

## Research Article

# Frailty in Older Adults: A Nationally Representative Profile in the United States

Karen Bandeen-Roche,<sup>1,2,3</sup> Christopher L. Seplaki,<sup>4</sup> Jin Huang,<sup>2,3</sup>  
Brian Buta,<sup>2,3</sup> Rita R. Kalyani,<sup>2,3</sup> Ravi Varadhan,<sup>2,5</sup> Qian-Li Xue,<sup>2,3</sup>  
Jeremy D. Walston,<sup>2,3</sup> and Judith D. Kasper<sup>6</sup>

<sup>1</sup>Department of Biostatistics, Bloomberg School of Public Health and <sup>2</sup>Center on Aging and Health, Johns Hopkins University, Baltimore, Maryland. <sup>3</sup>Department of Medicine, School of Medicine, Johns Hopkins University, Baltimore, Maryland. <sup>4</sup>Department of Public Health Sciences, University of Rochester School of Medicine and Dentistry, Rochester, New York. <sup>5</sup>Department of Oncology, School of Medicine, Johns Hopkins University, Baltimore, Maryland. <sup>6</sup>Department of Health Policy and Management, Bloomberg School of Public Health, Baltimore, Maryland.

Address correspondence to Karen Bandeen-Roche, PhD, Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health, 615 N. Wolfe Street, Baltimore, MD 21205. Email: [kbandeen@jhu.edu](mailto:kbandeen@jhu.edu)

Received February 26, 2015; Accepted July 14, 2015

**Decision Editor:** Stephen Kritchevsky, PhD

## Abstract

**Background.** Frailty assessment provides a means of identifying older adults most vulnerable to adverse outcomes. Attention to frailty in clinical practice is more likely with better understanding of its prevalence and associations with patient characteristics. We sought to provide national estimates of frailty in older people.

**Methods.** A popular, validated frailty phenotype proposed by Fried and colleagues was applied to 7,439 participants in the 2011 baseline of the National Health and Aging Trends Study, a national longitudinal study of persons aged 65 and older. All measures drew on a 2-hour in-person interview. Weighted estimates of frailty prevalence were obtained.

**Results.** Fifteen percent (95% CI: 14%, 16%) of the older non-nursing home population is frail, and 45% is prefrail (95% CI: 44%, 47%). Frailty is more prevalent at older ages, among women, racial and ethnic minorities, those in supportive residential settings, and persons of lower income. Independently of these characteristics, frailty prevalence varies substantially across geographic regions. Chronic disease and disability prevalence increase steeply with frailty. Among the frail, 42% were hospitalized in the previous year, compared to 22% of the prefrail and 11% of persons considered robust. Hip, back, and heart surgery in the last year were associated with frailty. Over half of frail persons had a fall in the previous year.

**Conclusions.** Our findings support the importance of frailty in late-life health etiology and potential value of frailty as a marker of risk for adverse health outcomes and as a means of identifying opportunities for intervention in clinical practice and public health policy.

**Key Words:** Epidemiology—Health disparities—Public health

With an expanding older population, interventions to prolong health and tools to assist in treating medically complex patients are urgently needed. Such needs require that we identify older people at

greatest risk for adverse health events; frail older adults are a major, identifiable subset of those most vulnerable (1). This study provides nationally representative estimates of frailty prevalence in 2011, and

characterizes, by frailty status, the risk of adverse events that affect health care costs and quality of life for older Americans.

Frailty assessment has been operationalized in dozens of instruments (2–12). Here, we employ the widely cited “Fried”/“Cardiovascular Health Study” (CHS) physical frailty phenotype (PFP; ref. 13). The PFP methodology considers frailty a syndrome of dysregulated energetics resulting in slowing, fatigue, and decreased muscle mass, strength, and physical activity (14). It has identified older adults at increased risk of mortality, falls, disability, and adverse events following surgery (15–18). PFP-based estimates of frailty prevalence among community-dwelling elders have ranged from 4% to 17% in studies with varying geographic catchment and methods of sample selection (19–21).

