CLINICAL INVESTIGATION

Recurrent Measurement of Frailty Is Important for Mortality Prediction: Findings from the North West Adelaide Health Study

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OBJECTIVES: Frailty places individuals at greater risk of adverse health outcomes. However, it is a dynamic condition and may not always lead to decline. Our objective was to determine the relationship between frailty status (at baseline and follow-up) and mortality using both the frailty phenotype (FP) and frailty index (FI).

DESIGN: Population-based cohort.

SETTING: Community-dwelling older adults.

PARTICIPANTS: A total of 909 individuals aged 65 years or older (55% female), mean age 74.4 (SD 6.2) years, had frailty measurement at baseline. Overall, 549 participants had frailty measurement at two time points.

MEASUREMENTS: Frailty was measured using the FP and FI, with a mean 4.5 years between baseline and follow-up. Mortality was matched to official death records with a minimum of 10 years of follow-up.

RESULTS: For both measures, baseline frailty was a significant predictor of mortality up to 10 years, with initially good predictive ability (area under the curve [AUC] = .8-.9) decreasing over time. Repeated measurement at follow-up resulted in good prediction compared with lower (AUC = .6-.7) discrimination of equivalent baseline frailty status. In a multivariable model, frailty measurement at follow-up was a stronger predictor of mortality compared with baseline. Frailty change for the Continuous FI was a significant predictor of decreased or increased mortality risk based on corresponding improvement or worsening of score (hazard ratio = 1.04; 95% confidence interval = 1.02-1.07; P = .001).

CONCLUSIONS: Frailty measurement is a good predictor of mortality up to 10 years; however, recency of frailty measurement is important for improved prediction. A regular review of frailty status is required in older adults. **J Am Geriatr Soc 00:1-7, 2019.**

Key words: frailty; Australia; mortality; longitudinal study; older adults

Frailty represents a state of decreased physiologic reserve that places individuals at a greater risk of adverse outcomes such as disability, institutionalization, and death.[1,2] Despite the negative perceptions associated with frailty, it is possible for frailty status to improve or to remain stable over time.[3,4] This finding is pertinent because interventions exist that may slow or reverse the frailty process.[1,5] The routine assessment of the frailty status of older adults has been highlighted as a key activity in primary care so these interventions might be offered in a timely manner.[6-8]

The two main approaches to describing frailty are the frailty phenotype (FP) that defines frailty as a biological syndrome based on five physical variables,[9] and the accumulation of deficit approach that represents the proportion of deficits present across a range of systems and is represented as a frailty index (FI).[10] A number of studies examined the relationship between frailty and mortality, and they identified that when compared with non-frail individuals, those classified as frail by either the FP or FI have a greater risk of death.[2,11-14] The method of frailty measurement has an impact on both frailty prevalence and mortality risk, with the more encompassing definition of the FI generating a higher prevalence.[2] Additionally, there is a cumulative effect where the presence of an increased number of deficits is associated with greater mortality risk.[13]

Frailty was identified as a significant long-term predictor of mortality, with predictive strength best over a shorter

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follow-up,[2] potentially due to the dynamic nature of frailty where change is likely over time.[12] The relationship between change in frailty classification and mortality was explored in single studies for the FP[15] and the FI.[16] Although clinicians increasingly recognize the need for assessing frailty status,[8] review of frailty status following intervention requires just as much attention. Understanding the relationship between changing frailty status and mortality may help provide the evidence base that clinicians need to be convinced that both assessment and review of frailty status may be of benefit to their patients.

The aim of this study was to examine the predictive ability of frailty classification on mortality over 10 years and the effect of recency of frailty measurement (at follow-up 4.5 y later) on mortality prediction for both the FP and FI in the North West Adelaide Health Study (NWAHS).

METHODS

Sample

This study is a secondary analysis of the NWAHS, a longitudinal population survey consisting of community-dwelling adults randomly selected from households in the northwest region of metropolitan Adelaide.[17] Participants attended a clinic and completed a written and telephone survey for each study stage. Because the probability of selection was known, data were weighted to the area population. The South Australia Health Human Research Ethics Committee (reference no. HREC/15/TQEH/61) provided ethics approval for this study.

