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Development of a Frailty Measure for Older Adults: The Frailty Index for Elders

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Background and Purpose: Frailty is a significant challenge for health care. Therefore, it is important to identify frail individuals. Theoretical Framework: The Vulnerability/Risk/Human Response/Care Model. The purpose of this study was to develop and validate a measure to identify frail older adults. Methods: Instrument development encompassed the following: delineation of content domains, item generation, content validity, quantitative content validity analysis, and psychometric analysis. Results: Findings indicated the following: (a) Frailty is a complex concept, (b) the Frailty Index for Elders (FIFE) is composed of 10 items, (c) FIFE was able to predict depression, and (d) FIFE was able to differentiate differences in demographic profiles by social support environment. Conclusions: FIFE is a valid instrument. FIFE can be used to study the relationships among frailty determinants, provide standardized measurement, and develop and measure interventional studies.

Keywords: instrument development; frailty; elderly; older adults

The term *frailty* is often used within the field of geriatrics to describe older adults who are in poor health and vulnerable to stressors resulting in worsening morbidity, disability, and mortality. Although considered to be an easily recognized geriatric syndrome, there is no universal definition, thus challenging the ability to characterize frailty. Initial conceptual and operational definitions of frailty focused on physiological causes of frailty (Brown, Sinacore, Binder, & Kohrt, 2000; Dayhoff, Suhrheinrich, Wigglesworth, Topp, & Moore, 1998; Fried et al., 2001). As the concept has evolved, researchers have recognized frailty as a multifactorial paradigm and have included psychological and social domains in its measurement. Inclusion of multiple health domains

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supports the central tenet that frailty is an accumulation of decrements that affect multiple systems (Ahmed, Mandel, & Fain, 2007; Bortz, 2002; Campbell & Buchner, 1997; Fried et al., 2001; Lally & Crome, 2007; Rockwood, Fox, Stolee, Robertson, & Beattie, 1994).

The effect of multiple system decrements is a heightened vulnerability to stressors that increase morbidity and mortality. The health trajectory of frail older adults is of a slow decline, with steadily progressive disability. As the older adult population increases, society will experience the burden of increasing numbers of frail older adults. These frail individuals will have a substantial need for support and interventions. Therefore, it is important to develop an instrument to identify individuals as frail or at risk for frailty. A valid frailty instrument would allow clinicians to rapidly initiate intervention programs to minimize risk of poor outcomes. Without the ability to screen and assess older adults for frailty, effective management and coordination of health team member efforts to prevent the downward trajectory of disability and mortality will be thwarted. A valid frailty measure is also needed to aid researchers in the development and application of interventions to prevent or reverse frailty. The purpose of this study was to develop and validate a measure to identify frail older adults.

BACKGROUND AND CONCEPTUAL FRAMEWORK

Background

The development of instruments to measure frailty has been limited to geriatric research and practice. A prominent frailty measure, the Phenotype of Frailty (Fried et al., 2001), is one-dimensional and addresses only physiological components. Several frailty measures were developed to include physiological and psychosocial domains of frailty. These measures require multidimensional clinical data from a comprehensive geriatric assessment and have limited applicability to research or geriatric practices (Jones, Song, Mitnitski, & Rockwood, 2005; Kulminski et al., 2008; Rockwood, 2005; Searle, Mitnitski, Gahbauer, Gill, & Rockwood, 2008; Studenski et al., 2004). Presently, there are no measures using nursing assessment data to identify older adults as frail, leaving us unable to thwart a potentially reversible condition. The ability to identify frailty profoundly enhances preventative, treatment, and care management of persons who are at risk for frailty or who are frail. A valid, reliable, and concise frailty measure is essential for public health and for all providers who work with older adults. It allows for the identification of health factors that predispose an older adult to frailty as well as the development of preventative and treatment interventions.

Conceptual Framework

The Vulnerability/Risk/Human Response/Care (VRHR) Model (Figure 1) provided the theoretical framework for this study (Steele & Shaver, 1992).

This framework was chosen because it recognizes the multidimensional aspects of vulnerability and risk/support factors associated with frail older adults and their influence on health outcomes during a change in health status. The framework also allows for different combinations of both vulnerability and risk/support factors that may contribute to an individual's human response during a change in health status. Figure 2 illustrates the operationalization of the VRHR Model.

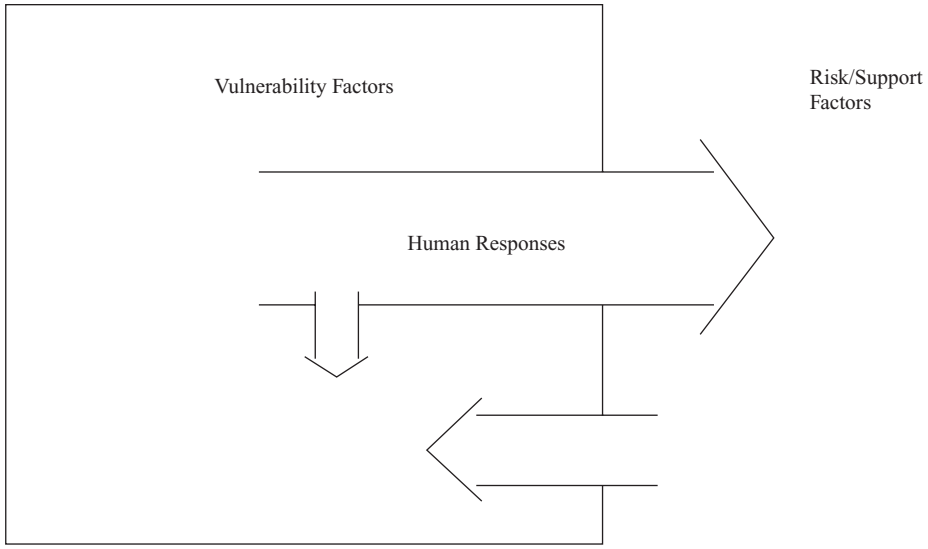

Figure 1. Vulnerability/Risk/Human Response/Care Model. Adapted from Steele, B., & Shaver, J. (1992). The dyspnea experience: Nociceptive properties and a model for research and practice. *Advances in Nursing Science*, *15*, 64–76; Shaver, J. (1985). A biopsychosocial view of human health. *Nursing Outlook*, *33*, 186–191.

METHODS

This study was a cross-sectional design for the development of a multidimensional measure of frailty in older adults. Instrument development included psychometric testing through the use of secondary analysis of data derived from a longitudinal prospective descriptive study ("Health Related Quality of Life: Elders in Long-Term Care," RO1-AG-025524-05, Principal Investigator Mary Naylor, PhD, RN, FAAN), which hence will be referred to as parent study.

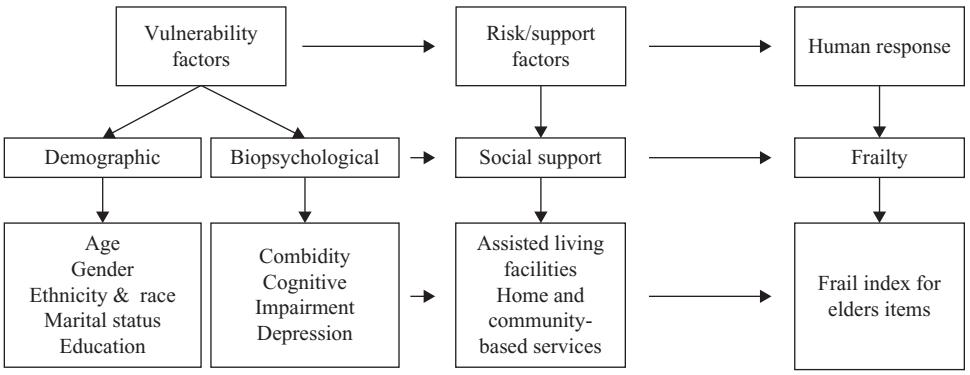

Figure 2. Operationalization of model.

Sample

The sample of older adults was composed of 312 individuals separated into two groups by social support environment: assisted living facility (ALF) and home and community-based care (HCB). The ALF group was composed of 156 individuals newly admitted to an ALF. Participants in the ALF group resided in an environment that had available services to meet functional needs if and when desired. In comparison, the HCB group had 156 participants newly admitted to HCB programs. The HCB group was composed of nursing home–certified older adults who had functional deficits requiring assistance and considered "frail" by regulation guidelines. The composition of the study sample was purposeful. Having a sample of older adults living in two contrasting social support environments allowed for comparison of social support factors that may influence frailty. This design also allowed testing of the ability of the measure FIFE to identify frailty determinants within each group.

The two study samples were heterogeneous in their demographic profiles (see Table 1). Participants in the ALF group were predominantly of older age (≥85 years), were White, had advanced education, had higher income, and had a mean of 10.5 health conditions. The HCB participants were mostly younger than 85 years of age (but older than 65 years of age), were of Hispanic ethnicity or were Black/African American, had low education levels, were of low income (Medicaid-eligible), and had a mean of 5.6 health conditions.

Setting

The settings were located in the metropolitan Philadelphia and New York area and were composed of 30 sites. The settings were 4 visiting nurse agencies providing in-home care and 26 assisted living facilities.

Procedures for Instrument Development

The Frailty Index for Elders (FIFE) was developed following a standardized process to maximize the representation of appropriate content domains within the instrument (DeVellis, 2003; Lynn, 1986). The process encompassed four steps: (a) delineating the content domains, (b) item generation, (c) content validity by an expert panel, and (d) quantitative content validity analysis.

Content Domains. A table of potential domains was produced through a systematic review of the literature. The review yielded 24 articles that conceptualized or measured frailty. Nine of the 24 studies were theoretical with the purpose of enhancing the concept of frailty. The remaining 15 studies were conducted to measure frailty. Most articles were retrieved from gerontological journals and the remainder within epidemiology. There were varying definitions and depictions of frailty among both the conceptual and measurement literature. Early works on frailty focused on physiological and functional domains of frailty and are still prominent in the literature (Abellan van Kan, Rolland, Houles, Gillette-Guyonnet, Soto, & Vallas, 2010; Bandeen-Roche et al., 2006; Bortz, 2002; Chin et al., 1999; Fried et al., 2001). However, the literature acknowledged that geriatric clinicians reported incidents of frailty in the absence of documented physiological or functional decline related to aging. Such empirical evidence and a holistic perspective in geriatrics led some researchers to consider psychosocial factors as triggers for the changes in physical activity associated with frailty. Frailty investigators began incorporating psychological and social domains of frailty after 2001.

TABLE 1. Description of Demographic Profile of Two Health Care Settings

Demographics	Combined Facilities *N* (%)	ALF *n* (%)	HCB *n* (%)
Total participants	312	156 (100)	156 (100)
Gender*			
Female	242 (77.6)	131 (84.0)	111 (71.2)
Male	70 (22.4)	25 (16.0)	45 (28.8)
Age* (years)			
<85	142 (45.5)	44 (28.2)	108 (69.2)
≥85	170 (54.5)	112 (71.8)	48 (30.8)
Ethnicity* (Hispanic)	87 (27.8)	3 (1.9)	84 (53.8)
Race*	311	156 (100)	155 (99.0)
White	188 (60.3)	149 (93.6)	42 (27.1)
Black/African American	65 (20.8)	3 (1.9)	62 (40.0)
Other	58 (18.6)	7 (4.4)	51 (32.3)
Marital Status*	311	156 (100)	155 (99.0)
Single	24 (8.0)	11 (7.1)	13 (8.4)
Married	66 (21.0)	32 (20.5)	34 (21.9)
Widowed	174 (56.0)	103 (66.0)	71 (45.8)
Divorced	29 (9.0)	9 (5.8)	20 (12.9)
Separated	18 (6.0)	1 (0.6)	17 (11.0)
Income*			
$0–9,999	76 (24.0)	3 (3.6)	73 (59.3)
$10,000–19,000	52 (17.0)	12 (14.5)	40 (32.5)
$20,000–29,000	17 (5.0)	14 (16.9)	3 (2.4)
$30,000–39,999	9 (3.0)	6 (7.2)	3 (2.4)
$40,000–49,999	22 (7.0)	21 (25.3)	1 (0.8)
$50,000+	30 (10.0)	27 (32.5)	3 (2.4)
GDS score ≥7*	69 (22.0)	19 (12.2)	50 (32.1)
MMSE ≥23	256 (82.3)	131 (84.0)	125 (77.4)
	Mean (*SD*)		
Education* (Mean years)**	12.00 (5.0)	14.99 (3.3)	8.87 (4.5)
Total no. of conditions**	8.00 (4.0)	10.52 (4.6)	5.64 (2.6)

Note. ALF = assisted living facility; HCB = home and community-based care; GDS = Geriatric Depression Scale; MMSE = Mini-Mental State Examination; *SD* = standard deviation.
*Significance: ≤0.05. ***t*-test findings with mean, standard deviation, and significance.

