
Slow Walking Speed	16 (26%)	3 (12%)	.15
Exhaustion	29 (48%)	7 (28%)	.09
Low activity	55 (92%)	16 (64%)	.003
Dietary Data mean (SD)			
Energy (kcal)*	1357 (1119-1582)	1371 (1076-1542)	.54
Protein (grams)	65 (21.4)	72 (24.1)	.21
Protein (g/kg/day)	0.91 (0.32)	1.07 (0.43)	.12
Symptoms n (%)			
Anorexia	31 (51%)	10 (40%)	.33
Nausea	9 (15%)	5 (20%)	.54
Vomit	3 (5%)	3 (12%)	.35
Dry/sore Mouth	39 (65%)	17 (68%)	.79
Constipation	18 (30%)	11 (44%)	.22
Diarrhea	8 (13%)	1 (4%)	.27
Taste Changes	23 (38%)	7 (28%)	.36
Number of Symptoms*	2 (1-3)	2 (1-3)	.81
Symptom Severity*	1.33 (1-2)	1.33 (1-2)	.65
Biochemistry mean (SD)			
Urea*	23.1 (19.5-29.7)	26.9 (23.6-28.7)	.13
Creatinine*	364 (275-524)	517 (467-615)	< .001
eGFR*	12 (8.5-16)	7 (7-9)	< .001
Bicarbonate	23.1 (3.9)	22.1 (3.5)	.3
Albumin	34.5 (.3)	31.7 (3.7)	.015
Potassium	4.7 (0.7)	4.4 (0.6)	.08
Phosphate	1.57 (0.36)	1.7 (0.41)	.19
Hemoglobin	106.8 (15.8)	108.1 (17.1)	.76

eGFR, estimated glomerular filtration rate; IQR, interquartile range; SD, standard deviation.
*Data presented as median (IQR).

($P < .001$) (Table 3). Additionally, those who were frail reported significantly higher rates of anorexia, dry mouth, a higher number of GI symptoms, and reported these symptoms to be more severe (Table 3). When assessing dietary intake, people who were frail reported to consume significantly less protein, 0.9 g per kilogram body weight compared to 1.05 g per kilogram body weight for people who were not frail ($P = .03$). Although there was no difference in total protein intake between people assessed as frail (65 g per day) and not frail (72 g per day) (Table 3), there were no differences in biochemical parameters between frail and not frail participants.

At baseline, predictors of frailty were tested using logistic regression adjusting for age, gender, treatment pathway (CKM vs. dialysis), nutritional status, number of symptoms, symptom severity, and protein intake adjusted for weight was conducted. In the unadjusted model, malnutrition ($P < .001$), symptom severity ($P < .001$), total number of symptoms ($P = .006$), and protein intake adjusted for weight ($P = .043$) were predictors of frailty, while treatment of kidney failure (conservative or dialysis management), eGFR, age, and gender were not. After adjusting for all variables, being malnourished was associated with a 5 times increased likelihood of being frail (odds ratio 5.6; 95% confidence interval 1.14, 21.7; $P = .013$) and having more severe symptoms was associated with a 2 times increased likelihood of being frail (odds ratio 2.8; 95% confidence interval 1.1, 7.0; $P = .025$) (Table 4).

Nutritional Status

Overall, 33% of people in the total cohort were assessed as being malnourished (Table 5). The malnourished cohort had significantly lower albumin levels, 31 g/L compared to 35 g/L in people who were well-nourished ($P < .001$). All