The baseline cohort of this study included participants aged 65 years or older who completed stage 2 (2004-2006) (baseline). We excluded participants who had a FP score with fewer than three valid responses or a FI with fewer than 27 (20% missing) valid responses at baseline. To examine the effect of recency of frailty measurement, we analyzed a returning sample of participants who attended both stage 2 (baseline) and stage 3 (2008-2010) (follow-up) with the same exclusion criteria for FP and FI valid responses as at baseline. Participant mortality information was drawn from data matched to official death records and used to calculate number of years survived from follow-up, with all participants having a minimum of 10 years of follow-up from baseline.

Frailty Phenotype

A modified FP was used in this study with identical variables used at baseline and follow-up (Table S1). Three iterations of the FP were used: a Continuous FP; a 5-Category FP (0 characteristics, 1 characteristic, 2 characteristics, 3 characteristics, 4-5 characteristics); and a 3-Category FP (individuals with three or more characteristics were classified as frail; those with one or two characteristics were classified as pre-frail; and those with no characteristics present were non-frail).[9] The modified FP used in NWAHS was described previously.[18] Although the FP was originally designed as a categorical variable, it has been used in continuous form.[18,19]

Frailty Index

We developed a 34-item FI following a standard methodology[20] (Table S1). Three iterations of the FI were used: a Continuous FI; a 10% Increment FI (0-10%, 10-20%, 20-30%, 30-40%, 40-50%, and >50% proportion of deficits); and a 3-Category FI (>.21 proportion of deficits = frail; .10 and .21 = pre-frail; and <.10 non-frail). The FI used in NWAHS was described previously.[18]

Data Analysis

We used SPSS v.23 software (IBM Corp, Armonk, NY) for all statistical analysis. Cohort case weights were used in analysis and for reporting percentages to ensure the sample was representative of the population of North West Adelaide. Weighting was rescaled to sum to the sample size for the returning sample to adjust for attrition. An α value of .05 was used for determining statistical significance. Participants in the cohort were matched against death records to determine the time of death. All-cause mortality was analyzed. Descriptive characteristics and the number and proportion of participants classified as non-frail, pre-frail, and frail were reported according to mortality rate at 1, 2, 4, 6, 8, and 10 years from baseline. State transitions including participants lost to follow-up were reported. Complex samples procedures were used in SPSS to allow for the effect of the sample design on the standard error of estimates. We performed significance testing of cross-tabs using a Pearson χ^2 test and tests for linear by linear association. Survival was modeled using complex samples Cox regression to allow for the design of the sample, and we reported the hazard ratio. Multivariable analysis included combined frailty classification at baseline and follow-up, sex, age group, education level, and income level. A predictive probability of surviving 1, 2, 4, 6, 8 and 10 years from baseline was generated through logistic regression to generate an area under the curve (AUC) value for frailty classification at baseline as well as at follow-up.

RESULTS

This study included 909 participants (mean age = 74.4 [SD 6.2] y; 55% female) at baseline (Table 1). We excluded 36 participants from analysis at baseline due to insufficient FI or FP variables. For the returning cohort analysis, we included 549 participants who had frailty measurement at both stages 2 and 3. Of those excluded from the returning cohort, 147 had died between baseline and follow-up, and a further 213 were either lost to follow-up or had insufficient FI or FP variables. The 360 participants excluded from the returning cohort were significantly more likely to be older (mean age = 76.9 [SD 6.2] y), have lower income status, and higher baseline frailty prevalence (FP = 29.1% frail; FI = 62.0% frail) than the whole sample (Table S2). All participants at baseline had a minimum of 10 years of survival data.