Consensus of the literature indicated that physiological ($n = 22$) and functional domains ($n = 15$) are essential to the concept of frailty. Slightly less than half ($n = 11$) included psychological dimensions and seven researchers considered social support as important domains of frailty. Health utilization was identified as a domain of frailty in two studies. Only one study identified all five domains of frailty as essential components.

Method of administration varied among the studies with the use of self-report instruments, a combination of self-report and standardized measurement, and clinical judgment. Several studies developed frailty measures to specifically be used by researchers ($n = 3$), geriatricians ($n = 3$), and clinicians ($n = 5$). None of the studies measured frailty using administrative data sets or with the intention of the measure to be applied by nurse providers.

Researchers who have studied frailty agreed that frailty is a constellation of deficits that are superimposed on the normal physiological processes of aging. It is the accumulation and interaction of deficits that culminate overtime. These deficits increase the likelihood of developing frailty and are risk factors for the geriatric syndrome. The final results of this analysis demonstrated frailty as a multidimensional concept with several health domains, and it is the accumulation of deficits (risk factors) from these health domains that increase the likelihood of developing frailty. The five health domains are (a) function, relating to activities of daily living and instrumental activities of daily living; (b) physiologic, which incorporated comorbidity and physical changes related to illness such as weight loss, decreased strength, balance, walking speed, and weakness; (c) psychological symptoms of depression and cognitive impairment; (d) social support, pertaining to availability of social support; and (e) health utilization (see Table 2).

Item Generation. Subsequent to review of both the conceptual and measurement literature on frailty, variables indicating frailty were identified based on the following criteria: evidence from the literature, reflect health status versus normal changes associated with aging, cover multiple domains, incorporate variables that contribute to development of frailty, prevalence generally increases with age, and are present in administrative data sets. There were 37 potential variables identified. Of the 37 potential variables, 33 items matched with a variable available in the parent study data set, and each of the five health domains of frailty was operationalized. The excluded items pertained to measurement of gait speed and grip strength, balance, and falls. The 33 variables were phrased to be consistent with the parent study data set and sent to an expert panel for verification of content validity.

Expert Panel and Qualitative Content Validity Analysis. The expert panel (EP) included researchers and clinicians in medicine and nursing, all with expertise in geriatrics. They were selected with deliberate intention of garnering diverse perspectives. The EP assessed the 33 frailty items for content validity relevance on a scale from 0 to 4 (0 = *no response*, 1 = *not relevant*, 2 = *somewhat relevant*, 3 = *quite relevant*, 4 = *very relevant*). A content validity index (CVI) was generated from relevance scores by calculating the proportion of items receiving a score of 3 or 4. The CVI by item ranged from .42 to .86. However, one member of the EP only selected items within the physiological and functional domains. The CVIs were recalculated with that individual excluded, yielding an increase in CVI range from .50 to 1.00. Items with a rating score of 3 (*quite relevant*) or 4 (*very relevant*) by most of the expert panelists (four out of seven) were retained (Table 3).

Consistent with the literature, the EP concluded the best conceptual fit for measuring frailty was an instrument that consisted of multiple domains of health. Individually, frailty items are risk factors of frailty, consequences of frailty, or can be attributed to different

TABLE 2. Literature Review Frailty Variables (descending order by domain)

Frailty Domain	Frailty Categories	Total Number of Sources
Function	ADL/IADL	15
Physiologic	Physical activity	13
	Nutrition/weight	13
	Strength	10
	Comorbidity	10
	Balance	9
	Sensory	9
	Gait speed	6
	Weakness	5
	Albumin	2
	Falls	2
Psychological	Depression	12
	Cognitive impairment	12
	Exhaustion	8
	Self-report of health	7
Social support	Social status/support	7
Health utilization	Health utilization	2

Note. ADL = activities of daily living; IADL = instrumental activities of daily living.

concepts (such as disability or comorbidity). However, when the frailty items are combined, they provide the ability to assess the effects of accumulated deficits on overall elder health and function.

Similarities between the literature and EP consisted of the following: weight loss, tires easily, and limits physical activity because of health as items to measure frailty. The EP differed from the literature on several variables. The literature indicated the importance of cognition, comorbidity, and use of senses in the measurement of frailty. However, only two of the seven panelists considered these items as quite or very relevant. The EP emphasized the need to include health utilization as a frailty variable (four of seven panelists) and an additional panelist considered health utilization as an important risk factor. The panel recommended separating health utilization into four items: hospitalization, emergency room visits, rehabilitation, and short-term nursing home stay.

In summary, the systematic review and EP assessment concluded in 15 frailty risk items (see Figure 3). The literature review identified 37 potential variables that spanned five health domains. The 37 items were further reduced to 33 by inclusion of only variables accessible in the parent study data set. The second step of development included content validity assessment by a seven-member EP. All seven panelists identified physiological factors as measures of frailty. Five panelists noted function and social support as frailty measures, and four included psychological and health utilization as components of frailty. The EP further refined the frailty risk items to 12, which are contained in the frailty

TABLE 3. Frailty Index for Elders Items

Domain	Initial FIFE Model Items	Total CVI	CVI with 6 of 7 Panelists	Mean Relevance Score
Functional	1. Help with bathing	.66	.80	3.8
	2. Help getting in/out of bed	.50	.60	4.0
Physiological	3. Lost or gained 10 lbs. in last 6 months	.71	.71	4.0
	4. Tooth/mouth pain that makes it difficult to eat	.57	.66	4.0
	5. Poor appetite or quickly feels full after eating	.71	.83	3.4
	7. Limits physical activity because of health	.86	1.0	4.0
	6. Albumin	.71	.71	4.0
Psychological	8. Self-report of poor or fair health	.42	.50	3.3
	10. Tires easily or most of the time	.71	.63	4.0
	11. In good spirits most of the time	.57	.67	3.3
Social support	9. Little or no support if confined to bed	.57	.66	3.8
Health care use	12. Hospitalized in last 3 months	.57	.67	3.5
	13. Emergency room visit in last 3 months	.57	.67	3.5
	14. Rehabilitation center for physical health problems in last 3 months	.57	.67	3.5
	15. Nursing home for physical health problems in last 3 months	.57	.67	3.5

Note. Item 12, health care use, was separated into four items by health care facility type as suggested by EP members. FIFE = Frailty Index for Elders; CVI = content validity index.

domains of functional, physiological, psychological, social support, and health utilization. As suggested, health utilization was further divided into four separate types of institutional care for clarity.

The result of the instrument development was the inclusion of 15 items to measure risk of frailty in older adults. Each item was dichotomized such that indicator of frailty was coded as "1" and absence of frailty was coded as "0."

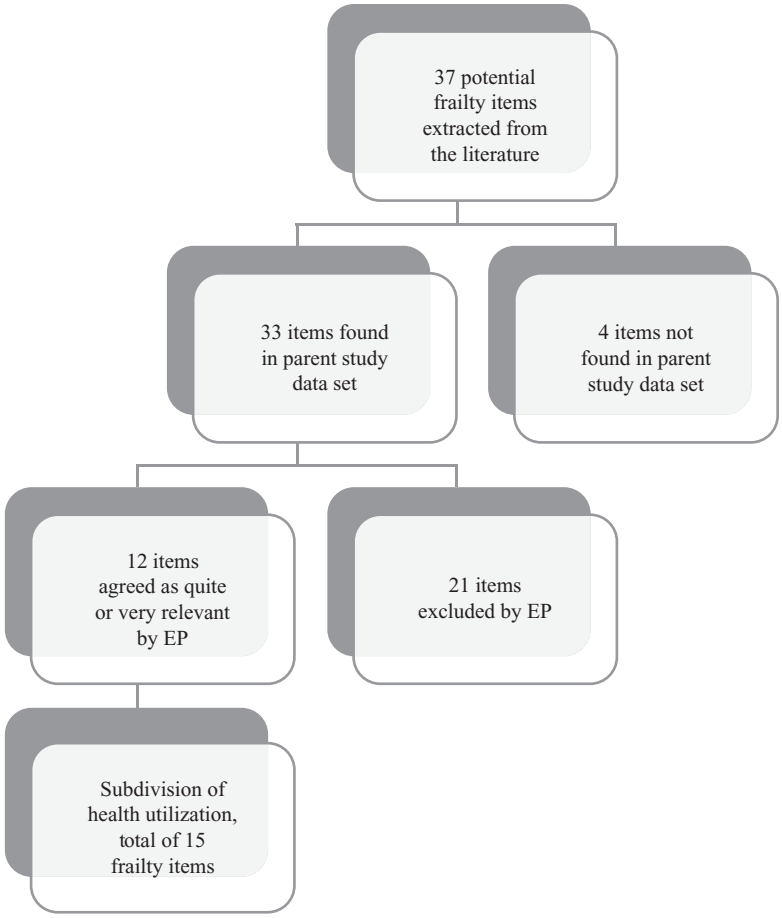

Figure 3. Frailty item selection process. EP = expert panel.

Instrument Validation

Several psychometric analyses were conducted on data from the parent study to assess the validity and reliability of FIFE. Frequencies, chi-square, and intercorrelations examined validity. Internal consistency reliability was assessed by Kuder-Richardson formula 20 (*KR20*), which is appropriate for measures consisting of dichotomous items. Most analyses were conducted by setting, with comparison between the settings.

Compare Factors Related to Frailty per Placement Setting. Frequencies were conducted on the proportion of participants in each health care setting that had a positive frailty item response. Chi-square was also calculated to determine whether there was a statistically significant relationship between item response and health care setting. Frequencies for total sample, by setting, as well as chi-square probability levels are displayed in Table 4. Of note, Item 6, albumin, was deleted because of large percentage (70%) of missing data in the parent study.

TABLE 4. Frequency of Frailty Indicators and Chi-square Comparisons Between Health Care Settings

	Combined *N* (%)	ALF *n* (%)	HCB *n* (%)	*p* Value
1. Bed	32 (12)	11 (8)	21 (15)	0.09
2. Bath	68 (25)	19 (14)	49 (35)	0.00*
3. Weight	99 (32)	44 (29)	55 (35)	0.24
4. Pain/eating	69 (22)	17 (11)	52 (33)	0.00*
5. Appetite	97 (31)	34 (22)	63 (40)	0.001**
6. Albumin	N/A	N/A	N/A	N/A
7. Limits activities	130 (33)	42 (27)	88 (56.4)	0.00*
8. Self-report of health	153 (49)	45 (28.8)	108 (69.2)	0.00*
9. Social support	36 (12)	6 (6.8)	30 (19.2)	0.00*
10. Tires easily	184 (60)	76 (48.7)	108 (69.2)	0.001**
11. Good spirits	29 (9.4)	6 (3.8)	23 (14.4)	0.001**
12. Hospitalization	68 (22)	39 (25)	29 (19)	0.22
13. ER	59 (19)	22 (14)	37 (24)	0.04*
14. Rehabilitation	25 (8)	24 (15)	1 (1)	0.00*
15. Nursing home	25 (8)	23 (15)	2 (1)	0.00*

Note. ALF = assisted living facility; HCB = home and community-based care; ER = emergency room.
*Significant at ≤.05. **Significant at ≤0.001.

