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Title: Detection And Significance Of Frailty In Elderly Insurance Applicants

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Purpose/value: Identification of older people who are frail and at risk for functional decline is becoming a more important aspect of risk selection and classification for insurers that sell life and long term care insurance.

DETECTION AND SIGNIFICANCE OF FRAILTY IN ELDERLY INSURANCE APPLICANTS

ABSTRACT

Frailty is a geriatric syndrome of advanced age that leaves a person vulnerable to falls, functional decline, morbidity and mortality. Key elements of this syndrome are loss of functional reserve in multiple domains and existence at a level that is close to or past the threshold for failure. This article reviews the geriatric literature to identify risk factors that could be used by insurers to identify existing or incipient frailty. The principal factors include age, gender, functional and cognitive impairment, nutritional status, comorbid impairments, self-reported function, and difficulties with mobility, balance, and aerobic capacity. There are also culture-specific risk factors in some countries, such as Japan. Frail insurance applicants could often be identified via historical data and simple tests of cognitive and physical performance.

Frailty may be described as a geriatric syndrome of advanced age that leaves a person vulnerable to falls, functional decline, morbidity and mortality.[1] Despite the fact that this syndrome is often discussed in the gerontology literature, there is no consensus as to the definition or how it can be measured. In some cases frailty may simply denote a broad range of physical problems in old age or even aging itself. Examples include defining frailty based on a certain age range or the onset of conditions that are relatively common in old age. According to these definitions, the majority of older people would be considered frail. Other researchers define frailty narrowly and limit the diagnosis to people who are severely impaired or are institutionalized. By these measures only a small proportion of older people would be considered frail and all of them would be disabled.[2,3]

Identification of people who are frail and at risk for functional decline is an essential part of geriatric assessment. It is also becoming a more important aspect of risk selection and classification for insurers that sell life and long term care insurance to older applicants. This article reviews the geriatric literature to identify risk factors that could be used by insurers to identify existing or incipient frailty.

DESCRIPTIONS OF FRAILTY

Because of the absence of a generally accepted definition of frailty, geriatric specialists have chosen to describe the components of this syndrome. Sample descriptions are listed in Table 1.[1,2,4,5,6]

Table 1. Descriptions of the frailty syndrome

Condition of advanced age characterized by vulnerability to stressors and decreased ability to maintain homeostasis*
Precarious balance between the ability to maintain health and function, and deficits that threaten the balance
Diminished ability to carry out important practical and social activities of daily living
Lack of physiologic reserve, "living on the edge," near the threshold for failure
Inability to mount a response in the face of stress
Multisystem impairment
Instability, with changes over time
Inability to regain function after acute illness
Low energy expenditure, decreased muscle mass and strength, reduced mobility
Three of the following: involuntary weight loss, slow walking speed, low level of physical activity, subjective exhaustion, low grip strength

* Homeostasis is the ability to maintain functional status.

These descriptions of frailty have two underlying themes: (1) loss of functional reserve in multiple domains (areas), such as strength, balance, flexibility, reaction time, coordination, nutrition, cardiovascular endurance, vision and hearing, and cognitive performance, and (2) existence at a level that is close to or past the threshold for failure, with negligible tolerance of external stress.[2,7,8,9,10] Thus, a frail elderly person is someone with deficiencies in more than one functional domain with little or no reserve to cope with the routine stresses of day-to-day living. The result is that frail people are at high

risk for inability to perform the instrumental activities of daily living (IADL) and the activities of daily living (ADL).

Frailty differs from disability

Frailty is not the same as disability.[1,6] Both frailty and disability are more common with advanced age, confer an increased risk of death, compromise function, and are associated with dependency. However, they differ in three respects. First, disability can arise from dysfunction of a single system or from many systems, whereas frailty always means multisystem dysfunction. Second, disability may be stable, whereas frailty is always unstable. In the context of frailty, "instability" means that small changes (e.g., minor illness or injury, low-grade physical or emotional stress) lead to disproportionately large effects (immobility, dependency, death). Third, frailty is present in a significant percentage of older people who are not disabled. These latter two points underlie the description of frailty as "subclinical" or "preclinical" disability, i.e., frail people may not be disabled, but they are at high risk for future disability.[11]

PREVALENCE

Strawbridge et al.[3] reported the prevalence of frailty in 574 subjects after 29-year follow-up in the Alameda County Study (California), a longitudinal analysis of health and mortality (Table 2). The cohort included both community-dwelling and institutionalized people. Frailty was defined as "a syndrome involving deficiencies in two or more domains involving physical (e.g., sudden loss of balance, weakness), nutritive (e.g., loss of appetite or unexplained weight loss), cognitive, and sensory (e.g., reading a newspaper,

hearing over the telephone) capabilities." As expected, the proportion of frail subjects increased sharply with age.

Table 2. Prevalence of frailty (%), including community-dwelling and institutionalized subjects

Age	Subjects	Frail (%)
65-69	169	18.3
70-74	175	21.7
75-79	109	32.1
80-84	80	32.5
85+	41	48.8

Fried et al.[12] determined the prevalence of frailty in 5,317 community-dwelling people aged 65 years and older. Frailty was defined by the presence of three or more of the following criteria: unintentional weight loss, self-reported exhaustion, weakness, slow walking speed, and low physical activity. Frailty increased with age and was higher for women than men (Table 3). Frailty was also associated with lower socioeconomic status.

Table 3. Prevalence of frailty (%) in community-dwelling subjects

Age	Subjects	Female	Male
65-70	2308	3.0	1.6
71-74	1271	6.7	2.9
75-79	1057	11.5	5.5
80-84	490	16.3	14.2
85-89	152	31.3	15.5
90+	39	12.5	36.8

PATHOPHYSIOLOGY

Walston and Fried[1] proposed a triad of age-related changes that underlie the syndrome of frailty: sarcopenia, neuroendocrine dysregulation, and immune dysfunction.

Sarcopenia

Sarcopenia (age-related decline in muscle mass) is a key component of frailty. It is associated with slow walking speed, low levels of physical activity, decreased exercise tolerance, low grip strength, increased fall rates, and decreased ability to maintain body temperature. There is a steady age-related decline in muscle mass in both genders, but sarcopenia affects women to a greater extent because they have a lower baseline total muscle mass and an increased rate of loss of muscle mass in the postmenopausal period. Thus, women reach a threshold of muscle mass loss and weakness more quickly.

Sarcopenia can be diagnosed via a combination of height, weight, hip circumference, grip strength, and skinfold thickness.[13] Research indicates that risk for functional im-

pairment, disability, and falls is significantly higher in people with sarcopenia and obesity (BMI ≥27 kg/m^2, the “fat frail”), compared to lean subjects with sarcopenia.[14] Because sarcopenic-obese elderly people have increased body fat that masks their sarcopenia, they may not be recognized as frail unless muscle mass and strength are measured.

Neuroendocrine dysregulation

The process begins with age-related changes in hypothalamic response to stress. This leads to dysregulation between the hypothalamus, pituitary gland, and adrenal glands.

- Increased cortisol- Secretion of cortisol by the adrenal glands increases with age in both genders, and elevated cortisol levels are associated with sarcopenia and decreased resistance to infectious diseases. Women tend to have higher cortisol levels than men at older ages, contributing to the greater incidence of frailty.
- Decreased growth hormone- Growth hormone (GH) is important at all ages for development and maintenance of muscle mass. Secretion of GH decreases with age in both genders, but levels remain higher in older males, and males are more sensitive to the beneficial effects of GH. As a result, sarcopenia develops at a slower rate in males.
- Decreased testosterone- Testosterone helps maintain muscle mass in older men, and decreasing testosterone levels contribute to sarcopenia. In men, there is a gradual age-related decline in testosterone levels due to dysregulation of the hypothalamic-pituitary axis, plus a degree of testicular failure.

- Estrogen- Estrogen levels decline abruptly at menopause, triggering accelerated loss of muscle mass.

Immune dysfunction

Cytokines are regulatory peptides produced by nucleated cells in the body. The cytokine family includes the interleukins, interferons, tumor necrosis factor, transforming growth factor, colony-stimulating factor, and others.[15] Aging is associated with increased levels of catabolic cytokines (e.g., interleukin-6 and tumor necrosis factor) and a decline in humoral immunity. This hastens the development of sarcopenia and exacerbates alterations in neuroendocrine regulation at the level of the hypothalamus. Testosterone limits production of catabolic cytokines in men, whereas estrogen may exacerbate production, again contributing to the higher incidence of frailty in women.

Other factors

Bone loss is not central to the model of frailty but it is clinically related. Women lose up to 5% of bone mass annually in the first few years after menopause, followed by 2% to 3% annual loss thereafter. Older men lose 1% to 2% of bone mineral density per year, starting from a higher baseline. The sequence of events is then (1) more weakness and increased risk of falls in women due to greater sarcopenia, (2) followed by a higher incidence of fractures and other injuries after falls.

Behavioral and environmental factors also influence the likelihood of frailty. Older men generally have higher levels of activity than women, and hence improved maintenance

of muscle mass and slower development of sarcopenia. Men also have higher levels of food intake, which helps preserve muscle mass.

Gender differences

The triad of sarcopenia, neuroendocrine dysregulation, and immune dysfunction provides much of the explanation for why women are approximately twice as likely to develop frailty. Also contributing to gender differences is the higher death rate in younger, less healthy men, thereby selecting stronger, healthier male survivors who are less likely to be frail as they age.[1,6]

PREDICTORS OF FRAILTY

Factors associated with morbidity and mortality

Table 4 lists many of the factors that have been associated with morbidity and mortality in the elderly. These factors are also common in frail elderly people.[9] Advanced age, functional decline, and comorbidity (multiple physical and/or cognitive disorders) are established predictors of deterioration. The geriatric syndromes are relatively recent additions to the list. This diverse group of disorders is strongly associated with decreased functional reserve and reduced life expectancy. With the exception of dementia, these syndromes are almost never listed on death certificates as the primary cause of death even though they often contribute to (e.g., depression, failure to thrive, osteoporosis, neglect and abuse) or directly cause (e.g., falls) death, and/or are markers of frailty that identify high risk people (e.g., delirium, incontinence, polypharmacy).

Table 4. Factors associated with morbidity and mortality in the elderly

Advanced age
Functional decline
Instrumental activities of daily living
Activities of daily living
Comorbidity
Number of comorbid conditions
Severity of comorbid conditions
Geriatric syndromes
Delirium*
Dementia
Depression
Osteoporosis
Failure to thrive†
Falls
Incontinence
Neglect and abuse
Polypharmacy‡

* Delirium is transient cognitive impairment due to a medical condition unrelated to the central nervous system.

† Failure to thrive is a poorly understood syndrome characterized by weight loss despite adequate food intake.

‡ Polypharmacy means five or more medications.

Factors associated with functional decline

Stuck et al.[16] published a comprehensive review of risk factors associated with functional decline in community-dwelling people based on a review of the literature published between 1985 and 1997. Table 5 summarizes these findings.

Table 5. Summary of risk factors associated with decline in functional status

Variable	Risk of decline
Psychiatric	--
Depression	Higher
Anxiety	None
Alcohol	--
Small to moderate amounts	Lower, males and females
Heavy drinking	Higher, males only (insufficient data for females)
Cognition	Higher (highly significant)
Comorbidity	Higher, but variable depending on disease combinations
Falls	Higher, but only if more than one fall
Functional limitation	Higher (highly significant, a precursor to further decline)
Hearing	Higher, but minimally higher
Medications	Higher if ≥5 medications, independent of underlying diseases
Nutrition	Higher for both high and low BMI
Physical activity	Higher with physical inactivity, lower with physical activity
Self-rated health	Higher if poor self-rated health
Smoking	Higher if current or former smoker
Social factors	Higher if social isolation*
Vision	Higher with visual impairment
Specific medical disorders	Higher with many impairments (innumerable combinations)
Socio-demographic	--
Age	Always the highest risk factor
Gender	Males and females similar after adjusting for other variables
Income	Higher with low income
Education	Higher if less education
Marital status	None

* Social isolation may indicate cognitive impairment or existing problems with IADLs or ADLs.

Many of these associations could be useful from an underwriting perspective. For example,

- risk was higher with depression;
- small to moderate amounts of alcohol lowered risk;
- risk associated with comorbidity depended on which diseases where involved;
- risk was higher if the patient used five or more medications, regardless of underlying diseases; and
- risk was higher with social isolation.

Long term prospective study of frailty

The previously cited Alameda County Study reported the likelihood of frailty over 29-year follow-up.[3] Using the odds ratio (OR, odds of frailty with a given risk factor divided by odds of frailty without the risk factor) as a measure of the likelihood of becoming frail, the strongest predictors of frailty (Table 6) were a history of fair or poor perceived health (OR, 4.1), depression (OR, 3.2), two or more chronic symptoms (OR, 2.6), and physical inactivity (OR, 2.0). Risk was also higher for socially isolated people, both alcohol abstainers and heavy drinkers (typical J-shaped curve associated with alcohol intake), and cigarette smoking. Regarding smoking, the conflicting results in the literature might be related to the relatively small proportion of smokers who survive to old age. Despite the relatively low odds ratio (OR, 1.4) of frailty in smokers, the authors suggested that “prior smoking may cast a long shadow impacting frailty in old age.”

Table 6. Likelihood of frailty over 29-year follow-up

Characteristic	Subjects	Odds ratio
Fair/poor perceived health	67	4.1
Depressed	53	3.2
2+ chronic symptoms	177	2.6
Physically inactive	355	2.0
Socially isolated	78	1.6
Alcohol consumption	--	--
Abstainer	94	1.6
Heavy drinker	69	1.4
Cigarette smoker	173	1.4
Obesity	97	1.2

Modified physical performance test

Brown et al.[8] used a modified version of the physical performance test (PPT) to provide an objective assessment of frailty in the elderly (Table 7). Prior studies demonstrated that this battery of tests has a high correlation with degree of disability, loss of independence, early mortality, and nursing home placement. The cohort consisted of 107 community-dwelling people aged 78 years or older (mean age, 83±4; one-fourth males). Subjects had an average of three chronic medical conditions, with the largest percentage presenting with arthritis or congestive heart failure. A complete battery of physical measures was also performed in a laboratory setting to assess upper and lower extremity strength, range of motion, balance, gait characteristics (e.g., speed, stride length), coordination and reaction speed, and sensation. The intent was to determine if the predictive ability of a complete geriatric frailty assessment (which far exceeds what

could be done in an insurance context) could be approximated by the much simpler PPT.

Table 7. Modified physical performance test items*

1. Book lift. A book of about 7 pounds (3.2 kg) is lifted from waist height to a shelf approximately 12 inches (31 cm) above shoulder level.
2. Put on and take off a coat. Subjects put on and take off a standard lab coat of appropriate size as quickly as possible.
3. Pick up a penny. Subjects pick up as quickly as possible a penny that is located about 12 inches (31 cm) in front of the foot.
4. Chair rise. Subjects sit in a chair that has a seat height of 16 inches (41 cm). They then stand fully and sit back down, without using the hands, five times, as quickly as possible.
5. Turn 360 degrees. Participants turn both clockwise and counterclockwise quickly but safely. They are subjectively graded on steadiness and ability to produce continuous turning movement.
6. 50-foot (15 m) walk. Subjects walk 25 feet (7.5 m) in a straight line, turn, and return to the initial starting place as quickly as possible, safely.
7. One flight of stairs. The time required to ascend 10 steps.
8. Four flights of stairs. Participants climb four flights of stairs. One point is given for each flight of stairs completed.
9. Progressive Romberg tests. Subject are scored according to their ability to maintain a reduced base of support: feet together, semi-tandem, and full tandem, for a maximum of 10 seconds.

* Each of the nine items of the PPT was worth a maximum of four points, for a perfect score of 36. Frailty status was assessed as follows: not frail, 32 to 36 points; mild frailty, 25 to 31 points; and moderate frailty, 17 to 24 points. Prior experience indicated that subjects with scores below 17 could not live independently in the community.

Scores on the modified PPT were significantly associated with laboratory measures of strength, balance, gait speed, range of motion, speed of movement, and sensation. Principal findings included the following:

- Frailty was multidimensional and characterized by the accumulation of deficits across multiple domains. In particular, isolated measures such as strength, flexibility, and coordination were insufficient for identification of frailty.
- Balance was most strongly associated with PPT score, a finding which agrees with other reports indicating that balance is a major determinant of frailty.
- Fast gait was significantly associated with PPT score. Subjects with moderate frailty (PPT score, 17-24) had an average "fast" gait speed that was almost equal to the preferred (untested) gait speed of "not frail" subjects. In fact, the fastest gait speed of subjects in the "moderately frail" group was so slow that they would not be able to cross the street in the time it takes for a stop light to change from green to red. (It has been estimated that a walking speed of 4 feet/second [1.2 meters/second] is necessary to cross the street before a *Walk* sign changes to *Don't Walk*.[1]) Other investigators have also found that slow gait is a strong predictor of functional decline, perhaps because it is a marker for unmeasured comorbidity.[17]
- The PPT did not identify all of the individuals who might be considered frail. The authors suggested that other factors contributed to frailty, such as cognitive impairment, depression, impairment of vision or hearing, pain, and comorbidities.

Physical performance tests also serve to confirm satisfactory cognitive function. One of the principal reasons why people are unable to complete physical tests is because they lack the cognitive ability to understand and follow the instructions.[18]

Frailty indices

Campbell and Buchner[10] proposed a frailty index based on four components and measures of frailty (Table 8). The idea was that tests of multiple domains would give a better indication of the degree of functional reserve, i.e., how well an individual could withstand the minor stresses of day-to-day life. However, there is no generally accepted scoring system for this index. It is likely that frailty will eventually be defined and quantified via some index, but much work remains to be done to determine the index components, measures, and scoring system.

Table 8. Components and measures of frailty

Component	Measurement
Musculoskeletal function	Grip strength
	Chair stand†
Aerobic capacity	Sub-maximal stress test
	6-minute walk
Cognitive/integrative neurologic function*	Mini-mental state exam
	Static balance test
Nutritional state	Body mass index

† Time to complete five chair stands, i.e., stand up and sit down without using one's arms.

* Functions required for interaction with the environment.

Fried et al.[12] suggested a definition of frailty based on long term follow-up of 5,317 community-dwelling people aged 65 years and older (Table 9). Subjects with three or more criteria were considered frail, those with one or two criteria were hypothesized to be in an intermediate, possibly pre-frail stage, and people who met none of the criteria were considered not frail.

Table 9. Frailty criteria*

Criteria	Measurement
Unintentional weight loss of 10 pounds (4.5 kg) in past year	Single question
Self-reported exhaustion	Single question
Weakness	Hand-grip strength
Slow walking speed	Time to walk 15 feet (4.6 m) at usual pace
Low physical activity	Short questionnaire

* Three or more criteria = frail, one or two criteria = possibly pre-frail, no criteria = not frail.

At three- and seven-year follow-up, subjects defined as frail were far more likely to die, have a new hospitalization or fall, or experience worsening of ADL disability or mobility disability (Table 10). Individuals in the intermediate category experienced event rates that were between the frail and nonfrail subjects.

Table 10. Incidence of adverse outcomes associated with frailty at 3 and 7 years after study entry (%)

	Death		New hospitalization		New fall		Worsening ADL disability		Worsening mobility disability	
Baseline status*	3 yr	7 yr	3 yr	7 yr	3 yr	7 yr	3 yr	7 yr	3 yr	7 yr
Not frail	3	12	33	79	15	27	8	23	23	41
Possibly pre-frail	7	23	43	83	19	33	20	41	40	58
Frail	18	43	59	96	28	41	39	63	51	71

* At baseline, 2469 subjects were not frail, 2480 were possibly pre-frail, and 368 were frail.

Noteworthy was the observation that some of the frail subjects had none of the major chronic diseases that are typically associated with frailty. The authors suggested that there might be two different pathways to frailty: (1) physiologic changes of aging that are not disease-based (sarcopenia, neuroendocrine dysregulation, immune dysfunction), and (2) a final common pathway of severe disease or comorbidity.

Self-reported function

Alexander et al.[19] assessed the relationship between various self-reported physical functions and actual performance measures of walking ability, balance, and chair rise in 221 subjects (mean age, 80 years) in the U.S. The score on the Rosow-Breslau questionnaire (Table 11) demonstrated the highest correlation with actual performance measures. Self-reported walking ability was the best single predictor of overall functional mobility, leading the authors to suggest that "self-reported walking ability may be the best indicator of ADL and mobility performance in community-dwelling older adults." A possible explanation is that decreased walking ability could be a marker of difficulty with other common tasks. This relationship between walking and disability has been ob-

served in most similar studies.[11] Difficulty with mobility predicts future disability in tasks essential to living independently in the community (e.g., IADLs such as shopping and meal preparation) and to self-care (e.g., ADLs such as bathing and dressing).[20]

Table 11. Roslow-Breslau questionnaire

Able to do heavy work around the house like shoveling snow and washing windows, walls, or floors without help
Able to walk up and down stairs to the second floor without help
Able to walk a half a mile (1.6 km) without help

Fried et al.[21] observed a cohort of 436 healthy community-dwelling American women aged 70 to 79 years to identify preclinical indicators of future mobility difficulties. Three stages were defined based on self-reported data: (1) no difficulty performing tasks of daily living, including mobility, upper extremity function, household management, and self-care, (2) task modification, i.e., all tasks could be performed, but underlying health problems led to modification of the method or the frequency with which the task was performed (modification of mobility was by far the most common reason for inclusion in this group), and (3) difficulty performing tasks of daily living. Two objective tests were also done: time to walk four meters (13 feet), and time required to climb up and down a flight of 14 stairs.

After 18-month follow-up, mobility status was estimated by asking subjects if they could walk one-half mile (0.8 km) or climb ten stairs. Difficulty with one or both of these mobility tasks was much more likely for subjects initially classified in the “task modification”

group. Specifically, those in the “task modification” group 18 months earlier were almost four times more likely to report subjective difficulty with the half-mile (0.8 km) walk or 10-stair climb. As reported in other studies,[22] objective tests of baseline walking speed and 14-stair climb also correlated with subsequent mobility difficulty, with the stair-climb test being a more sensitive predictor of future disability. Thus, this study indicated that both self-reported task modification (particularly if the task involves mobility) and objective measures of mobility (time to walk four meters/13 feet, and time required to climb up and down a flight of 14 stairs) predicted who would become disabled in the future. It is likely that task modifications serve to maintain function for a period of time, and hence no difficulty performing the task is perceived, but the body’s reserve capabilities are eventually exceeded, thereby leading to difficulty with mobility and subsequent functional impairment.

Although self-reported health is a useful measure of frailty, it is not captured by performance measures.[18] From an insurance perspective, this means that even the most detailed battery of cognitive and physical performance tests would not detect all cases of frailty. Insurers might consider asking applicants to estimate the status of their health. Negative comments would be rare - most applicants would be healthy plus insurance coverage would be desired (and negative comments could jeopardize the application) - but unfavorable answers could be highly significant. Other application questions might address task modification. Compared to objective performance measures, self-reported task modification is more sensitive to early functional decline because people know when deterioration is occurring.[21] Applications for elderly persons could ask about (1)

task modifications (changes in method or frequency), and (2) difficulties performing the tasks. In the former circumstance, functional impairment could be predicted (the applicant would be in a preclinical stage of disability), and in the latter, functional impairment would already be present. It would also be worthwhile to ask the applicant's physician about self-reported health and task modification. Applicants may discuss these matters with their physicians but not admit the information on the application form.

Laboratory tests

Numerous studies have reported higher mortality in community-dwelling older people with a low serum albumin level. For example, Reuben et al.[23] reported that the relative risk for mortality in healthy, nondisabled older persons was 2.2 times higher in subjects with an albumin level below 4.0 g/dL (Table 12).

Table 12. Relative risk of four-year mortality, by serum albumin level

Serum albumin (g/dL)	Relative risk
≥4.4	1.0
4.2-4.3	1.6
4.0-4.1	1.6
<4.0	2.2

A study of 637 elderly hospitalized patients in Italy also identified low serum cholesterol as a risk factor for frailty.[24]

Other predictors of frailty

Many studies have reported risk factors that were associated with a higher likelihood of frailty. Examples are listed below.

- Carlson et al.[25] determined that elderly American subjects who experienced a decline in functional status after hospitalization were 50% more likely to be readmitted to the hospital or to be placed in a nursing home in the following six months. They postulated that the explanation was reduced physiologic reserve.
- Regarding overweight, the literature indicated that only very obese elderly women (BMI of 29 kg/m^2 or greater) were at increased risk for functional decline.[17]
- Chin A Paw et al.[26] studied elderly Dutch subjects to identify a simple "working" definition of frailty. The best predictor of future morbidity and mortality was the combination of physical inactivity (less than 3.5 hours per week of exercise or participation in avocations requiring physical exertion) and weight loss of more than 4 kg (9 pounds) in the prior five years.
- A study of 3571 elderly Japanese American men observed a higher risk of frailty in the presence of orthostatic hypotension (defined as a drop in systolic blood pressure of 20 mm Hg or more, or a drop in diastolic blood pressure of 10 mm Hg or more).[27]
- Inability to walk one kilometer (0.6 miles) was associated with a higher risk of frailty in 3,266 community-dwelling elderly Japanese subjects.[28]

Japan

Although the elderly population is increasing worldwide, this trend is particularly prominent in Japan. Accompanying growth in this segment of the population is a marked increase in the number of people who require assistance with ADLs. In 1999, the number of ambulatory frail elderly Japanese was estimated at 1.3 million and the number of bedridden elderly people with senile dementia was about 1.4 million. Difficulties in caring for the elderly are further complicated by changes in family size and responsibilities due to industrialization in the 20th century: smaller families, more working women, and reduced ability to care for frail elderly parents. Together these factors are modifying the traditional expectations of family care.[29]

Ishizaki et al.[30] examined predictors for functional decline among 583 nondisabled, rural Japanese aged 65 to 89 years (mean age, 71±5; 44% male) who lived in Akita Prefecture (Honshu). Data were collected during 1992 to 1995. Assessment of IADLs, intellectual activity, and social role was based on answers to the Tokyo Metropolitan Institute of Gerontology Index of Competence (Table 13). ADLs were measured using walking, feeding, continence, bathing, and dressing.

Table 13. Tokyo Metropolitan Institute of Gerontology Index of Competence

1. Can you use public transportation (bus or train) by yourself?
2. Are you able to shop for daily necessities?
3. Are you able to prepare meals by yourself?
4. Are you able to pay bills?
5. Can you handle your own banking?
6. Are you able to fill out forms for your pension?
7. Do you read newspapers?
8. Do you read books or magazines?
9. Are you interested in news stories or programs dealing with health?
10. Do you visit the homes of friends?
11. Are you sometimes called on for advice?
12. Are you able to visit sick friends?
13. Do you sometimes initiate conversations with young people?

During three-year follow-up, decline in IADL function was predicted by age 75 years or older, low hand-grip strength, hospitalization in the prior year, poor intellectual activities, and poor social role. Decline in ADL function was predicted by age 75 years or older, low hand-grip strength, hospitalization in the prior year, and no habit of daily walking (Table 14).

Table 14. Risk factors for IADL and ADL decline

Risk factor	Predictor of IADL decline	Predictor of ADL decline
Age ≥75	Yes	Yes
Low hand-grip strength	Yes	Yes
Hospitalization in prior year	Yes	Yes
Poor intellectual activities	Yes	--
Poor social role	Yes	--
No habit of daily walking	--	Yes

An editorial comment by Yukawa and McCormick[20] observed that this study highlighted a number of culture-specific frailty risk factors.

- The association between low hand-grip strength and decline in functional status has been reported in many other studies, the reason being that hand-grip strength correlates well with upper body strength. But this factor is particularly important in Japan. People in traditional Japanese homes sit on tatami (straw) mats and sleep on the floor, and greater upper and lower body strength is required to get up from sitting and lying positions, compared to rising from a chair or a bed, respectively. Thus, decreased upper body strength (as measured by decreased hand-grip strength) indicates that the individual is at high risk for IADL and ALD failure.
- Many rural and urban Japanese use public transportation which requires adequate upper and lower body strength, and the necessity to walk to the bus stop. Again, two of the factors associated with IADL and ADL failure - low hand-grip strength and no habit of daily walking - were more likely to be associated with decline compared to Western populations that make greater use of private automobiles for transportation.
- Poor social role (measured by visiting the homes of friends and being called on for advice) was also associated with IADL decline even though 83% of subjects lived with their children and 65% lived with their spouse.

China

Woo et al.[31] identified risk factors for functional decline in elderly Hong Kong Chinese that were similar to those reported in Western populations. Among people aged 70 years and older, risk factors for institutionalization included older age, female gender,

being single, poor cognitive function, low formal education, depression, and existing ADL dependency. The elderly also faced many of the same difficulties in obtaining long term care. For the elderly, care has traditionally been provided by the extended family. However, with recent economic developments, the lack of living space, and the need for both husband and wife to work, there is often no one in the family to provide care when the elderly begin to require supervision or assistance. This situation was reported in a survey where three-fifths of respondents agreed that disabled people should live in an institution rather than at home.[32] The authors of this study opined that there will be a growth in private insurance to cover long term care because the Government would be unable to fund these costs. A separate report also indicated that death due to frailty (falls, pneumonia and septicemia) was becoming more common in Chinese people.[33]

EXERCISE AS A MEANS TO LIMIT FRAILTY

Physical capacity peaks in young adulthood and then declines at a rate which varies from one individual to another. Part of the physical decline is due to aging and is not amenable to intervention. Even healthy aging is associated with a striking loss of muscle mass and strength, with about half the muscle mass lost by age 80 years. The practical importance of this is that an older person is often precariously close to the threshold at which a small decline in physical capacity (e.g., after a minor illness) will make it impossible to perform basic everyday activities, such as walking or rising from a chair.[34]

Some age-related changes are due to disuse and not aging, and the lost fitness can be regained with regular physical activity, even in extreme old age.[34] Most of the health

benefits of exercise can be gained by performing moderate intensity physical activities - the equivalent to brisk walking at three to four miles (4.8 to 6.4 km) per hour - outside of formal exercise programs.[34] Strength training does not halt the underlying loss of muscle fibers, but the improvement in strength may be equivalent to 10 to 20 years of "rejuvenation" and may prevent an individual from falling below functionally important thresholds. Many other health benefits are associated with regular physical activity in old age. Weight bearing exercise may slow the rate of bone loss in older women, balance training and tai chi may make falls less likely, and regular exercise may help in major depression. The social benefits of group exercise activities in later life should not be underestimated in a population where social isolation and loneliness may be common.