Table 3. Outcomes by Frailty Status

Variables	Frail (N = 48)	Not-Frail (N = 37)	*P* Value
Age mean (SD)	81.4 (6.5)	80.5 (5.6)	.37
Sex, male n (%)	28 (58%)	25 (68%)	.5
Primary language, English n (%)	32 (67%)	24 (65%)	1.0
Country of Birth, Australia n (%)	14 (29%)	16 (43%)	.25
Comorbidities n (%)	5.1 (2.4)	4.1 (2.6)	.03
Frailty domains n (%)			
Unintentional weight loss	27 (56%)	4 (11%)	< .001
Weakness	42 (86%)	24 (65%)	.025
Slow Walking Speed	17 (35%)	2 (5%)	< .001
Exhaustion	34 (71%)	2 (5%)	< .001
Low activity	47 (98%)	24 (65%)	< .001
Nutritional status n (%)			
Malnutrition	25 (45%)	3 (10%)	< .001
Dietary Data mean (SD)			
Energy (kcal)*	1234 (993-1590)	1400 (1145-1546)	.2
Protein (grams)	64.4 (23.0)	71.4 (20.5)	.16
Protein (g/kg/day)	0.90 (0.37)	1.06 (0.33)	.06
Symptoms N (%)			
Anorexia	32 (58%)	9 (30%)	.01
Nausea	12 (22%)	2 (7%)	.07
Vomit	5 (9%)	1 (3%)	.42
Dry/sore Mouth	42 (76%)	14 (46%)	.006
Constipation	18 (33%)	11 (36%)	.71
Diarrhea	6 (11%)	3 (10%)	1.00
Taste Changes	22 (40%)	8 (26%)	.22
Number of Symptoms*	3 (2-4)	2 (1-3)	< .001
Symptom Severity*	1.75 (1.3-2.3)	1 (1-1.7)	< .001
Biochemistry mean (SD)			
Urea*	25 (17.4-34.2)	24.1 (20.9-28.4)	.32
Creatinine*	401 (334-517)	429 (300-526)	.09
eGFR*	11 (7-12)	9 (7-14)	.2
Bicarbonate	23.2 (4.1)	22.1 (3.4)	.22
Albumin	32.3 (5.3)	33.8 (6.4)	.61
Potassium	4.5 (0.7)	4.7 (0.6)	.22
Phosphate	1.57 (0.35)	1.62 (0.38)	.34
Hemoglobin	105.8 (16)	107.1 (17.3)	.85

eGFR, estimated glomerular filtration rate; IQR, interquartile range; SD, standard deviation.
*Data presented as median (IQR).

other biochemical parameters were similar between malnourished and well-nourished participants. Those who were malnourished reported significantly higher rates of anorexia, dry/sore mouth, taste changes, a higher number of GI symptoms, and more severe symptoms. There was a higher rate of frailty in people assessed as malnourished (89%) compared to those who were well-nourished (53%) ($P < .001$). Frailty criteria of weight loss and exhaustion were significantly higher in people who were malnourished, while rates of weakness, slow walking, and low physical activity levels were similar. Both total energy and protein intakes were significantly lower in people who were malnourished (Table 5).

Discussion

There was a high overall prevalence of frailty (56%) and malnutrition (33%) in this cohort of people with kidney failure. Rates of frailty were similar between those receiving CKM (62%) and those receiving dialysis (44%). Low physical activity and weakness were the most common frailty criteria identified, reported by > 75% of the total cohort, with clinically significant but lower rates of exhaustion (42%), unintentional weight loss (36%), and slow walking speed (22%). There were no differences in rates of malnutrition, dietary intake, or GI symptoms when comparing those commencing CKM and dialysis. When analyzing the total cohort as frail or not frail, there were significantly higher rates of malnutrition, more symptoms, and symptoms rated higher in severity among those assessed as frail, with malnutrition and symptom severity significantly increasing the likelihood of being frail. We also found that people assessed as being malnourished had higher rates of frailty, unintentional weight loss, exhaustion, lower energy and protein intakes, and a higher GI symptom burden.

Rate of frailty in this kidney failure population was 62% in CKM, which differs from estimates of 7%–47%.[4,16] Prior

Table 4. Predictors of Frailty

Variable	Odds Ratio	95% Confidence Interval	*P* Value
Age	1.0	0.9, 1.1	.57
Gender	0.5	0.2, 1.6	.24
eGFR	1.1	0.9, 1.2	.4
Kidney failure treatment	0.9	0.25, 3.4	.9
Number of gastrointestinal symptoms	1.1	0.7, 1.8	.78
Symptom severity score	2.8	1.1, 7.0	.025
Protein intake (adjusted for weight)	1.1	0.2, 6.1	.9
Malnourished	5.6	1.4, 21.7	.013

eGFR, estimated glomerular filtration rate.

data that have reported nondialysis populations have generally been in younger people with CKD stages 2-4 (eGFR 15-60), with few elderly people with kidney failure receiving CKM being included. It has been well documented that rates of frailty increase as CKD progresses and are higher in the elderly,[4] and may explain the difference in rates. On the other hand, rates of frailty in the current dialysis cohort were lower than those previously estimated at ≈50%-70%.[4,16] While previous studies have most often used the FFI,[16] several studies have developed a modified version where objective measures (such as hand grip strength for weakness) have been replaced by self-report (such as ability to open a jam jar or being more or less active than people of the same age). While

Table 5. Outcomes by Nutritional Status

Variables	Malnourished (N = 28)	Well Nourished (N = 57)	*P* Value
Age mean (SD)	80.5 (5.9)	81.2 (6.2)	.63
Sex, male n (%)	17 (60%)	36 (63%)	1.0
Primary language, English n (%)	17 (61%)	39 (68%)	.63
Country of Birth, Australia n (%)	9 (32%)	21 (37%)	.81
Comorbidities n (%)	5.3 (2.8)	4.4 (2.3)	.054
Frailty domains			
Frailty n (%)	25 (89%)	30 (53%)	< .001
Unintentional weight loss	20 (71%)	11 (19%)	< .001
Weakness	23 (82%)	43 (75%)	.56
Slow Walking Speed	9 (32%)	10 (18%)	.15
Exhaustion	26 (93%)	35 (61%)	.002
Low activity	26 (93%)	45 (79%)	.13
Dietary Data mean (SD)			
Energy (kcal)	1234 (788-1500)	1400 (1151-1598)	.01
Protein (grams)	51 (20)	74 (19)	< .001
Protein (g/kg/day)	0.77 (0.33)	1.05 (0.35)	< .001
Symptoms n (%)			
Anorexia	23 (82%)	18 (32%)	< .001
Nausea	7 (25%)	7 (12%)	.21
Vomit	2 (7%)	4 (7%)	1.00
Dry/sore Mouth	24 (86%)	32 (56%)	.007
Constipation	10 (36%)	19 (33%)	.82
Diarrhea	5 (18%)	4 (7%)	.15
Taste Changes	14 (50%)	16 (28%)	.047
Number of Symptoms*	3 (2-4)	2 (1-3)	< .001
Symptom Severity*	1.75 (1.3-2.3)	1 (1-1.7)	< .001
Biochemistry mean (SD)			
Urea*	25 (16.2-34.8)	24.1 (20.4-28.1)	.86
Creatinine*	401 (303-518)	429 (329-526)	.59
eGFR*	11 (7-14)	9 (7-11)	.46
Bicarbonate	22.5 (3.5)	22.9 (3.9)	.52
Albumin	30.6 (4.8)	35.1 (5.6)	< .001
Potassium	4.4 (0.8)	4.7 (0.6)	.17
Phosphate	1.63 (0.44)	1.61 (0.35)	.9
Hemoglobin	105.2 (18)	108.1 (15.2)	.39

eGFR, estimated glomerular filtration rate; IQR, interquartile range; SD, standard deviation.
*Data presented as median (IQR).

the use of self-reported measures may be more pragmatic and overcome the physical assessment barrier, they have been shown to overestimate frailty.[17] In addition, in the present study, frailty was assessed at the commencement of dialysis, unlike previous studies with participants being established on dialysis, with functional decline being seen within the first 6 months of commencing dialysis.[6]

Rates of malnutrition in this cohort were 33% and are generally reflective of global prevalence estimates of 42.7% (35.2%-50.6%).[8] The rate of malnutrition in CKM cohort (38%) is largely in line with global estimates of malnutrition in nondialysis CKD (38.5%). However, the rate of malnutrition in our dialysis cohort (20%) is lower than that reported elsewhere, with global estimates being approximately 45%.[8] This may be due to estimates in the present study being at initiation of dialysis, while other studies have assessed nutritional status after dialysis commencement with factors such as metabolic acidosis, inflammation, and increased amino acid losses, contributing to the development and progression of malnutrition.[18,19]

This study demonstrated that malnutrition and more severe GI symptoms are predictors of frailty. This has highlighted the importance of early and regular screening of nutritional status, which should include the identification of GI symptoms, particularly anorexia, nausea, and taste changes. Previous studies support the significant association of anorexia, taste changes, and dry mouth with malnutrition.[12] Routine assessment to identify these symptoms is needed, with interventions specifically targeting these symptoms before malnutrition is evident. Given the high rates of symptoms and malnutrition at commencement of both CKM and dialysis, assessment and management are needed before a person has progressed to kidney failure.

This study highlighted the concomitant nature of frailty and malnutrition, with 89% of participants who were malnourished also being frail, and conversely, of the participants assessed as being not frail only 10% were malnourished. While the development of frailty and malnutrition is different,[20] one important aspect common to both is reduced dietary intake.[4,10] In this study, lower protein intakes were identified in those who were malnourished and those who were frail. Guidelines for the management of malnutrition and frailty in the elderly general population recommend $>$ 1.0 g of protein per kilogram of bodyweight each day.[21] In addition to total intake, consideration of protein source, meal distribution, and timing may also impact on muscle protein synthesis.[22] However, in people with kidney failure not receiving dialysis, protein intake is generally restricted to $<$ 0.8 g protein per kilogram per day to reduce the accumulation of uraemic toxins.[11] Of note, very few studies evaluating the use of low-protein diets in kidney failure and CKD have included elderly people (i.e., aged $>$ 75 years). Further research evaluating protein intake with malnutrition and frailty in people, particularly those receiving CKM, is urgently needed.

The strengths of this study include its prospective design that assessed frailty and malnutrition along with novel data regarding dietary intake and GI symptom burden. However, there are some limitations to the study. This dialysis population was primarily commenced on peritoneal dialysis and may not be representative of the general dialysis population that is predominantly hemodialysis. Enrollment of people commencing dialysis was discontinued due to the COVID-19 pandemic and slow recruitment thereby limiting power to detect differences between CKM and dialysis cohorts due to small sample size. The FFI uses objective measures, which may be considered strength; however with the need for physical distancing during COVID-19, the use of objective measures limited recruitment and follow-up assessments. In addition, physical activity levels were self-reported and therefore may have been overestimated, leading to an inflated rate of frailty. However, the use of self-reported measures has commonly been used in other studies and therefore our results should not be an anomaly. Dietary intake was self-reported, and assessment of intake used a study-developed dietary calculator. These methods may have underestimated actual intake; however, the same calculator and dietary recall methods were used by dietitians at all sites, minimizing variation between sites.

In conclusion, frailty and malnutrition are common and are associated with reduced dietary intake and higher GI symptom burden. Early identification of both frailty and malnutrition are needed in the earlier stages of CKD, before a person has kidney failure. Interventions targeting anorexia, dry/sore mouth, and taste changes may be particularly important at mitigating the development and progression of both frailty and malnutrition. Future research is needed to determine a dietary protein intake target for elderly people with kidney failure receiving CKM and to evaluate effective interventions to delay the development and progression of frailty of elderly people with kidney failure.

Practical Application

Given the high prevalence of both frailty and malnutrition, early assessment and management are needed. The use of pragmatic assessment tools, which can be incorporated into clinical care, such as the Clinical Frailty Scale that uses a subjective scale based off clinical judgment of a person's presentation,[23] may be more easily conducted in clinical (remote and in-person) settings. Early identification and management of GI symptoms, particularly those that are rated as moderately or more severe, in addition to dietary counseling to avoid or delay malnutrition should be undertaken by a dietitian before a person reaches kidney failure. There are currently no guidelines regarding optimal

protein intake to manage frailty and malnutrition in CKD, with more research needed.

Credit Authorship Contribution Statement

Cameron McLean: Contributed to data analysis, Formal analysis, writing – original draft, Manuscript preparation. **Ann-Maree Randall:** Contributed to design, Conceptualization, Methodology, Resources, Writing–original draft, Investigation, Manuscript preparation. **Michele Ryan:** Contributed to design, Methodology, Resources, Writing–original draft, Data collection, Manuscript preparation. **Brendan Smyth:** Contributed to data analysis, Formal analysis, writing – original draft, Manuscript preparation. **Max Thomsett:** Contributed to data analysis, Formal analysis, writing – original draft, Manuscript preparation. **Mark A. Brown:** Contributed to design, Conceptualization, Methodology, Supervision, Writing – original draft, Manuscript preparation. **Jessica K. Dawson:** Contributed to design, Conceptualization, Methodology, Supervision, Resources, Formal analysis, Writing – original draft, Writing – review & editing, Data collection, Data analysis, Manuscript preparation.

Acknowledgments

The authors would like to acknowledge the involvement and support of all the patients involved in this study. The authors would like to thank the staff who contributed to the study design (Prof K Sud, Dr F Brennan, Dr CK Li, M E Josland, and M A Smyth) and data collection (Ms S Bahceci, M C Fitzmaurice, M A Finn, and M R Taylor). B.S. is supported by the Jacquot Research Establishment Fellowship via the Royal Australasian College of Physicians.

Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1053/j.jrn.2023.10.006.

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