This paper employs the National Health and Aging Trends Study (NHATS), which provides a nationally representative sample of Medicare enrollees aged 65 and older. We estimate prevalence of frailty in the United States and of a subclinical, “pre-” frail state, by demographic characteristics and geographic region, and we also examine variation in chronic disease prevalence, falls, disability, and surgical uptake by frailty status. Thereby, we aim to highlight frailty as a means of identifying opportunities to intervene in clinical practice and public health policy.

## Methods

Data are from the 2011 NHATS baseline. The sample was drawn from the Medicare enrollment file (22). The response rate of 71% (23) yielded 8,245 participants. In 93% of these cases, the sample person was able to complete the NHATS interview; otherwise, proxy interviews (7%) were conducted. Our initial sample was restricted to persons assessed in-person and dwelling in community or residential care settings outside nursing homes ( $n = 7,609$ ); 170 cases were dropped for insufficient data (see below) leaving an analytic sample of 7,439. The NHATS was approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

## Measures

### Frailty

Frailty was assessed by the PFP paradigm that is grounded in five criteria: exhaustion, low physical activity, weakness, slowness, and shrinking. Criteria were operationalized from NHATS interview and performance assessments ([www.nhats.org](http://www.nhats.org)).

Participants met criteria for “exhaustion” who reported recently having low energy or being easily exhausted: enough to limit their activities. They met criteria for “low physical activity” if, recently, they never walked for exercise or engaged in vigorous activities. Participants met criteria for “shrinking” if they had body mass index (BMI) less than 18.5 kg/m<sup>2</sup>, based on self-reported height and weight, or reported unintentionally losing 10 or more pounds in the last year.

“Low walking speed” was defined, using the first of two usual pace walking trials, as being at or below the 20th percentile of the weighted population distribution within four sex-by-height categories. “Weakness” was defined, using maximum dominant hand grip strength over two trials, as being at or below the 20th percentile within eight sex-by-BMI categories. These two criteria are detailed in [Supplementary Tables 1 and 2](#). For each, participants not tested because of safety concerns, ineligible due to recent surgery or pain, or who attempted but were unable to complete a test, were scored as “0” following recommended practice (24,25). These criteria provide nationally representative standards.

“Frail status” was assigned using the number of criteria met: those with none were considered “robust”; those with one to two, “pre-frail”; and those with three to five, “frail.”

### Demographic Characteristics

Age (5-year categories from 65 to 90 years old and a final category of 90 years of age or older), sex, race/ethnicity (white non-Hispanic, black non-Hispanic, Hispanic, other), and annual income for individuals or couples (quartiles—imputed when missing; we employed the first of five imputations NHATS provides) (26) were considered. Residence in one of nine census divisions was assigned using the participant’s home address.

### Medical Conditions and Utilization

Participants were asked whether a doctor had ever told them they had: arthritis, diabetes, heart disease, high blood pressure, lung disease, osteoporosis, and stroke. Self-report of chronic conditions has shown good diagnostic accuracy against medical records and claims (27). Probable dementia was assessed using report of a diagnosis, a screening instrument administered to proxy respondents (28), and cognitive tests (29). Overnight hospitalization, surgery (back, heart, knee, hip), falls, and worry about falling were self-reported.

### Disability

The NHATS survey assesses *self-care* (bathing, dressing, eating, toileting), *mobility* (getting around inside, going outside, getting out of bed), and *household activities* (doing laundry, preparing meals, shopping for groceries or personal items, medication management, handling bills and banking). We used a hierarchical disability measure reflecting *receipt of help* (with any self-care or mobility activity; with any household activity for health or functioning reasons), *no receipt of help but difficulty* in performing one or more activities, and *no help or difficulty* with any activities.