Overall, there were significant differences in the proportion of participants in each health care setting that had a positive frailty response in all items except Items 1 (bed), 3 (weight), and 12 (hospitalization). The ALF group had a significantly greater percentage of participants that had a positive response to Items 14 (rehabilitation) and 15 (nursing home). The HCB group had significantly higher percentages in Items 2 (bath), 4 (pain/eating), 5 (appetite), 7 (limits activities), 8 (self-report of health), 9 (social support), 10 (tires easily), 11 (good spirits), and 13 (emergency room [ER]). Thus, for 9 of the 14 items, frequency of HCB group participants with frailty was greater than for ALF group participants. This is consistent with the expectation that HCB participants are more frail.

Determine Intercorrelations Between Frailty Items Within Each Group and to Identify Differences Between Groups in the Correlations. The inter-item correlations between frailty items were computed via Kappa coefficient within each health care setting. The correlations were then tested for equality between the two groups. These procedures provided the ability to observe relationships between items in each setting and also to identify how the relationship differed between the groups. Of the 91 intercorrelations between items (for each setting), 13 were significantly different between settings. These differences were noted in FIFE Items 3 (weight), 4 (pain/eating), 8 (self-report of health), 9 (social

support) 10 (tires easily), 12 (hospitalization), 13 (ER), 14 (rehabilitation), and 15 (nursing home). This suggests there are correlation differences among the health care settings. The results also indicated that Items 14 (rehabilitation) and 15 (nursing home) did not correlate with other items. These two items were eliminated from further analysis.

Item Discrimination. Item discrimination focuses on performance of each item difference within the group. It reflects the proportion of respondents in the group known to have less of the attribute (frailty) subtracted from proportion of the group known to possess more of the attribute divided by the number of respondents in the group with more of the attribute (Soeken, 2005). The score may range from 0 to 1, and it is closer to 1 because total FIFE score is more discriminated by item *i* (i.e., it is analogous to item–total correlation). A value range of item discrimination from 0.40 to 1.00 is highly desirable. Item discrimination for the ALF group ranged from 0.25 to 0.88, with seven items in the highly desirable range and five with lower item discrimination values.

Item discrimination ranged from 0.18 to 0.83 in the HCB group. Six items were considered to be in the highly desirable item discrimination range, and six items had lower item discrimination values ($<$0.20).

Point-Biserial Correlation. Point-biserial correlation provided evaluation of the relationship between the continuous variable (FIFE score) and each binary variable (each FIFE item). The higher the point-biserial correlation would be, the more participants with frailty responded affirmatively to an item, in contrast to participants without frailty responding affirmatively to the same item. A value of greater than 0.25 is desirable. For the ALF setting, 10 items were noted to be in the desirable range and 2 items were in less desirable levels.

For the HCB group, eight items were in the desired range, and two items were in a less than desirable range of less than 0.25.

Reliability. Higher *KR20* value was noted in the ALF setting as compared to the HCB setting (*KR20* of .60 vs. .36, respectively). Because of disparity of validity and reliability results in the two health care groups, analysis was recalculated with the elimination of items with low point-biserial correlation and corrected item–total correlation. The deleted items were Items 9 (social support) and 11 (good spirits). The elimination of the two items results in point-biserial correlation values by item being equal or greater than 0.25 in both the ALF and HCB groups with the exception of Items 4 (pain/eating) and 5 (appetite) in the ALF setting. Similarly, corrected item–total correlation with item deletion improved in each variable except Items 1 (bed), 2 (bath), 3 (weight), 4 (pain/eating), and 12 (hospitalization) in the HCB setting. The revised 10-item FIFE had higher *KR20* values as compared to the 12-item FIFE in both settings (.67 vs. .60 in the ALF setting and .39 vs. .36 in the HCB setting). Overall, the analysis indicated improved and acceptable reliability of the 10-item FIFE in the ALF setting, but reliability in the HCB setting is questionable (see Table 5). Figure 4 depicts process of revised FIFE items.

Frailty Index for Elders Subdimensions and Reliability. Because of multiple domains associated with frailty, the FIFE items were examined for commonality and separated into three subdimensions: (a) physical activities associated with frailty, (b) illness consequences of frailty, and (c) health utilization associated with frailty. Table 6 identifies the items in each of the subdimensions. Comparison of total 10-item FIFE *KR20* to the subdimensions in the ALF group indicated that the total FIFE reliability was higher at .69 than each of the three subdimensions (functional activity, .54; illness consequences, .61; and health utilization, .54, respectively). In contrast, the HCB group had improved reliability in Subdimension 2 (illness consequences, .54) and Subdimension 3 (health utilization,

TABLE 5. Item Analysis

	Item Discrimination		Item–Total Correlation (point-biserial correlations)		Corrected Item–Total Correlation	
	ALF	HCB	ALF	HCB	ALF	HCB
1. Bed	0.25	0.18	0.40[a]	0.20	0.29[a]	0.02
2. Bath	0.39	0.35	0.51[a]	0.32[a]	0.39[a]	0.10
3. Weight	0.63[a]	0.40[a]	0.55[a]	0.37[a]	0.37[a]	0.14
4. Pain/eating	0.22	0.55[a]	0.35[a]	0.39[a]	0.21	0.17
5. Appetite	0.44[a]	0.69[a]	0.42[a]	0.49[a]	0.24	0.27[a]
7. Limits activities	0.63[a]	0.83[a]	0.55[a]	0.55[a]	0.37[a]	0.34[a]
8. Self-report of health	0.68[a]	0.76[a]	0.62[a]	0.56[a]	0.46[a]	0.37[a]
9. Social support	0.05	0.19	—	—	—	—
10. Tires easily	0.88[a]	0.83[a]	0.63[a]	0.58[a]	0.45[a]	0.39[a]
11. Good spirits	0.12	0.33	—	—	—	—
12. Hospitalization	0.61[a]	0.24	0.50[a]	0.20	0.33[a]	0.00
13. ER	0.43[a]	0.32	0.51[a]	0.66[a]	0.37[a]	0.51[a]

Note. Column 1: Item discrimination values reflect 12-item FIFE. Columns 2 and 3: Item–total correction and corrected item–total correction values reflect 10-item FIFE. ALF = assisted living facility; HCB = home and community-based care; ER = emergency room.
[a]Indicates desirable range.

.75) as compared to its total 10-item FIFE (.47). Subdimension 1 (functional activities) in the HCB group had a lower reliability (.35) than the total 10-item FIFE (.47). Comparison analysis of each subdimension to setting indicated the ALF group had a higher reliability in Subdimension 1 (functional activities, .54 vs. .35) and Subdimension 2 (illness consequences, .61 vs. .54). Subdimension 3 (health utilization) had greater reliability in the HCB group than compared to the ALF group (0.75 vs. 0.54; respectively).

Subdimension reliability analysis of FIFE concluded higher reliability in the total 10-item scale value as compared to its subdimensions in the ALF group. However, in the HCB group, Subdimension 2 (illness consequences) and Subdimension 3 (health utilization) had greater reliability than total FIFE; Subdimension 1 (functional activities) had less reliability.

Summary of Frailty Index for Elders

With refinements made via these analyses, FIFE consists of 10 items that incorporate risk factors from the five health domains associated with frailty (see Table 7). The index is summative with a total score of 10. A score of equal or greater than 4 indicates frailty. A minimum of 4 points indicates an individual's health deficits in more than one domain. Higher scores indicate greater degree of frailty. The major strength of the FIFE is the rigorous scientific inquiry used for the instrument development. All items were developed

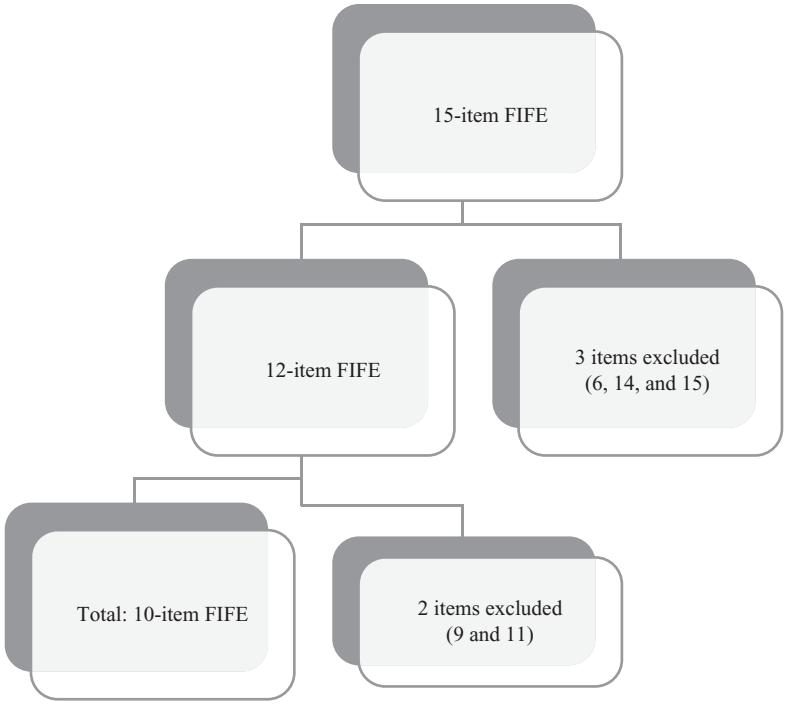

Figure 4. Revised Frailty Index for elders items. FIFE = Frailty Index for Elders.

TABLE 6. Subdimensions

		KR20	
Subscale	Item	ALF	HCB
1. Functional activities	1. Getting in/out of bed	.54	.35
	2. Help bathing		
	4. Tooth/pain making difficult to eat		
2. Illness consequences	3. Weight loss or gain in 6 months	.61	.54
	5. Poor appetite		
	7. Limits physical activity because of health		
	8. Self-report of poor/fair health		
	10. Tires easily or most of the time		
3. Health care use	12. Hospitalized last 3 months	.54	.75
	13. ER last 3 months		

Note. *KR20* = Kuder-Richardson formula 20; ALF = assisted living facility; HCB = home and community-based care; ER = emergency room.

TABLE 7. Frailty Index for Elders

Item	Circle Response	
1. Do you need help getting in or out of bed?	Yes	No
2. Do you need help with washing or bathing?	Yes	No
3. Without wanting to, have you lost or gained 10 lbs. in the last 6 months?	Yes	No
4. Do you have tooth or mouth problems that make it hard to eat?	Yes	No
5. Do you have a poor appetite and quickly feel full when you eat?	Yes	No
6. Did your physical health or emotional problems interfere with your social activities?[a]	Yes	No
7. Would you say your health is fair or poor?[a]	Yes	No
8. Do you get tired easily?[a]	Yes	No
9. Were you hospitalized in the last 3 months?[a]	Yes	No
10. Did you visit an emergency room for a health problem in the past 3 months?[a]	Yes	No

[a]Items are renumbered to reflect revisions of FIFE.

through a triangular process involving standard procedures for assessing and evaluating reliability and validity.

The original FIFE model consisted of 15 frailty risk items that were derived from evidence supported by systematic review of the literature and an EP. Five items were deleted from the original model. The first item eliminated was albumin because of a high percentage of missing data from the parent study. It had been considered as an important frailty indicator by six of the seven expert panelist, especially regarding measurement of a multidimensional geriatric syndrome. Hypoalbuminemia was considered a biomarker of frailty because of its association with malnutrition and the inflammatory/stress response of disease (Rockwood et al., 2005; Searle et al., 2008; Studenski et al., 2004). However, most of the frailty measurement literature did not include low albumin as a frailty factor. Several of the frailty reports are secondary analyses and do not specifically state if the exclusion of albumin was because of the inability to access laboratory findings. Most studies used weight loss as a proxy for malnutrition and did not collect laboratory data such as albumin to corroborate the adverse effect of malnutrition on physiological function. However, the high support for including low albumin as a biomarker of frailty by the EP suggests the inclusion of hypoalbuminemia in future prospective testing of the FIFE.

Item 9 (little or no support when confined to bed) and Item 11 (not in good spirits most of the time) were deleted because of analysis findings. The reliability of FIFE improved in each health care setting with the exclusion of these items. However, omission of these items in future testing of the FIFE warrants discussion. Social support and psychological well-being have been identified as essential components of a multidimensional measure of frailty in both the literature and by the EP. The most likely explanation for the disparity between reliability results and literature and EP findings is the multidimensionality of frailty. Frailty is a phenomenon with complex interplay of multiple factors. These factors may not necessarily correlate well with one another, even if each is a risk factor for frailty.

It is the effect of the interaction of risk factors that increases the likelihood of developing frailty. Therefore, individuals with frailty may have positive risk factors in dissimilar domains. For example, an older adult may be frail because of positive risk responses to items within functional and health utilization domains, and conversely, another older adult may be frail because of positive risk responses to items within psychological and social support domains. Both older adults are frail but as a result of deficits in different domains. The interactive relationship of factors from multiple domains within an individual is supported by the theoretical framework of this study. It is the interaction of vulnerability factors and risk/support factors of an individual that results in a human response (frailty).

FIFE Items 14 (rehabilitation) and 15 (nursing home) were also eliminated from the original model because of the lack of correlation noted in this analysis. Both the literature and EP supported the inclusion of health care use within the past 3 months as a frailty factor. Recent health care use has been associated with adverse health outcomes and therefore is a risk factor for frailty (Rolfson, Majumdar, Tsuyuki, Tahir, & Rockwood, 2006; Studenski et al., 2004). These items had the lowest overall frequency (8%), which may have limited possibility of correlating with other items of FIFE. Additional explanations for the discrepancy between study analysis and literature and EP findings related to Items 9 (social support), 11 (good spirits), 14 (rehabilitation), and 15 (nursing home) may be lack of a participant's understanding of item question and response options, characteristics of the participant at time of administration of testing, loss of measurement information as items were dichotomized, or measurement error. Further testing with the inclusion of all 15 FIFE items would provide valuable evidence to determine whether these items are helpful to the measurement of frailty.

DISCUSSION

The FIFE is a robust measure to identify frailty risk factors in older adults. The instrument is conceptually sound with excellent content validity. FIFE consists of 10 items that incorporate risk factors from the five health domains associated with frailty. The major strength of the FIFE is the rigorous scientific inquiry used for the instrument development. All items were developed through established procedures for determinants of reliability and validity.

The FIFE was examined retrospectively in a study that included two samples of older adults newly admitted to long-term care services. The samples were equally divided among those residing in an ALF or residing at home while receiving HCB care. For instrument development, this was an ideal situation to demonstrate sensitivity of the FIFE. The desired effect was that the FIFE would be able to distinguish which sample had a greater number of participants whom were frail. The FIFE did establish sensitivity to differences between the two samples, with the HCB group having higher frequencies on 6 of 10 indicators of frailty.

The literature and an EP determined frailty was best measured as an accumulation of risk factors across several health domains rather than limiting it to one health domain. Comparison of item frequency in two health care settings provided evidence to support the need to address multiple domain factors.

Correlations between frailty items demonstrated similarities and differences in each setting. Medium correlations in both settings were noted between psychological Item 10 (tires easily) with Item 8 (self-report of health) and the psychological Item 8 (self-report of health) with Item 7 (limits activities). A medium or large correlation was also noted among

health care use: Items 12 (hospitalization) and 13 (ER). The remainder of the items had small correlations in both settings. These findings were not surprising because it would be expected for items representing the same domain to correlate together and those not representing the same domain to have lower correlations. This study is the first to evaluate item correlations, so comparison to other frailty measures is not possible.

Another expected finding was the low reliability values for FIFE. FIFE is designed as an index rather than a scale. Thus, as described in DeVellis (2012, p. 12), each item should be thought of a "cause indicator" rather than an "effect indicator." As an index, FIFE represents the multiple domains of frailty and the labile nature of the phenomenon.

The clinical application of the FIFE would be enhanced with established cutoff points to determine nonfrail versus at risk for frailty versus frail. However, a beginning conceptual cutoff score of 4 has been established. Future psychometric analysis of the predictive properties of FIFE will allow for the determination of empirically based cutoff points.

LIMITATIONS

Limitations to this study were related to the use of secondary analysis. A challenge of using secondary data was the lack of control over the original data collection and choice of measures used. The parent study did not include all the variables identified in the content analysis as characteristics or outcomes of frailty (e.g., albumin and falls). The cross-sectional design of the study does not allow for untangling indicators of frailty from correlates including risk factors and outcomes.

Reliability of FIFE as indicated by *KR20* is not high, indicating independence of items. However, this may also be interpreted as a strength because it indicates unique coverage of each item. Frailty is a fluid concept and events may never be exactly duplicated because of changes in an individual's health and perspective of an individual's health status. There may also be the possibility of frailty being defined according to population. Consequently, measurement reliability, as indicated by consistency between items, may not be a realistic goal of a frailty measure.

Limitations of the secondary analysis are balanced by tremendous strength of this study. The parent study provided rich data, had an ample sample from two diverse health care settings, and was a high-quality study. The ability to use a data set with a similar theoretical framework reduced the threat of construct validity for the FIFE. This first author (CT) was able to be a member of the parent study research team and participated in regular scheduled meetings with investigators to improve overall comprehension of data variables, data quality, and analysis.

CONCLUSIONS

The FIFE has use in both research and clinical practice. To date, there is not a universal definition of frailty, and consequently, there is no gold standard measure. The FIFE is a content valid instrument that incorporates items that reflect the multidimensional nature of frailty and items that are easily extrapolated from existing holistic research and administrative data sets for future research. The FIFE can be used to (a) study the relationship among frailty determinants, (b) provide standardized measurement to compare frailty among older adult populations, (c) develop interventional studies and measure the effect of interventions to prevent or thwart frailty, and (d) function as a quality of life outcome.

Clinically, the FIFE can be used as an assessment instrument with the use of all items to determine frailty, and individual items can be examined to determine risk for frailty. For example, an older adult may not be exhibiting deficits in all or in most of health domains of frailty, but by examining each frailty domain, areas of risk can be identified. The FIFE items are readily available in holistic administrative data sets such as Outcome and Assessment Information Set making extrapolation of items simple without the requirement of additional testing or questioning. Ease and accessibility are essential to measurement use. Cumbersome and time-consuming measures are a burden to nurses and older adults and impede comprehensive assessment.

An additional clinical implication is the importance of providing evidence-based care. The FIFE was developed through evidence provided in the literature. FIFE items were extrapolated from conceptual work and existing measures and tested in two older adult groups. Although further testing is needed to further establish construct validity of the index, FIFE items have been identified as important determinants of frailty in the literature and by an EP. Thus, there is evidence to support the use of the FIFE in assessing frailty risk.

In summary, consensus from the literature and the EP support frailty as multidimensional. Therefore, the inclusion of multiple health domains as components of frailty measurement was warranted in the FIFE. By considering frailty in terms of multidimensional attributes, a more complex and accurate assessment of an older adult's health status and characteristics that negatively influence well-being is provided. An index such as the FIFE assesses several health domains—functional, physiological, psychological, social, and health care use—and has use for research and clinical practice. Further psychometric testing of the FIFE with the full 15-item measure would provide additional evidence as to the items essential to the measurement of frailty.

REFERENCES

Abellan van Kan, G., Rolland, Y., Houles, M., Gillette-Guyonnet, S., Soto, M., & Vallas, B. (2010). The assessment of frailty in older adults. *Clinics in Geriatric Medicine*, *26*, 275–286.

Ahmed, N., Mandel, R., & Fain, M. J. (2007). Frailty: An emerging geriatric syndrome. *American Journal of Medicine*, *120*, 748–753.

Bandeen-Roche, K., Xue, Q. L., Ferrucci, L., Walston, J., Guralnik, J. M., Chaves, P., . . . Fried, L. P. (2006). Phenotype of frailty: Characterization in the women's health and aging studies. *Journal of Gerontology. Series A, Biological Sciences and Medical Sciences*, *61*, 262–266.

Bortz, W. M., II. (2002). A conceptual framework of frailty: A review. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *57*, M283–M288.

Brown, M., Sinacore, D. R., Binder, E. F., & Kohrt, W. M. (2000). Physical and performance measures for the identification of mild to moderate frailty. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *55*, M350–M355.

Campbell, A. J., & Buchner, D. M. (1997). Unstable disability and the fluctuations of frailty. *Age & Ageing*, *26*, 315–318.

Chin, A., Paw, M. J., Dekker, J. M., Feskens, E. J., Schouten, E. G., & Kromhout, D. (1999). How to select a frail elderly population? A comparison of three working definitions. *Journal of Clinical Epidemiology*, *52*, 1015–1021.

Dayhoff, N. E., Suhrheinrich, J., Wigglesworth, J., Topp, R., & Moore, S. (1998). Balance and muscle strength as predictors of frailty among older adults. *Journal of Gerontological Nursing*, *24*, 18–27.

DeVellis, R. F. (2003). Guidelines in scale development. In R. F. DeVellis. *Scale development: Theory and application* (pp. 60–101). Thousand Oaks, CA: Sage Publications.

DeVellis, R. F. (2012). *Scale development: Theory and application*. Thousand Oaks, CA: Sage.

Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., . . . McBurnie, M. A. (2001). Frailty in older adults: Evidence for a phenotype. *Journals of Gerontology. Series A, Biological Sciences & Medical Sciences*, *56*, M146–M156.

Jones, D., Song, X., Mitnitski, A., & Rockwood, K. (2005). Evaluation of a frailty index based on a comprehensive geriatric assessment in a population based study of elderly Canadians. *Aging Clinical and Experimental Research*, *17*, 465–471.

Kulminski, A. M., Ukraintseva, S. V., Kulminskaya, I. V., Arbeev, K. G., Land, K., & Yashin, A. I. (2008). Cumulative deficits better characterize susceptibility to death in elderly people than phenotypic frailty: Lessons from the Cardiovascular Health Study. *Journal of the American Geriatrics Society*, *56*, 898–903.

Lally, F., & Crome, P. (2007). Understanding frailty. *Postgraduate Medical Journal*, *83*, 16–20.

Lynn, M. R. (1986). Determination and quantification of content validity. *Nursing Research*, *35*, 382–385.

Rockwood, K. (2005). Frailty and its definition: A worthy challenge. *Journal of the American Geriatrics Society*, *53*, 1069–1070.

Rockwood, K., Fox, R. A., Stolee, P., Robertson, D., & Beattie, B. L. (1994). Frailty in elderly people: An evolving concept. *CMAJ Canadian Medical Association Journal*, *150*, 489–495.

Rockwood, K., Song, X., MacKnight, C., Bergman, H., Hogan, D. B., McDowell, I., & Mitnitski, A. (2005). A global clinical measure of fitness and frailty in elderly people. *Canadian Medical Association Journal, 173,* 489–495.

Rolfson, D. B., Majumdar, S. R., Tsuyuki, R. T., Tahir, A., & Rockwood, K. (2006). Validity and reliability of the Edmonton Frail Scale. *Age & Ageing*, *35*, 526–529.

Searle, S. D., Mitnitski, A., Gahbauer, E. A., Gill, T. M., & Rockwood, K. (2008). A standard procedure for creating a frailty index. *BMC Geriatrics*, *8*, 24.

Shaver, J. (1985). A biopsychosocial view of human health. *Nursing Outlook*, *33*, 186–191.

Soeken, K. L. (2005). Validity of measures. In C. F. Waltz, Ol L. Strickland, & E. R. Lenz (Eds.). *Measurement in nursing and health research.* (3rd ed.) (pp. 154–189). New York: Springer Publishing Company, Inc.

Steele, B., & Shaver, J. (1992). The dyspnea experience: Nociceptive properties and a model for research and practice. *Advances in Nursing Science*, *15*, 64–76.

Studenski, S., Hayes, R. P., Leibowitz, R. Q., Bode, R., Lavery, L., Walston, J., . . . Perera, S. (2004). Clinical global impression of change in physical frailty: Development of a measure based on clinical judgment. *Journal of the American Geriatrics Society*, *52*, 1560–1566.

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