Over a 10-year period, 292 (33.8%) participants died, with men having significantly higher mortality rates (40.1%) compared with their female counterparts (28.6%) (Table 1, Figure 1, and Table S3). Likewise, for older age group, 10-year mortality for those aged 75 years or older (54.3%) was significantly higher than for those aged 65 to 74 years (17.8%). Low-income category was also significantly associated with mortality at the 10-year mark, at 35.5% for the lowest income group compared with 11.6% for the higher group.

The 3-Category FP classified 18.3% of participants as frail at baseline; 48.1% were frail according to the 3-Category FI. Mortality was significantly higher for increasing levels of

Table 1. Descriptive Characteristics of Sample at Baseline and Frailty Status for the Frailty Phenotype and Frailty Index

	Whole sample n (%) 909	3-Category FP, n (%)			3-Category FI, n (%)		
		Non-frail 289 (30.1)	Pre-frail 470 (51.6)	Frail 150 (18.3)	Non-frail 211 (21.5)	Pre-frail 285 (30.4)	Frail 413 (48.1)
Sex							
Male	453 (45.2)	165 (36.5)	229 (50.2)	59 (13.3)*	124 (27.0)	151 (34.1)	178 (38.9)*
Female	456 (54.8)	124 (24.8)	241 (57.2)	91 (22.5)	87 (16.9)	134 (27.4)	235 (55.7)
Age groups, y							
65-74	554 (56.3)	204 (35.7)	295 (53.4)	55 (10.8)*	147 (26.1)	192 (33.9)	215 (40.0)*
≥75	355 (43.7)	85 (22.8)	175 (49.2)	95 (28.0)	64 (15.5)	93 (25.9)	198 (58.5)
Education level[a]							
Up to secondary	569 (63.5)	159 (26.9)	308 (52.9)	102 (20.3)*	110 (17.8)	190 (33.3)	269 (48.9)*
Trade/Certificate/Diploma	288 (30.6)	115 (37.0)	133 (49.0)	40 (14.0)	87 (28.1)	80 (25.3)	121 (46.6)
≥Bachelor's degree	25 (2.5)	13 (58.2)	10 (32.9)	2 (8.9)	10 (41.6)	10 (38.4)	5 (19.9)
Income groups[a]							
Up to $20 k	462 (46.5)	117 (23.1)	254 (55.5)	91 (21.4)*	81 (15.6)	144 (30.1)	237 (54.3)*
$20-$40 k	281 (33.5)	117 (41.2)	129 (44.6)	35 (14.2)	87 (29.1)	93 (32.3)	101 (38.6)
$40-$60 k	59 (6.8)	29 (43.6)	24 (45.3)	6 (11.1)	21 (33.1)	17 (30.4)	21 (36.5)
>$60 k	26 (2.6)	13 (47.1)	12 (49.4)	1 (3.5)	11 (36.8)	10 (39.1)	5 (24.2)

Abbreviations: FI, frailty index; FP, frailty phenotype.

Note: n, unweighted; % reported using cohort case weights. The 3-Category FP, no. of characteristics: 0, non-frail; 1-2, pre-frail, ≥3, frail; 3-Category FI, proportion of deficits: 0 to ≤.10, non-frail; >.10 to ≤.21, pre-frail; >.21, frail.

*$P < .05$ (main effects reported).

[a]Missing nor included.

frailty for both the FP and FI. For the 3-Category FP, 60.2% of individuals classified as frail had died at 10 years compared with 26.3% of those who were non-frail. Of those classified as frail by the 3-Category FI, 45.1% had died at 10 years, in comparison with 21.4% of non-frail individuals. Frailty state transitions for this cohort are presented in Table S4 and were discussed in detail elsewhere.[4]

FP and FI classification at baseline significantly predicted the probability of surviving 1, 2, 4, 6, 8, and 10 years from baseline (Table 2) through AUC analysis. Mortality prediction was strongest at 1 year with good discrimination (AUC = .8-.9) for all iterations of FP and FI measures: All iterations retained acceptable discrimination (AUC = .7-.8) at 2 and 4 years and low (AUC: .6-.7) but significant prediction of mortality at 6, 8, and 10 years. Repeated frailty measurement at follow-up, for the returning cohort of 563 participants, resulted in good discriminative ability for all iterations of the FP and FI at 6, 8, and 10 years from baseline (that equates to approximately 2, 4, and 6 years post follow-up), compared with low discrimination for equivalent baseline measurement (Table 2).