## Statistical Analysis

Persons assessed on at least three frailty criteria (including “0” scores) were considered eligible ( $n = 7,439$ , of whom 87.5% were assessed on all five criteria, 9.2% on four criteria, and 3.3% on three criteria). Prevalence of frailty status was examined by demographics, residential setting, and income. Multinomial logistic regression of frailty (three categories) on demographic characteristics was used to assess statistical significance (Wald global test for nullity of all predictor variable coefficients). Prevalence by census divisions was examined adjusting for income quartiles, age, and race/ethnicity using binary logistic regression. Prevalence of chronic conditions, prior-12 month surgeries and overnight hospitalization, falls, fear of falling, and disability, was examined by frailty status. Logistic regression of health conditions and events (present/absent) on frailty status adjusting for age and sex was used to assess statistical significance (Wald tests for nullity of all frailty coefficients).

To determine frailty associations with health and functional status independent of demographic characteristics, binary and multinomial logistic regression were used. Number of diseases (0, 1–3, 4+), any surgery in the last year, any fall in the last year, and disability outcomes were regressed on frailty, age, gender, race, income quartile, and census division.

Whereas frailty is expected to associate with disability, persons with frailty preceding disability are of particular clinical interest. Therefore, frailty prevalence was characterized among persons receiving no help in functional tasks, and among persons

additionally not reporting any difficulty, separately for the various domains of disability.

Even after scoring persons who did not do a test because of health/safety concerns as zero (worst performance), some missing values remained for individuals who did not do a test for nonhealth/safety reasons (eg, space constraints for the walking test). To address these, we employed multiple imputation (10 replicates) using chained equations (30) incorporating all variables defined above. The percentage imputed was 8.67% for walking speed and no greater than 0.5% for any other variable.

We conducted three sensitivity analyses because our study differed from others, including the foundational CHS paper (13), by including older adults living in residential care, treating health/safety-related inability to complete grip strength and walking assessments as “lowest” outcomes rather than missing, and imputing missing item data. To assess the impact of these choices, we repeated frailty prevalence analyses eliminating those in residential care, applying published PFP criteria for walking speed and grip strength (13), and determining frailty status using only nonmissing criterion assessments. Ramifications for criterion definition are detailed in [Supplementary Tables 1 and 2](#).

All analyses incorporated the NHATS sampling weights, strata, and clustering elements of the sample design (31).

## Results

The 2011 U.S. prevalence of frailty among adults aged 65 years and older (excluding nursing home residents) was estimated at 15.3% (95% CI: 14.2%–16.4%), with 45.5% prefrail (95% CI: 44.0%–46.9%) and 39.2% robust (95% CI: 37.7%–40.8%; [Table 1](#)). Expectedly, higher frailty prevalence was observed among older

persons, women and racial/ethnic minorities, persons in residential care, and persons with lower incomes. The extent of variation was striking, with frailty prevalence 65%–85% higher for blacks and Hispanics than whites, more than twofold higher among those in residential care versus the community dwelling, and more than fourfold higher among the oldest age group relative to the youngest, and the lowest income quartile relative to the highest. Individual frailty criterion analyses are shown in [Supplementary Table 3](#).