There is evidence that morbidity is being compressed into the final years of life and that healthy aging may be achievable, particularly for well educated, affluent older people. A landmark study from the University of Pennsylvania (U.S.) followed graduates from their early 40s to their mid-70s.[35] The study focused on three potentially modifiable risk factors: cigarette smoking, body mass index, and exercise patterns. Subjects who had these risk factors in their mid-60s had both an earlier onset of disability and a greater level of cumulative disability, as well as more disability in the final year of life. In contrast, age at onset of disability was postponed by more than five years in the low risk group. In this study, adopting low risk habits in later life was associated with not only an increase in life-span but also an increase in healthspan.[34]

CONCLUSIONS

Characteristics of frailty

- Frailty means (1) loss of functional reserve in multiple areas (domains), and (2) existence at a level close to or past the threshold for failure, with negligible tolerance of the external stresses of day-to-day living.
- It indicates multisystem failure, instability, and subclinical" or "preclinical" disability.

Physical performance strongly associated with outcome

- Mobility- Risk is higher if the applicant walks less often or not as far; cannot walk 1/2 mile (about 1 km); slow walking speed, e.g., less than 4 feet (1.2 m) per second; less than 30 minutes of strenuous (for age) activity per day; decreased exercise tolerance; short duration of exercise (for age) during treadmill test.
- Balance and aerobic capacity- Possible questions for the application include the following: How far can you walk? How often do you walk and how far? When did you last walk this distance? Do you walk less now than previously? Why? How many flights of stairs can you climb? Do you exercise daily? What type? Do you do heavy work in the house (e.g., shovel snow, wash windows and floors) or do you need help?
- Use of physical performance tests by long term care insurers would increase the accuracy of risk classification. Tests should emphasize mobility and balance. An additional benefit is that the ability to follow test instructions confirms good cognitive status.

Self-reported function

- Consider asking the applicant, agent, and physician questions about general health and overall function; walking ability (walks less often/not as far, holds wall/furniture when walking); task modification (change in method or frequency); and use of assistive devices (cane/walking stick, jar openers). However, applicants and physicians may not always indicate actual self-reported function.
- Comments less favorable than “good” (self-reported function) would generally indicate higher risk.

Nutrition and laboratory tests

- Nutritional items of importance include loss of appetite; unexplained weight loss (often found in the physician’s statement); overweight or underweight based on values appropriate for the market (e.g., for Western populations, risk of frailty is higher if BMI is 22 kg/m^2 or less, and risk of functional decline is higher if BMI is 29 kg/m^2 or greater); episode of hypothermia; and complaint of always being cold (beyond what is expected for age)
- Risk is higher in the following situations: serum albumin below normal, serum cholesterol below 3.8 mmol/L (145 mg/dl), low creatinine for body size, or anemia (many causes other than frailty).

Driving status

- Risk is higher if there is a history of frequent automobile accidents, one or more single-car accidents, or multiple citations for bad driving. Stopping driving may indicate problems with vision, reaction time, and cognitive state.
- Consider asking the applicant: Do you still drive? (If no) Why not? (If yes) May I see your driver's license for purposes of identification (to confirm that license is current)?

Social factors

- Important information includes living arrangements (with spouse/friend or alone), social isolation, and volunteer work and avocations (if discontinued, why).
- Higher risk is associated with less education and lower socioeconomic status.

Physician's statement

- Generally contains major diagnoses, medications, control, compliance, complications, weight over time, laboratory tests, and falls that caused injury.
- May contain lifestyle information, test results (e.g., exercise test, bone density test, pulmonary function test), overall condition, activity level, and history of depression and incontinence.
- Generally does not contain functional and cognitive status (unless significantly impaired).
- Consider asking specific questions about cognitive status, IADLs and ADLs, frailty, task modification, trends, and overall assessment with regard to type of insurance (long term care, life, etc.).

Underwriting assessment

- A frail person is at high risk for disability (disability insurance), failure of IADLs and ADLs (long term care insurance), and death (life insurance and substandard annuities).
- The underwriting assessment of frailty is based on these factors: age and gender; impairments and severity; cognitive impairment; IADL and ADL problems; geriatric syndromes; mobility, balance, and aerobic capacity; physical performance tests; self-reported function; nutrition; laboratory tests; social factors; and specific questions asked in the application and the attending physician's statement.
- Risk is high in the following situations: IADL or ADL failure; cognitive impairment; history of nursing home confinement; hospitalization in the prior year (especially if loss of function after hospitalization); downward trend in physical, social, or cognitive function; and occurrence of a geriatric syndrome.
- Risk is higher with sarcopenia plus obesity (the "fat frail"), or if three or more criteria of the Fried[12] frailty index are present (unintentional weight loss of 10 pounds [4.5 kg] in the past year, self-reported exhaustion, weakness, slow walking speed, and low physical activity).
- With regard to falls, risk is higher if the fall was caused by a minor event (e.g., a fall at home) vs. during exercise. Prolonged duration on the floor is less favorable.
- Orthostatic hypotension often indicates higher risk.

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