In a multivariable model that included frailty status at both baseline and follow-up for the returning sample of 563 participants, frailty measurement at follow-up, but not at baseline, was significantly associated with mortality for all iterations of the FP and the 3 Category FI; however, both time points were significant for the Continuous FI and the 10% Increment FI (Table 3). The significant negative coefficient for the latter measures at baseline is a masked result due to possible suppression by the stronger predictor at follow-up. Addressing this by including frailty change (Continuous FI: follow-up minus baseline) in the model, each 1% improvement or worsening in the Continuous FI was associated with a corresponding 4% significant increase or decrease, respectively, in mortality risk (hazard ratio [HR] = 1.04; 95% confidence interval [CI] = 1.02-1.07; $P = .001$). The Continuous FI at follow-up remained a significant mortality predictor in this model. Analysis of the returning sample examining baseline and follow-up frailty classification separately illustrated the stronger association between follow-up frailty measurement and mortality in comparison with baseline measurement (Tables S5, S6, and S7).

Compared with a reference category of 0 characteristics, significant elevated mortality risk was identified at three characteristics for the 5-Category FP at follow-up (HR = 2.97; 95% CI = 1.33-6.63; $P = .008$). For the 10% increment FI, with a reference category of 0% to 10%, a marginally significant elevation of mortality risk was observed for a 10% to 20% proportion of deficits at follow-up (HR = 2.55; 95% CI = 1.00-6.46; $P = .49$), and significant for the 20% to 30% proportion (HR = 4.82; 95%CI = 1.83-12.69; $P = .002$). HRs at higher proportions of characteristics/deficits increased exponentially and were highly significant for both the FP and FI.

DISCUSSION

Frailty classification was a significant predictor of mortality up to 10 years in this cohort of community-dwelling Australian older adults, with predictive ability strongest immediately after measurement and gradually decreasing over time. Mortality prediction was improved by repeated frailty measurement at follow-up.

Approximately one-third of participants died over 10 years, with mortality significantly higher for men, those in the older age group (≥75 y), and those on the lowest income group (<$20 000 per annum), consistent with other studies.[2,12,21]