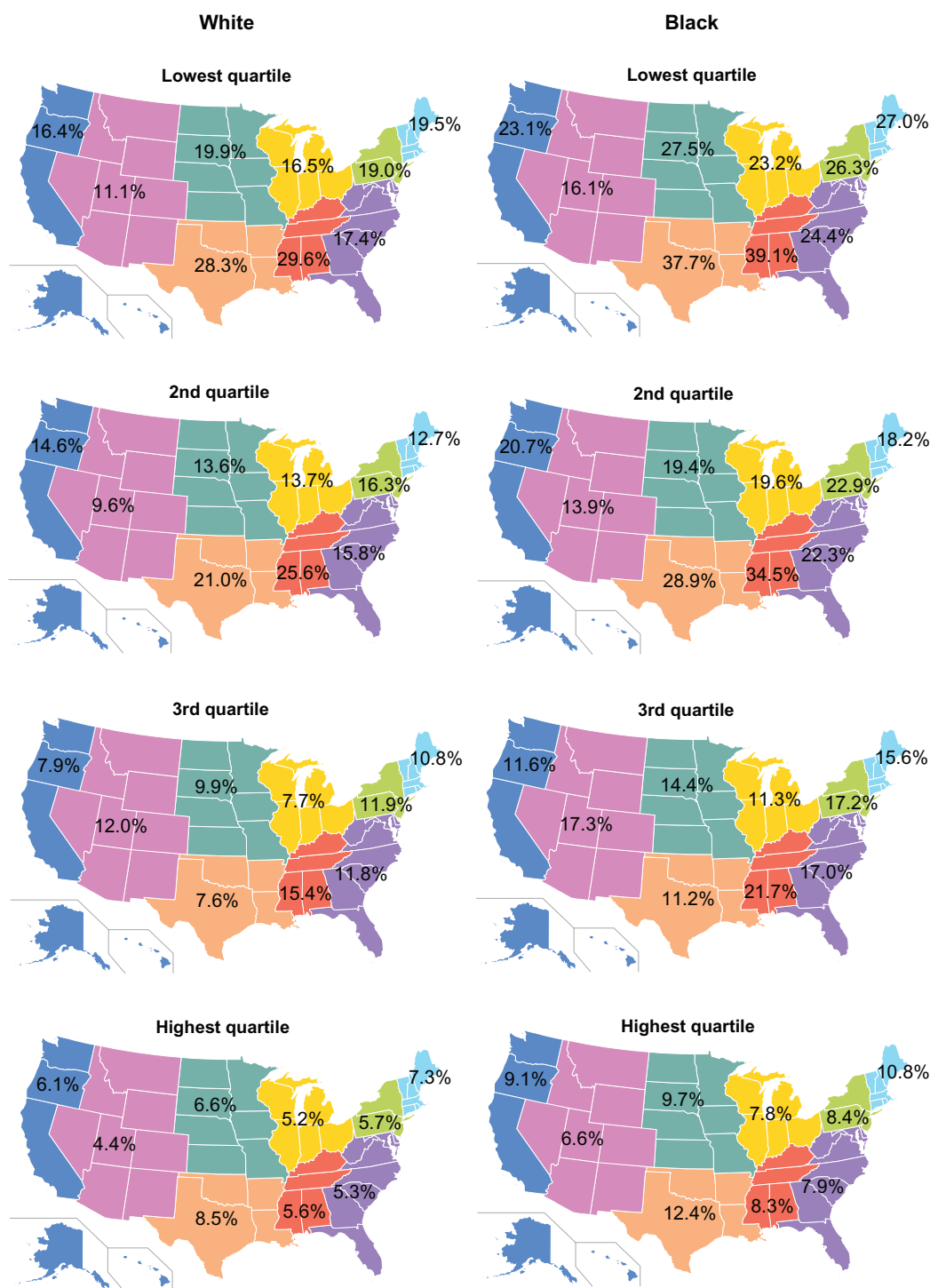
There was substantial regional variation. When considered crudely (not shown), frailty prevalence estimates varied approximately twofold from 10.4% in the mountain/desert west to 21.8% in the inland south. Regional patterns persisted after adjusting for age and race/ethnicity ([Figure 1](#); predicted values at mean age shown by income quartiles and race/ethnicity). For most regions, there was a generally decreasing trend in frailty prevalence with greater income; in the Mountain Division, frailty prevalence varied little among income quartiles below the highest. Regional differences were statistically significant only in the lowest quartile ( $p < .002$ , global Wald test for nullity of all region effects for the lowest income quartile in a model with age, race, income, region, and Income  $\times$  Region indicators). Detail with CIs is shown in [Supplementary Table 4](#).

Prevalence of chronic conditions and adverse event occurrence by frailty status are shown in [Table 2](#). For every chronic condition, we observed a steep prevalence gradient from robust to frail—more than twofold for diabetes, heart disease, lung disease, osteoporosis, and stroke. For probable dementia, the gradient spanned a factor of 10. Percentages falling in the previous year, or worried about falling, were three to four times higher among the frail than the robust; for multiple falls, percentages were sevenfold higher. The percentage with a hospital stay in the

**Table 1.** Prevalence of Frail Status by Demographic Subgroups: National Health and Aging Trends Study, 2011;  $n = 7,439$

Characteristic	Subgroup Prevalence (%)	Frail Status Prevalence Within Subgroup (%)		
		Robust	Prefrail	Frail
Age***	28.1	51.6	39.5	8.9
65–69	25.0	44.2	45.1	10.7
70–74	19.1	37.2	49.3	13.5
75–79	14.6	29.3	50.6	20.1
80–84	9.0	19.3	47.4	33.3
85–89	4.2	13.4	48.7	37.9
90+				
Sex***				
Male	43.6	43.8	43.3	12.9
Female	56.4	35.6	47.2	17.2
Race/ethnicity***				
White non-Hispanic	81.7	40.8	45.3	13.8
Black non-Hispanic	8.3	31.1	46.0	22.9
Hispanic	6.7	28.8	46.5	24.6
Other	3.4	40.5	45.8	13.7
Residence***				
Community	94.6	40.3	45.2	14.5
Residential care	5.4	19.8	50.7	29.5
Income***				
Lowest quartile	23.6	23.8	50.4	25.8
2nd quartile	24.1	32.4	47.9	19.7
3rd quartile	26.9	43.0	46.1	11.0
Highest quartiles	25.4	56.0	38.1	5.9

Notes: Overall prevalence estimates were 15.3% frail (95% CI: 14.2%, 16.4%), 45.5% prefrail (95% CI: = 44.0%, 46.9%), and 39.2% robust (95% CI: 37.7%, 40.8%). Per characteristic, comparisons were statistically significant at \*\*\* $p < .001$ .



**Figure 1.** Age-adjusted frailty prevalence by census divisions, income quartiles, and white/black race/ethnicity. Census divisions are colored as: Pacific: dark blue; Mountain: pink; West South Central: tan; East South Central: red; South Atlantic: purple; West North Central: dark green; East North Central: yellow; Middle Atlantic: light green; New England: light blue.

previous year was almost four times higher among frail persons, and, except knee surgery, other types of surgery also were significantly higher.

Help with functional tasks for health reasons was rare among the robust (Figure 2). Large percentages of frail persons received help in self-care (45%), mobility (50%), and household (68%) activities, but considerable percentages also reported “no difficulty” (32%,

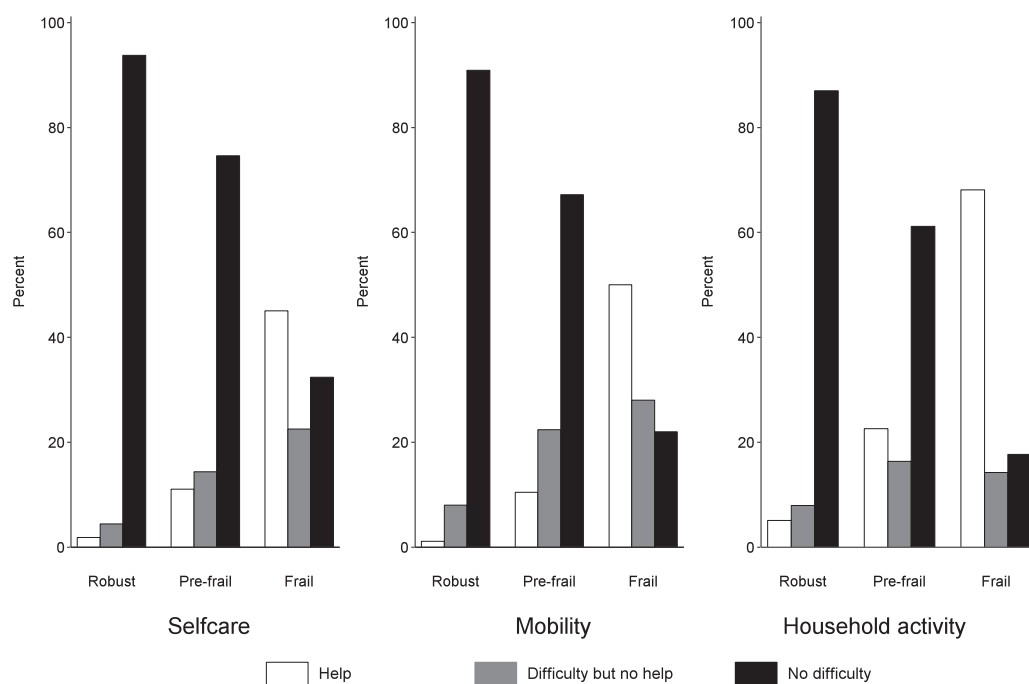
22%, 18%, respectively). Assistance increased stepwise in the pre-frail and frail.

Strong associations of health outcomes with frailty status persisted after adjustment for age, gender, race/ethnicity, income, and census division (Table 3). The estimated odds of having four or more comorbid conditions were more than 40 times higher among the frail than the robust (95% CI: 24, 69); the odds were yet more

**Table 2.** Prevalence of Diseases, Health Events, and Disability in Older Persons by Frailty Status

Health Conditions/Events	Total (%)	Frailty status		
		Robust (%)	Prefrail (%)	Frail (%)
Chronic diseases				
Arthritis***	53.7	40.9	57.6	75.4
Diabetes***	23.8	17.2	25.5	35.4
Heart disease***	24.6	16.2	25.8	42.4
High blood pressure***	64.1	56.2	68.0	72.5
Lung disease***	15.6	9.2	17.5	26.2
Osteoporosis***	21.2	15.6	22.3	31.8
Stroke***	10.1	4.7	10.7	21.9
Dementia (probable)***	9.7	2.7	9.2	29.3
Overnight hospitalization last 12 months***	20.9	11.1	22.1	42.4
Surgery last 12 months				
Back surgery***	0.8	0.4	0.8	1.9
Heart surgery**	2.2	1.5	2.6	2.8
Knee surgery	1.5	1.2	1.7	1.6
Hip surgery**	0.7	0.3	0.7	2.0
Falls in last 12 months***	30.5	18.1	32.9	54.9
Fallen more than once in last 12 months***	13.7	5.0	13.8	35.2
Worry about falling in last month***	27.3	12.4	30.2	56.9

Notes: Crude estimates are provided; tests comparing disease, event, and disability prevalence among frailty groups are age- and sex-adjusted. For age- and sex-adjusted comparisons among robust, prefrail, frail: \*\* $p < .01$ ; \*\*\* $p < .001$ .

**Figure 2.** Disability prevalence by frail status.

highly elevated for needing help in functional tasks, whatever the domain. Compared to the robust, the prefrail had odds ratios of 5.0 for having four or more diseases, and their odds of receiving help were increased from nearly 5 to more than 10 times across functional domains.

Frailty prevalence among nondisabled persons was diminished compared to the overall prevalence of 15.3%, but still appreciable. Estimates were 9.6% (95% CI: 8.6%, 10.7%) for persons

not receiving help in any self-care task and 6.6% (95% CI: 5.7%, 7.4%) for persons additionally reporting no difficulty. Estimates of frailty prevalence for other domains ranged from 4.2% for persons reporting neither help nor difficulty in any household activity to 8.8% for persons not receiving help in any mobility task. Estimates of prefrail prevalence approximated those in the overall population regardless of domain. Detail is provided in [Supplementary Table 5](#).

**Table 3.** Odds of Health Events and Disability for Frail and Prefrail, Relative to Robust, