



# High prevalence of malnutrition and frailty among older adults at admission to residential aged care

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## ABSTRACT

**INTRODUCTION:** Malnutrition is an under-recognised and under-treated problem often affecting older adults.

**AIM:** The aim of this study was to evaluate the prevalence of and factors associated with malnutrition and frailty among older adults at early admission to residential aged care.

**METHODS:** A cross-sectional study was undertaken among eligible older adults within the first week of admission to residential aged care. Participants were assessed for malnutrition risk using the Mini Nutritional Assessment Short Form, frailty using the Fried phenotype criterion, muscle strength using a grip strength dynamometer and gait speed using a 2.4-m walk test. A Cox regression analysis was conducted to identify factors associated with malnutrition risk and frailty status.

**RESULTS:** Of 174 participants (mean age 85.5 years, 61% women), two-thirds (66%) were admitted to residential aged care from the community. Most (93%) were either malnourished (48%) or at risk of malnutrition (45%). A total of 76% of participants were frail and 24% were pre-frail. Forty-three percent were both malnourished and frail. Low risk of malnutrition was associated with increases in muscle strength [0.96 (0.93–0.99)], gait speed [0.27 (0.10–0.73)] and pre-frailty status [0.32 (0.12–0.83)].

**DISCUSSION:** This study provides preliminary evidence for high prevalence of malnutrition and frailty at admission to residential aged care. Almost all participants were malnourished or at nutrition risk. Findings highlight the need for strategies to prevent, detect and treat malnutrition in community health care and support nutrition screening at admission to residential aged care.

**Keywords:** Malnutrition; frailty; residential aged care

## Introduction

Malnutrition is a common geriatric syndrome, which is associated with loss of independence, poor quality of life and high mortality risk.<sup>1–8</sup> Loss of independence is a key factor that necessitates placement to residential aged care.<sup>9,10</sup> Residential aged care placement is less preferable than living in the community for many older adults,<sup>9–11</sup> as well as

an economic burden to the health system. Currently, older adults use ~42% of district health board expenses, of which over half (60%) is used for support services in residential aged care.<sup>12</sup> In New Zealand, approximately half of older adults enter residential aged care before they die<sup>13</sup> and almost 13% die (all cause mortality) within the first 6 months of placement.<sup>14</sup>

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## WHAT GAP THIS FILLS

**What is already known:** Poor nutrition prevents healthy ageing and approximately one-in-three older adults living in the community are at risk of malnutrition.

**What this study adds:** This study reports the prevalence of both malnutrition and frailty at admission to residential aged care facilities in the Waitemata District Health Board area. The findings help inform primary health-care clinicians about the utility of nutrition screening and early intervention.

Nutrition screening is recommended across all health-care settings by international and national nutrition organisations to allow early identification of malnutrition risk.<sup>15,16</sup> A plethora of nutrition screening tools have been developed to identify people at risk of malnutrition who might benefit from full nutrition assessment and intervention. Based on its validity, reliability, sensitivity and specificity testing, the Mini Nutritional Assessment Short Form (MNA®-SF) is the most frequently used tool for nutrition risk screening in older adults.<sup>17</sup> In 2009, the MNA®-SF was revised to include use of calf circumference as an alternative to body mass index (BMI),<sup>18</sup> improving its helpfulness in residential aged care where measurement of height and weight may be difficult. Among older adults who live in residential care, a high prevalence (30–50%) of malnutrition (inadequate nutrient and energy intake) has been reported.<sup>19–21</sup>

Malnourished older adults tend to have more comorbidities than their peers who are well nourished, and the prevalence of malnutrition is likely to increase with increasing frailty.<sup>22</sup> Age-related loss of muscle mass and strength (sarcopenia) is considered to be both a component<sup>23</sup> and an additional cause of physical frailty with advancing age.<sup>4</sup> By definition, frailty is a framework for identifying increased vulnerability resulting from failure of multiple physiologic systems.<sup>24</sup> The Fried phenotype criterion<sup>24</sup> is a robust and frequently used frailty assessment instrument.<sup>25,26</sup> Older adults in residential aged care are frequently considered frail, but few studies have objectively reported the prevalence of frailty in this setting. In a systematic review and meta-analysis, only nine studies assessing frailty among residential aged care residents

were identified, reporting a wide range of frailty prevalence (19–76%).<sup>27</sup>

Both malnutrition and frailty are linked to a general decline in health, increased medication use and comorbidities, poor dentition, swallowing difficulties, low cognition,<sup>22,28,29</sup> loss of independence and poor quality of life.<sup>6,7</sup> Similarities in symptoms and factors associated with malnutrition and frailty explain why sometimes similar intervention strategies are implemented for people who appear malnourished or frail.<sup>2</sup> However, the differences in aetiology of these conditions<sup>5</sup> means a minimum set of indicators that capture both conditions is required to develop complementary interventions that address mechanisms for both frailty and malnutrition.<sup>2</sup> The importance of considering the overlap and distinctiveness of these conditions in research and clinical practice is recognised,<sup>1,2</sup> but such studies in residential aged care are limited.<sup>2</sup> The aim of this study was to evaluate the prevalence and factors associated with malnutrition and frailty at early admission to residential aged care.

## Methods

## Study design

A cross-sectional study was conducted among 174 adults aged  $\geq 65$  years ( $\geq 55$  years for Māori and Pacific participants as they have a lower life expectancy than people of other ethnicities<sup>30</sup>), within the first week of admission to residential aged care. There are four main types of residential aged care depending on the level of care required; rest home, long-stay hospital, dementia and psycho-geriatric units.<sup>31</sup> The study included residents admitted for rest home or hospital level of care, at facilities of the Waitemata District Health Board (DHB) region of Auckland, New Zealand. Participants were excluded if they were in palliative care or previously diagnosed with dementia, swallow disorders, malabsorptive disorders, cancer of the larynx or psychiatric eating disorders. An opportunistic sample of 174 older adults was included as no prior sample size calculation was conducted.

The Health and Disability Ethics Committee: Northern A (Application 14/NTA/70) approved the study.

### Recruitment and data collection

Forty-one of the 63 residential aged care facilities registered with the Waitemata DHB agreed to participate. Weekly calls to facility managers were made to check for new admissions. Investigators visited potential participants to provide study details and seek written consent. Family members were proxies for participants who were unable to provide written consent. Demographic and health data were recorded from the participants and their medical files. The health data included comorbidities, medications and nutritional supplements taken. Participants were asked if they were able to perform activities of daily living (ADL) such as shopping, cleaning and cooking, before residential care admission. Self-reported dental status was recorded as either dentate (able to chew food without appliances) or non-dentate (missing teeth contributing to chewing problems or usage of dental appliance). All data were collected during a single visit between April and October 2017 and all assessments were conducted by three nutrition and dietetics researchers (IC, DH, SS).

### Malnutrition status

Using the Mini Nutritional Assessment Short Form (MNA®SF) cut-off points,<sup>18</sup> nutrition status was defined as 'well nourished' (MNA®SF score  $\geq 12$ ), 'at risk of malnutrition' (MNA®SF 8–11) or 'malnourished' (MNA®SF score 0–7). Subsequently, malnutrition status was categorised as 'malnourished' (MNA®SF score 0–7) and 'non-malnourished' (MNA®SF score 8–14). All assessments were performed as per the MNA®SF user guide.<sup>32</sup>

### Dysphagia risk

The Eating Assessment Tool-10 (EAT-10) is a 10 item self-reported validated questionnaire that assesses perception of swallowing difficulty (dysphagia). An increased EAT-10 score indicates increasing dysphagia risk or swallowing difficulties and an EAT-10 score  $\geq 3$  is suggestive of swallow impairment.<sup>33</sup>

### Cognitive status

Cognitive status was determined using the Montreal Cognitive Assessment (MoCA) tool.<sup>34</sup> A standardised protocol using the MoCA screened for

mild cognitive impairment.<sup>35</sup> The total possible score is 30 points, and a score  $\leq 26$  indicates some level of cognitive impairment.<sup>34</sup>

### Muscle strength

Muscle strength was assessed using hand grip strength<sup>36</sup> measured by the Jamar Hydraulic Dynamometer (model #5030J1; Sammons Preston, USA). The measurement procedure followed the standard approved by the American Society of Hand Therapists.<sup>37</sup> We recorded the mean of three measurements from the dominant hand. A cut-off point of  $<20$  kg for women and  $<30$  kg for men indicates low muscle strength and risk for sarcopenia,<sup>36</sup> so it was used to indicate a positive score for the frailty low muscle strength criterion.

### Gait speed

Mobility was assessed by a 2.4-m (8-foot) walk test. Two cones were placed 0.6 m apart at one end of an unobstructed area of floor. A third cone was placed 2.4 m from the second cone, and a fourth cone was placed 0.6 m from the third. A stopwatch (Accusplit, Survivor, Pleasanton, CA, USA) measured the time taken to complete the 2.4-m walk between the second and third cone.<sup>38</sup> The 2.4-m walk was performed three times and the mean and fastest time taken to complete the walk were recorded in seconds. The fastest 2.4-m walk (s) was converted to a 2.4-m gait speed (m/s) and the 2.4-m gait speed was converted to a 4-m gait speed using the following equations:<sup>39</sup>

$$\text{For } 2.4\text{-m gait speed} \leq 1.0 \text{ m/s : } 4\text{-m gait speed} \\ = 0.01 + (2.4\text{-m gait speed} \times 1.052).$$

$$\text{For } 2.4\text{-m gait speed} > 1.0 \text{ m/s : } 4\text{-m gait speed} \\ = 0.481 + (2.4\text{-m gait speed} \times 0.581).$$

From the 4-m gait speed, a cut-off point of  $\leq 0.8$  m/s indicates low gait speed and sarcopenia risk,<sup>36</sup> so it was used to indicate a positive score for the frailty low gait speed criterion. Participants who were chair bound or whose clinical notes indicated a recent fall or 'risk of fall' were not asked to perform the walk test and were also recorded as having a low gait speed.

### Frailty status

Frailty assessment was based on the Fried phenotype criterion, which describes frailty as having three or more positive frailty scores of the following: low gait speed, low muscle strength, low physical activity, extreme exhaustion and unintentional weight loss.<sup>24</sup> Having one or two of the conditions was considered 'pre-frail'.<sup>24</sup> If it was not feasible to record a score for one or two components, the data were recorded as 'not scored' and the total frailty score was taken from the remaining criterion.<sup>40</sup>

Positive frailty scores for low gait speed and low muscle strength were recorded from the assessments above. A positive score for the frailty '**low physical activity**' criterion was recorded for participants responding: 'one to three times a month' or 'hardly ever or never' to the question: '*How often do you engage in activities that require a low or moderate level of energy such as gardening, cleaning the car, or going for a walk?*'<sup>41</sup> (response options were: 1 = 'more than once a week'; 2 = 'once a week'; 3 = 'one to three times a month' and 4 = 'hardly ever or never'). As recommended by Fried *et al.*,<sup>24</sup> **exhaustion** was assessed using the two statements from the Centre for Epidemiologic Studies Depression (CES-D) Scale.<sup>42</sup> A positive score for the frailty exhaustion criterion was recorded if participants answered 'moderate or most of the time' to either of the two questions: '*how often in the last week did you feel that everything you did was an effort*' and '*how often in the last week did you feel that you could not get going*' (responses: 1 = rarely or none of the time [ $<1$  day]; 2 = some or little of the time [1 – 2 days]; moderate amount of the time [3 – 4 days]; 4 = most of the time [5 – 7 days]). Finally, **unintentional weight loss** was self-reported or if previous weight was available in the medical record, it was calculated through subtracting the 'current bodyweight' on the data collection day from records made in the previous 3 months. A positive score for the frailty unintentional weight loss criterion was met for participants who had lost  $>3$  kg within the preceding 3 months.

### Statistical analysis

All statistical analyses were completed using SPSS version 24 (SPSS Inc., Chicago, IL, USA). Results were considered significant at  $P < 0.05$ . Analyses

compared participant characteristics by malnutrition status (non-malnourished vs. malnourished) and by frailty status (non-frail vs. frail). Continuous data were checked for normality. Independent  $t$ -tests were performed to compare the differences between normally distributed data (mean  $\pm$  s.d.) and non-parametric data (median and interquartile range [IQR]) were analysed using the Mann–Whitney  $U$ -test. Categorical data are presented as frequencies and percentages, and chi-squared tests of independence or the Fisher's exact test were used to compare the differences between categories. To assess for factors associated with malnutrition and frailty, we performed Cox regression analyses, adjusting for non-modifiable human factors (age, gender and ethnicity), number of medications and comorbidities, as these factors are known to influence malnutrition and institutionalisation. To assess whether an independent association existed between malnutrition and frailty, an additional Cox regression analysis adjusting for all variables assessed was conducted. Prevalence ratios (PRs) and 95% confidence intervals (CIs) were reported from the regression analyses.

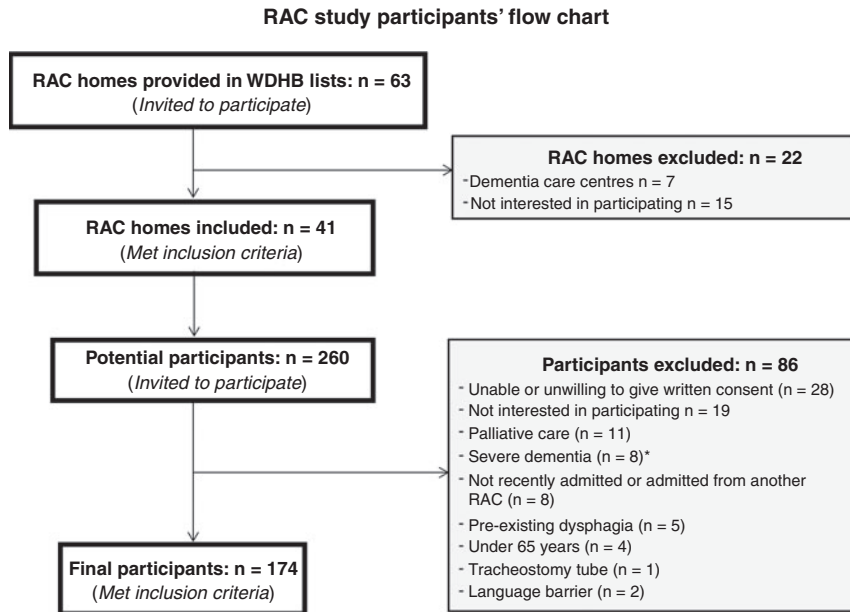
Due to the high prevalence of malnutrition and frailty, a Cox regression with equal follow-up time was conducted, as there was a high chance for logistic regression to overestimate PRs and inadequately control for confounding factors.<sup>43</sup> Findings from the logistic regression analyses confirmed the overestimation of the PR, and when adjusting for similar confounding factors used in the Cox regression model, more factors were identified as statistically associated with malnutrition and frailty.

## Results

### Participant characteristics

Figure 1 shows the participant recruitment process. A total of 174 older adults were recruited, of whom 75% were entering residential aged care as permanent residents and 25% were short-term (interim or respite) residents. Their mean age was 85.5 years ( $\pm 7.5$  years) and median BMI was 22.1 (6.8) kg/m<sup>2</sup>. Approximately 61% were women, 66% were single, widowed or divorced and 64% were of New Zealand European ethnicity. Most participants had a low gait speed (90%), low muscle strength (93%), mild cognitive impairment (69%), were non-dentate

Figure 1. Participant recruitment flow chart. Asterisk denotes additional numbers of participants who were admitted with dementia not captured because the residential aged care clinical managers screened and excluded them when providing the weekly list of newly admitted older adults.



(71%), with polypharmacy treatments (70%) and  $\geq 5$  comorbidities (65%). Over half (64%) of the participants took nutrition supplements – on average, one supplement, mostly vitamin D, an oral nutrition supplement or multivitamins. Table 1 shows the participant characteristics by malnutrition and frailty status.

### Malnutrition and frailty

Most participants (92.5%) were either malnourished (83; 47.7%) or at risk of malnutrition (78; 44.8%) and 13 (7.5%) were well nourished. Three-quarters were frail, 42 (24.1%) were pre-frail and none were robust. Table 2 shows the results from a Cox regression analysis of factors associated with malnutrition and frailty. After adjusting for age, gender, ethnicity, number of medications and comorbidities, lower risk for malnutrition was associated with level of residential care: rest home versus hospital, PR = 0.52 (CI: 0.33–0.83); unit increases in participants' muscle strength (kg), PR = 0.96 (CI: 0.93–0.99) and gait speed (m/s), PR = 0.27 (CI: 0.10–0.73); and frailty status: non-frail versus frail, PR = 0.37 (CI: 0.17–0.77). An independent association between malnutrition and

frailty was found after adjusting for several additional factors (full Cox regression model, Table 2), whereby non-frail older adults had ~68% lower risk for malnutrition (PR = 0.32 [CI: 0.12–0.83]), when compared to frail participants.

### Overlapping prevalence of malnutrition and frailty

Almost half (75; 43.1%) of the participants had coexisting malnutrition and frailty, 65 (37.4%) were either frail or malnourished and the remaining 34 (19.5%) were neither malnourished nor frail. Figure 2 illustrates the coexistence of malnutrition and frailty. Ninety percent of the malnourished participants were identified as frail and 55% of frail participants were malnourished.

### Discussion

This study reports the prevalence of both malnutrition and frailty at admission to residential aged care in the Waitemata DHB. The prevalence of malnutrition (48%) and frailty (76%) in the current study is similar to other observations among residential aged care residents, where up to 50% of older

Table 1. Participant characteristics by malnutrition and frailty status

Characteristics	Total N = 174	Malnutrition status		P value	Frailty status		P value
		Not malnourished <sup>a</sup>	Malnourished		Not frail <sup>a</sup>	Frail	
Gender							
Total N = 174		91 (52.3)	83 (47.7)		42 (24.1)	132 (75.9)	
Men	68 (39.1)	37 (54.4)	31 (45.6)	0.655	19 (27.9)	49 (72.1)	0.348
Women	106 (60.9)	54 (50.9)	52 (49.1)		23 (21.7)	83 (78.3)	
Age (years)							
Mean ± s.d.	85.5 ± 7.5	84.7 ± 7.5	86.4 ± 7.4	0.133	83.5 ± 7.5	86.1 ± 7.4	0.044*
BMI (kg/m <sup>2</sup> ) <sup>b</sup>							
Median (IQR)	22.2 (6.8)	23.1 (6.5)	20.5 (7.3)	0.002*	22.2 (7.7)	22.1 (6.7)	0.632
Ethnicity							
NZ European	111 (63.8)	56 (50.5)	55 (49.5)	0.517	22 (19.8)	89 (80.2)	0.077
'Other' ethnicities <sup>c</sup>	63 (36.2)	35 (55.6)	28 (44.4)		20 (31.7)	43 (68.3)	
Marital status							
Married/ Partnered	59 (33.9)	29 (49.2)	30 (50.8)	0.552	10 (16.9)	49 (83.1)	0.112
Single <sup>d</sup>	115 (66.1)	62 (53.9)	53 (46.1)		32 (27.8)	83 (72.2)	
Education							
Tertiary	41 (23.6)	18 (43.9)	23 (56.1)	0.319	7 (17.1)	34 (82.9)	0.349
Secondary	104 (59.8)	55 (52.9)	49 (47.1)		29 (27.9)	75 (72.1)	
Primary	29 (16.7)	18 (62.1)	11 (37.9)		6 (20.7)	23 (79.3)	
Income source							
Pension plus other income	42 (24.3)	16 (38.1)	26 (61.9)	0.030*	9 (21.4)	33 (78.6)	0.621
Pension only income	131 (75.7)	75 (57.3)	56 (42.7)		33 (25.2)	98 (74.8)	
Living arrangements prior to admission							
Lived with others	84 (48.3)	39 (46.4)	45 (53.6)	0.134	14 (16.7)	70 (83.3)	0.026*
Lived alone or spouse only <sup>e</sup>	90 (51.7)	52 (57.8)	38 (42)		28 (31.1)	62 (68.9)	
ADL disability prior to admission							
Not disabled	47 (27.0)	32 (68.1)	15 (31.9)	0.011*	18 (38.3)	29 (61.7)	0.008*
Disabled for ≥1 ADL	127 (73.0)	59 (46.5)	68 (53.5)		24 (18.9)	103 (81.1)	
Prior setting							
Community	114 (65.5)	66 (57.9)	48 (42.1)	0.042*	33 (28.9)	81 (71.1)	0.041*
Hospital	60 (34.5)	25 (41.7)	35 (58.3)		9 (15.0)	51 (85.0)	
Type of admission							
Short-term <sup>f</sup>	44 (25.3)	28 (63.6)	16 (36.4)	0.082	10 (22.7)	34 (77.3)	0.8

(Continued)



Table 1. (Continued)

			Malnutrition status		P value	Frailty status		P value
			Not malnourished <sup>a</sup>	Malnourished		Not frail <sup>a</sup>	Frail	
Permanent	130 (74.7)	63 (48.5)	67 (51.5)			32 (24.6)	98 (75.4)	
Residential aged care level of care								
Rest home	98 (56.3)	66 (67.3)	32 (32.7)		<0.001*	32 (32.7)	66 (67.3)	0.003*
Hospital	76 (43.7)	25 (32.9)	51 (67.1)			10 (13.2)	66 (86.8)	
Dental status								
Dentate	50 (28.7)	30 (60.0)	20 (40.0)		0.197	12 (24.0)	38 (76.0)	0.978
Non-dentate <sup>g</sup>	124 (71.3)	61 (49.2)	63 (50.8)			30 (24.2)	94 (75.8)	
Dysphagia								
No dysphagia	108 (62.1)	62 (57.4)	46 (42.6)		0.084	31 (28.7)	77 (71.3)	0.072
At dysphagia risk	66 (37.9)	29 (43.9)	37 (56.1)			11 (16.7)	55 (83.3)	
MoCA score <sup>h</sup>								
Mean $\pm$ s.d.	14.6 $\pm$ 6.1	14.9 $\pm$ 6.7	14.3 $\pm$ 5.4		0.555	14.2 $\pm$ 7.3	14.8 $\pm$ 5.7	0.657
Cognitive status <sup>h</sup>								
Normal cognition	4 (2.4)	4 (100)	0 (0.0)		0.008*	3 (75.0)	1 (25.0)	0.036*
$\geq$ mild cognitive impairment	115 (68.5)	66 (57.4)	49 (42.6)			29 (25.2)	86 (74.8)	
Incomplete MoCA	49 (29.2)	18 (36.7)	31 (63.3)			8 (16.3)	41 (83.7)	
Number of prescribed medications								
Mean $\pm$ s.d.	6.1 $\pm$ 2.9	5.6 $\pm$ 2.3	6.6 $\pm$ 3.3		0.023*	5.5 $\pm$ 2.4	6.3 $\pm$ 3.0	0.096
Polypharmacy								
$\geq$ 5 prescribed medications	53 (30.5)	29 (54.7)	24 (45.3)		0.673	15 (28.3)	38 (71.7)	0.396
<5 prescribed medications	121 (69.5)	62 (51.2)	59 (48.8)			27 (22.3)	94 (77.7)	
Number of comorbidities								
Mean $\pm$ s.d.	5.7 $\pm$ 2.3	5.5 $\pm$ 2.2	5.8 $\pm$ 2.3		0.457	5.6 $\pm$ 2.4	5.7 $\pm$ 2.2	0.738
<5 comorbidities	61 (35.1)	30 (49.2)	31 (50.8)		0.545	16 (26.2)	45 (73.8)	0.636
$\geq$ 5 comorbidities	113 (64.9)	61 (54.0)	52 (46.0)			26 (23.0)	87 (77.0)	
Nutrition supplements								
Not taking	63 (36.2)	41 (65.1)	22 (34.9)		0.011*	16 (25.4)	47 (74.6)	0.77
Taking <sup>i</sup>	111 (63.8)	50 (45.0)	61 (55.0)			26 (23.4)	85 (76.6)	
Muscle strength <sup>l</sup> (kg)								
Median HGS (IQR)	12.3 (10.5)	14.0 (9.3)	10.4 (11.5)		0.003*	NA	NA	NA
Healthy muscle strength	12 (7.5)	8 (66.7)	4 (33.3)		0.375	NA	NA	NA
Low muscle strength	149 (92.5)	76 (51.0)	73 (49.0)			NA	NA	NA

(Continued)

Table 1. (Continued)

		Malnutrition status		P value	Frailty status		P value
		Not malnourished <sup>a</sup>	Malnourished		Not frail <sup>a</sup>	Frail	
Gait speed <sup>k</sup> (m/s)				<0.001*			
Median (IQR)	0.01 (0.5)	0.28 (0.61)	0.01 (0.23)		NA	NA	NA
Healthy gait	16 (9.8)	15 (93.8)	1 (63.3)	0.001*	NA	NA	NA
Low gait	148 (90.2)	74 (50.0)	74 (50.0)		NA	NA	NA
Frailty status							
Non-frail	42 (24.1)	34 (81.0)	8 (19.0)	<0.001*	NA	NA	NA
Frail	132 (75.8)	57 (43.2)	75 (56.8)		NA	NA	NA

ADL, activities of daily living; BMI, body mass index; HGS, hand grip strength; IQR, interquartile range; MoCA, Montreal Cognitive Assessment; NA, not analysed; variables are components of the outcome measure; NZ, New Zealand; s.d., standard deviation.

Results reported as frequencies *n* (%), unless otherwise indicated. Percentages (%) in the total column are the percentages of the total study sample. All other percentages are percentages total within a characteristics' category.

\*P value significant at  $P < 0.05$ , mean  $\pm$  s.d., independent *t*-test; median (IQR), Mann-Whitney *U*-test; *n* (%), Chi-squared or Fisher's exact.

<sup>a</sup>Non-malnourished: well-nourished *n* = 13; at risk of malnutrition *n* = 78. Non-frail: Robust *n* = 0, pre-frail *n* = 42.

<sup>b</sup>BMI missing data *n* = 32, unwilling or unable to stand on scale.

<sup>c</sup>Other ethnicities: Māori/Pacific *n* = 5, others *n* = 58.

<sup>d</sup>Single: widowed *n* = 8, divorced *n* = 18, single/never married *n* = 13.

<sup>e</sup>*n* = 54 lived with spouse only.

<sup>f</sup>Short-term: interim care *n* = 15, respite care = 29.

<sup>g</sup>Non-dentate: *n* = 12 were edentulous, *n* = 112 used dental appliances.

<sup>h</sup>*n* = 29 missing data, unwilling to complete the MoCA.

<sup>i</sup>Average number of nutrition supplements taken *n* = 1.

<sup>j</sup>*n* = 10 missing data.

<sup>k</sup>*n* = 13 missing data.

adults have been reported to be malnourished<sup>19–21</sup> and up to 76% as frail.<sup>27</sup> We also found nearly half (45%) of the participants were at risk of malnutrition and approximately one-quarter (24%) were at risk of frailty (pre-frail). This indicates the substantial proportion of older adults where risk for malnutrition or frailty could be lowered with early screening and effective nutrition or frailty interventions.

Our study shows that 4 in 10 (43%) participants were both malnourished and frail at admission to residential aged care. This overlap is similar to the 47% prevalence reported among nursing home residents in Japan, where the coexistence of malnutrition and frailty predicted mortality.<sup>8</sup> The current study found no significant difference in the prevalence of malnutrition or frailty between participants requiring short-term versus permanent admission. Although adults entering short-term residential care are usually considered more independent than those entering residential aged care permanently, our finding suggests that both groups had a significant decline in physical function and nutritional status. During the 7-month data collection period, we identified several participants initially admitted for a short-term placement, who returned for permanent placement. Screening for malnutrition and frailty at admission to residential aged care, regardless of term of placement, will identify these conditions and enable support to be given to people returning to the community. Early identification and intervention may reduce the health burden and risk of complications for both community-dwelling older adults and aged care residents. As most participants (92.5%) were either malnourished (47.7%) or at risk (44.8%), the current study provides evidence for the importance of malnutrition screening at both admission to residential aged care and in all settings, as recommended by the Australian and New Zealand Society for Geriatric Medicine.<sup>15</sup>

Timely screening for malnutrition has some potential workforce and fiscal constraints. The opportunity to screen vulnerable older adults in primary care arises at routine health checks or influenza vaccination and may mitigate decline in nutrition status, especially if it leads to a care plan. Furthermore, in New Zealand, the interRAI (international Resident Assessment Instrument)



Table 2. Factors associated with malnutrition and frailty at admission to residential aged care: Cox regression model

Factors	Malnutrition		Frailty Adjusted*	P value*
	Adjusted*	P value*		
	PR (95% CI)		PR (95% CI)	
ADL disability				
Not disabled (vs. disabled for ≥1 ADL)	0.60 (0.34 – 1.06)	0.079	0.75 (0.50 – 1.14)	0.787
Prior setting				
Community (vs. hospital)	0.82 (0.52 – 1.29)	0.382	0.89 (0.62 – 1.29)	0.538
Type of admission				
Short-term (vs. permanent)	0.66 (0.38 – 1.15)	0.138	0.99 (0.67 – 1.48)	0.966
Residential aged care level of care				
Rest home (vs. hospital)	0.52 (0.33 – 0.83)	0.005**	0.81 (0.57 – 1.15)	0.236
Dental status				
Dentate (vs. non-dentate)	0.84 (0.50 – 1.39)	0.492	1.05 (0.72 – 1.55)	0.789
Dysphagia risk: EAT-10 score	1.02 (0.98 – 1.06)	0.263	1.00 (0.97 – 1.04)	0.954
Cognitive status (MoCA score)	0.99 (0.95 – 1.03)	0.703	1.01 (0.97 – 1.04)	0.719
Number of nutrition supplements	1.16 (0.95 – 1.43)	0.148	0.99 (0.83 – 1.19)	0.922
Muscle strength (kg)	0.96 (0.93 – 0.99)	0.017**	NA	NA
Gait speed (m/s)	0.27 (0.10 – 0.73)	0.010**	NA	NA
Frailty status				
Non-frail (vs. Frail)	0.37 (0.17 – 0.77)	0.008**	NA	NA
Full model† frailty status				
Non-frail (vs. Frail)	0.32 (0.12 – 0.83)	0.019**†	NA	NA

ADL, activities of daily living; CI, confidence interval; EAT-10, Eating Assessment Tool; MoCA, Montreal Cognitive Assessment tool; NA, not analysed: variables are components of the outcome measure; PR, prevalence ratio.

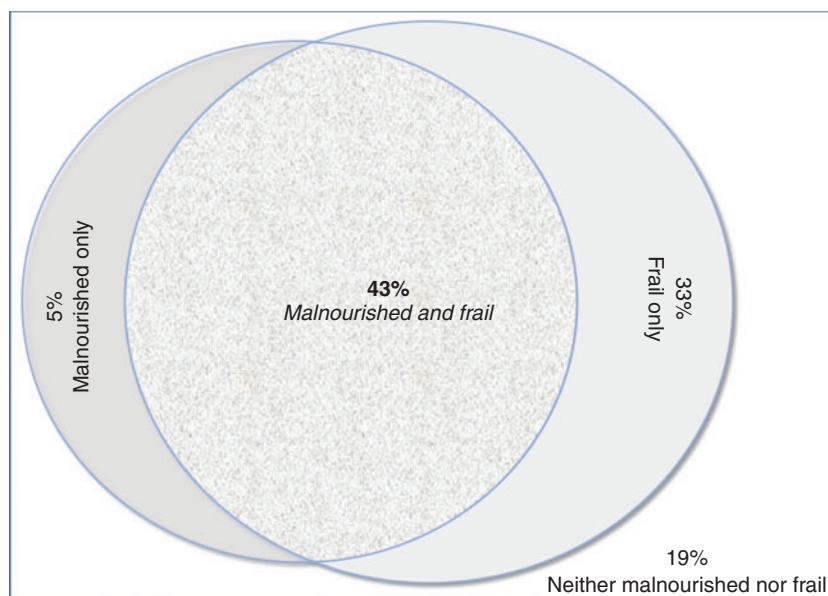
\*P value significant at  $P < 0.05$ , Cox regression analyses. All factors adjusted for age, gender, ethnicity, number of medications and comorbidities.

†Full model: Frailty status adjusted for age, gender, ethnicity, marital status, education, pension income, living arrangements, ADL disability, prior setting, admission type, level of care, dentate or non-dentate, EAT-10 final score, MoCA final score, number of regular prescription medications, number of comorbidities.

has been adopted and mandated as an assessment tool by the Ministry of Health; risk of malnutrition is being assessed as part of the interRAI suite.<sup>44</sup> The adoption of the interRAI occurred after the current study designing, so interRAI data were not collected. However, the interRAI nutrition indicators have a low sensitivity compared to the validated malnutrition screening tools (MNA®SF and SCREENII),<sup>45</sup> so we recommend that a short malnutrition screening tool such as the MNA®SF be administered alongside the interRAI, or at least to improve the sensitivity of the interRAI by changing the BMI cut-off point for detecting malnutrition risk to  $<23 \text{ kg/m}^2$  versus the current  $<20 \text{ kg/m}^2$ . A BMI  $>23 \text{ kg/m}^2$  has been found to have a protective effect in older adults so that cut-off is used in nutrition tools such as the MNA®SF.<sup>18</sup>

The current study demonstrates that after adjusting for several factors, non-frail older adults had ~68% lower risk for malnutrition than frail participants. An independent association between malnutrition and frailty has previously been reported among older adults (mean age 67<sup>46</sup> and 76 years<sup>47</sup>) residing in the community. In our study, malnutrition was found to be associated with low gait speed and low muscle strength (hand grip strength), which are both components of the Fried phenotype.<sup>24</sup> Although the Fried phenotype is the most widely used frailty assessment tool, consensus has not been reached on the gold standard for frailty assessment in older adults.<sup>23</sup> Some studies suggest use of one or two physical performance measures such as hand grip strength,<sup>48</sup> timed up and go and gait speed<sup>49</sup> as adequate markers for frailty. A bi-directional

Figure 2. Coexistence or overlap between malnutrition and frailty at admission to residential aged care.



hazardous relationship exists between malnutrition and frailty. Although malnutrition is a major cause of muscle loss and frailty<sup>50,51</sup> there are several mechanisms by which frailty can also lead to inadequate nutrient and energy intake. Frail older adults may have inadequate muscle strength or mobility<sup>24</sup> for meal preparation and are likely to have low appetite<sup>52</sup> and swallowing difficulties,<sup>53</sup> reducing food intake. Associations between malnutrition and some individual components of physical frailty, including lower physical health related quality of life,<sup>54</sup> low muscle strength<sup>55</sup> and low gait speed,<sup>56</sup> have been reported among older New Zealanders. The current study's findings provide support for co-existence of malnutrition and frailty among older New Zealanders across residential settings.

When adjusting for covariates, no statistically significant associations were found between malnutrition or frailty and potential risk factors including dental status, dysphagia risk, taking nutrition supplements and cognitive status. This is inconsistent with previous observations, where these factors have been associated with malnutrition<sup>22,28</sup> and frailty.<sup>29,57</sup> As our study design included an in-person clinic visit at residential aged care centres, with assessments over ~1 h, older adults with dementia, terminal illnesses or under palliative care

were excluded, and we acknowledge prevalence ratios would have been higher with the inclusion of those conditions. Initial exclusion criteria reduced the number of participants who would have shown pre-existing dysphagia complaints or cognitive impairments. In future, we would like to examine associations of malnutrition and frailty with these high-risk factors.

The following study limitations are noted. Although a snapshot of prevalence and coexistence of malnutrition and frailty at admission to residential aged care is provided, the sample size may not be statistically powered for external generalisability or preventing type two errors (failure to reject a false null hypothesis that there is no association between the risk factors and malnutrition or frailty). This may explain some of the non-statistically significant associations reported. Two-thirds of the participants showed some level of cognitive impairment; the possibility of recall bias cannot be completely ruled out for the assessments that relied on participants' memory. To increase reliability and accuracy of the subjective data collected from participants with some level of cognitive impairment, the data were cross-checked with clinical notes, a family member or a registered nurse at the residential care facility. Although the study design included body composition assessment

using bio-impedance analysis scales, only 42 participants completed this assessment, as most participants had metal implants or were unable to stand still on the scale. In future studies, the use of body composition assessment equipment where older adults lie prone may assist with measurement.

## Conclusion and implications

This study found that at admission to residential aged care, most (93%) older adults were either malnourished (48%) or at risk of malnutrition (45%) and 76% were frail. Four in 10 older adults had both malnutrition and frailty, indicating a wide overlap of the conditions. However, because distinct prevalence ratios were observed (48% for malnutrition and 76% for frailty), this study supports emerging research highlighting the importance of understanding the overlap and distinctiveness of both conditions, to design the most appropriate complementary interventions. Our findings support screening for early identification and intervention at admission to residential care. As two-thirds of the participants were admitted from the community, they may have benefited from screening in primary care to identify and treat malnutrition. Considering the co-occurrence of frailty and malnutrition, appropriate complementary interventions are needed.

## Competing interests

All authors declare no potential conflicts of interest with respect to the research, authorship or publication of this article.

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