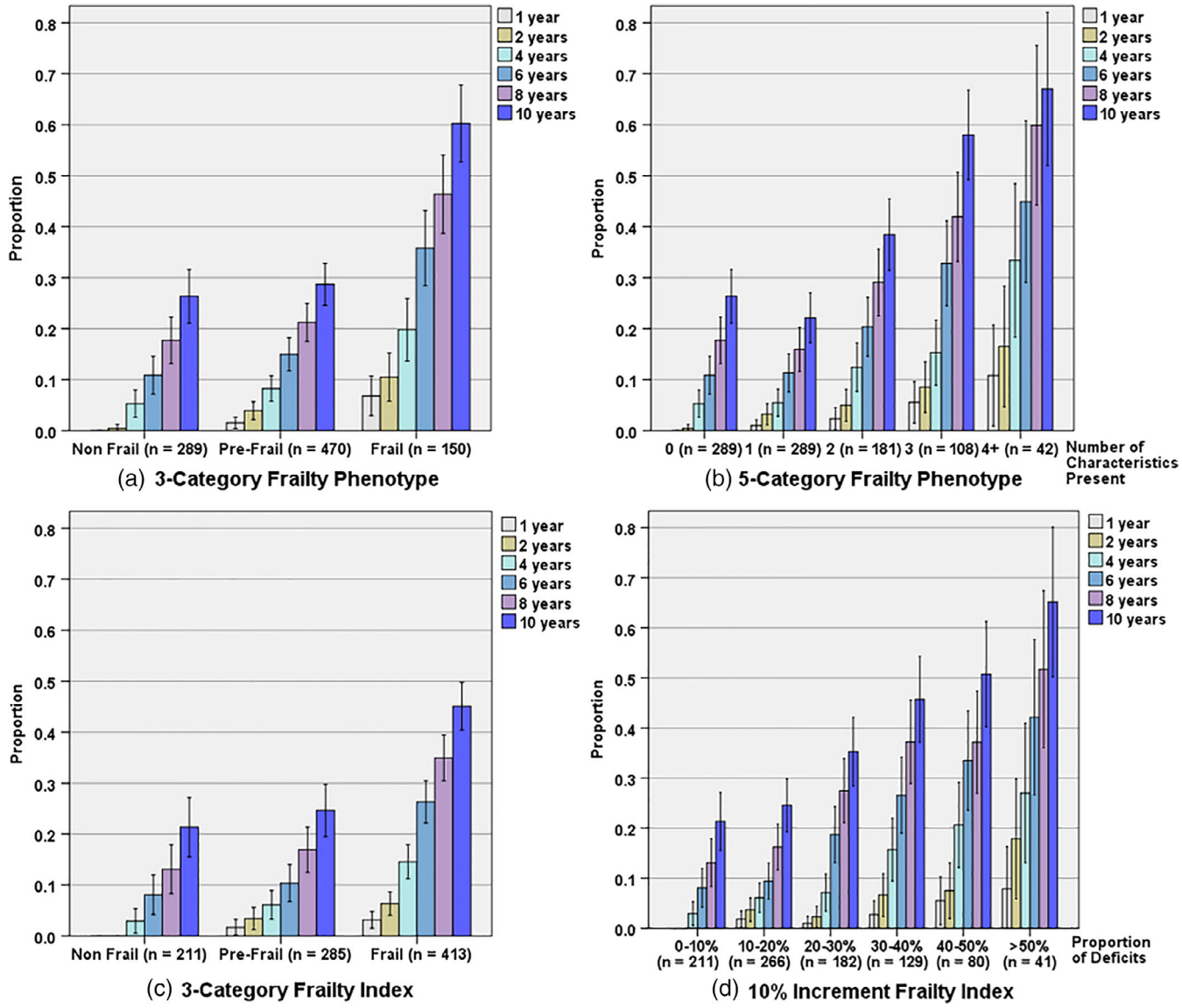

Figure 1. Mortality rates (proportion dead) over 10 years by baseline frailty status for the frailty phenotype (FP) and frailty index (FI). Proportions reported using cohort case weights. Error bars represent 95% confidence intervals. Note: 3-Category FP, no. of characteristics present: 0, non-frail; 1-2, pre-frail, ≥3, frail; 5-Category FP, no. of characteristics present: 0, 1, 2, 3, 4-5; 3-Category FI, proportion of deficits: 0 to ≤.10, non-frail; >.10 to ≤.21, pre-frail; >.21, frail; 10% Increment FI: 0%-10%, 10%-20%, 20%-30%, 30%-40%, 40%-50%, >50%.

We examined various iterations of the FP (Continuous, 5-Category, and 3-Category) and the FI (Continuous, 10% Increment, and 3-Category) with 18.3% of individuals classified as frail by the 3-Category FP and 48.1% by the 3-Category FI. Both frailty measures in all their iterations demonstrated significant discriminative ability in predicting mortality over 10 years, with AUC prediction initially excellent (AUC = .8-.9), decreasing incrementally over time to low (AUC = .6-.7).[22] Frailty measurement for all iterations of the FP and FI at follow-up had excellent discriminative ability for mortality, compared with the low AUC of corresponding baseline measurements. This finding is consistent with the literature, where the strongest association with mortality is immediately after the frailty measurement, remaining predictive up to 11 years.[2] These findings are likely due to the dynamic nature of frailty where individuals are more likely to worsen with increasing age; hence mortality prediction is better over shorter follow-up periods.[12]

When we examined each iteration of the FP and the FI in multivariable analysis that included both baseline and follow-up measurement, frailty measurement at follow-up, but not at baseline, was significantly associated with mortality for all iterations of the FP and the 3-Category FI; measurements at both time points were significant for the Continuous FI and 10% Increment FI. The separate analysis of the returning sample also illustrated the stronger association of follow-up measurement, countering the effect of bias of being more likely to lose those who were frail at baseline.

Frailty change (between baseline and follow-up) for the Continuous FI was a significant predictor of decreased or increased mortality risk in this study based on corresponding improvement or worsening of frailty, consistent with the

Table 2. Discriminative Ability of Frailty Phenotype and Frailty Index at Baseline and at Follow-up for Predicting Mortality[a]

	AUC (95% CI)					
Whole sample (n = 909)	**1 y**	**2 y**	**4 y**	**6 y**	**8 y**	**10 y**
FP at baseline						
Model 1: Continuous FP	.87 (.81-.94)*	.78 (.71-.85)*	.73 (.68-.79)*	.68 (.63-.73)*	.66 (.62-.71)*	.67 (.62-.71)*
Model 2: 5-Category FP	.87 (.80-.93)*	.78 (.71-.85)*	.73 (.68-.80)*	.69 (.64-.74)*	.67 (.63-.72)*	.67 (.63-.71)*
Model 3: 3-Category FP	.85 (.77-.93)*	.77 (.69-.84)*	.71 (.66-.78)*	.68 (.63-.73)*	.67 (.62-.71)*	.66 (.62-.71)*
FI at baseline						
Model 4: Continuous FI	.83 (.74-.92)*	.76 (.69-.84)*	.73 (.67-.79)*	.68 (.63-.73)*	.65 (.61-.70)*	.66 (.62-.70)*
Model 5: 10% Increment FI	.82 (.73-.92)*	.79 (.72-.86)*	.76 (.71-.81)*	.71 (.66-.76)*	.68 (.64-.73)*	.68 (.64-.72)*
Model 6: 3-Category FI	.80 (.70-.90)*	.75 (.68-.83)*	.73 (.68-.79)*	.70 (.65-.74)*	.68 (.64-.72)*	.68 (.64-.72)*
Returning sample (n = 549) [b]						
FP at follow-up				1.6 y[c]	3.6 y[c]	5.6 y[c]
Model 1: Continuous FP	-	-	-	.85 (.80-.91)*	.82 (.76-.88)*	.80 (.74-.85)*
Model 2: 5-Category FP	-	-	-	.88 (.83-.94)*	.84 (.78-.90)*	.80 (.75-.85)*
Model 3: 3-Category FP	-	-	-	.87 (.83-.91)*	.83 (.77-.88)*	.79 (.73-.84)*
FI at follow-up						
Model 4: Continuous FI	-	-	-	.87 (.82-.92) *	.82 (.77-.87)*	.80 (.75-.85)*
Model 5: 10% Increment FI	-	-	-	.87 (.82-.92)*	.85 (.80-.89)*	.81 (.76-.86)*
Model 6: 3-Category FI	-	-	-	.85 (.80-.89)*	.83 (.78-.87)*	.80 (.75-.85)*

Abbreviations: AUC, area under the curve; FI, frailty index; FP, frailty phenotype.

Note: 5-Category FP, no. of characteristics: 0, 1, 2, 3, 4-5; 3-Category FP, no. of characteristics: 0, non-frail; 1-2, pre-frail, ≥3, frail; 10% Increment FI: 0%-10%, 10%-20%, 20%-30%, 30%-40%, 40%-50%, >50%; 3-Category FI (proportion of deficits): 0 to ≤.10, non-frail; >.10 to ≤.21, pre-frail; >.21, frail.

*$P < .001$.

[a]AUC for years survived from baseline. Adjusted for age, sex, education, and income. Follow-up mean = 4.5 years.

[b]AUC for the returning sample at follow-up is based on survival years from baseline.

[c]Mean years between follow-up measurement and survival years from baseline.

findings of Chamberlain and colleagues.[16] Although not significant in this study, worsening of FP status was identified elsewhere with increased mortality risk.[15] The FI was described as being more sensitive to change and having more precise mortality risk prediction compared with the FP due to its more comprehensive nature.[12,16]

The findings of our research for the FP were consistent with those of the original FP study in which three characteristics was identified as a significant cut point for elevated mortality risk,[9] and furthermore, that each increase in the number of FP characteristics is associated with elevated mortality risk.[23]

However, our finding that those classified as frail by the 3-Category FP at follow-up had over triple the mortality risk compared with those who were non-frail was slightly higher than that of a systematic review by Chang and Lin[11] (pooled HR = 2.00) but was within the range of included studies. The FP has good predictive ability of mortality, and with only five variables for measurement, this approach is clinically feasible but limited in terms of the scope of characteristics measured compared with the FI.[23]

Likewise, our findings for the FI reflected those of other studies that demonstrated a dose-response relationship between higher proportions of FI deficits of worse survival.[10,14,24,25] In this study, the 7% increase in mortality risk for each 1% increase in proportion of deficits at follow-up for the Continuous FI was higher than the pooled risk of 4% per 1% increase in FI described in a systematic review by Kojima and colleagues.[12] However, it was within the upper range of studies included in that review. The FI was described as both pragmatic and flexible in terms of frailty measurement, and its graded system of measurement as valuable in providing a more sensitive risk prediction for adverse health outcomes.[12,25] The higher mortality rates for the FP and FI in this study may be associated with the lower socioeconomic status (SES) of the NWAHS region compared with the Australian population.[26] The use of routinely collated data from electronic health records in both the primary care and acute settings are likely to enhance the feasibility of automated repeat measurements of frailty,[27,28] and evolving wearable technologies may provide real-time data on the dynamic nature of the frailty syndrome.[29,30] These developments call for a new generation of dynamic frailty studies.

Strengths of this study were the use of population-based data for both the FP and FI, and 10 years of follow-up matched to official death records. Limitations of this study included a lack of some aging-specific variables such as walking speed or cognitive impairment in the data set, the use of a modified FP, and the lower SES of the NWAHS in comparison with the broader Adelaide metropolitan area. Additionally, the inclusion of only community-dwelling participants in this study, and the exclusion of 360 participants from the returning cohort who were more likely to be older, have lower income status, and higher baseline frailty prevalence than those included, is likely to have resulted in an underestimation of frailty prevalence at baseline and follow-up, and it may have weakened the mortality prediction for frailty at follow-up. Furthermore, the 4.5-year interval between baseline and follow-up allows the effect of time to become more evident with participants in the returning sample more likely

Table 3. Frailty Classification (FP and FI) at Baseline and Follow-Up and Mortality Risk (Hazard Ratio) for the Returning Sample[a]

Returning sample (n = 549)	Baseline		Follow-up	
FP	aHR (95% CI)	*P* value	aHR (95% CI)	*P* value
Model 1: Continuous FP per 1 score	.96 (.76-1.21)	.741	1.59 (1.27-2.00)	<.001*
Model 2: 5-Category FP				
0 characteristics (n = 207)	1	-	1	-
1 characteristic (n = 188)	.86 (.47-1.58)	.623	.91(.45-1.86)	.804
2 characteristics (n = 100)	.68 (.33-1.40)	.297	1.98 (.96-4.07)	.063
3 characteristics (n = 45)	1.05 (.47-2.37)	.899	2.97 (1.33-6.63)	.008*
4-5 characteristics (n = 9)	.62 (.14-2.66)	.515	6.24 (2.47-15.81)	<.001*
Model 3: 3-Category FP				
Non-frail (n = 207)	1	-	1	-
Pre-frail (n = 288)	.90 (.53-1.55)	.713	1.28 (.69-2.37)	.426
Frail (n = 54)	1.16 (.55-2.43)	.696	3.35 (1.65-6.79)	.001*
FI				
Model 4: Continuous FI per .01 score	.96 (.94-.98)	<.001*	1.07 (1.04-1.09)	<.001*
Model 5: 10% increment FI				
0%-10% (n = 160)	1	-	1	-
10%-20% (n = 177)	.62 (.31-1.24)	.178	2.55 (1.00-6.46)	.049*
20%-30% (n = 106)	.63 (.29-1.40)	.261	4.82 (1.83-12.69)	.002*
30%-40% (n = 59)	.46 (.18-1.18)	.105	5.53 (1.92-15.95)	.002*
40%-50% (n = 36)	.31 (.10-.98)	.047*	9.52 (3.16-28.69)	<.001*
>50% (n = 11)	.30 (.06-1.51)	.144	21.62 (6.11-76.47)	<.001*
Model 6: 3-Category FI				
Non-frail (n = 160)	1	-	1	-
Pre-frail (n = 191)	.67 (.34-1.33)	.251	2.42 (.95-6.15)	.063
Frail (n = 198)	.72 (.35-1.49)	.373	6.08 (2.38-15.57)	<.001*

Abbreviations: aHR, adjusted hazard ratio; CI, confidence interval; FI, frailty index; FP, frailty phenotype.

Note: 5-Category FP, no. of characteristics: 0, 1, 2, 3, 4-5; 3-Category FP, no. of characteristics: 0, non-frail; 1-2, pre-frail, ≥3, frail; 10% Increment FI: 0%-10%, 10%-20%, 20%-30%, 30%-40%, 40%-50%, >50%; 3-Category FI, proportion of deficits: 0 to ≤.10, non-frail; >.10 to ≤.21, pre-frail; >.21, frail. The follow-up window for mortality was from study entry over the period 2004-2006 to a censoring date of September 30, 2016 (minimum of 10 y of mortality data for all participants).

*$P < .05$.

[a]Weighted multivariable analysis adjusted for frailty at both time points, age, sex, education, and income.

to have higher levels of frailty at follow-up, which is to be expected for an aging cohort. Additionally, the Continuous FP is an ordinal measure that does not fulfill the preconditions of most parametric statistical tests; however, nearly all articles treat this as a continuous measure, as we have done.

In conclusion, this study identified that recency of frailty measurement is important for predicting survival. Although frailty measurement was a significant predictor of mortality risk up to 10 years, recency of measurement was a stronger predictor. Routine assessment of frailty in older adults was highlighted as important in the clinical setting,[7,8] which can feasibly be measured using routinely collected data.[6,27,28] The findings from this study have implications for the clinical setting where a more recent frailty assessment is likely to provide the best information about the health status of older adults, taking into account the dynamic nature of the frailty condition and that regular reevaluation is necessary to keep this frailty profile up to date.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article.

Table S1: Frailty Phenotype and Frailty Index Variables.

Table S2: Baseline Descriptive Characteristics and Frailty Classification of Participants Who Died Before July 31, 2018, or Who Were Lost to Follow-Up.

Table S3: Mortality Rates by Baseline Descriptive Characteristics, Frailty Status for the Frailty Phenotype (FP) and Frailty Index (FI).

Table S4: Frailty Status at Baseline and Follow-Up Status for the 3-Category Frailty Phenotype and Frailty Index

Table S5: Mortality Rates by Baseline Descriptive Characteristics, Frailty Status (Frailty Phenotype [FP] and Frailty Index [FI]) for the Returning Sample (n = 549).

Table S6: Frailty Classification (Frailty Phenotype and Frailty Index) at Baseline and Follow-Up and Mortality Risk (Hazard Ratio) for the Returning Sample (n = 549). Baseline and Follow-Up Frailty Classification are Considered separately. Weighted multivariable analysis adjusted for age, sex, education, and income.

Table S7: Frailty Classification (Frailty Phenotype and Frailty Index) at Baseline and Mortality Risk (Hazard Ratio) for the Whole Sample (n = 909). Weighted Multivariable Analysis Adjusted for Age, Sex, Education, and Income.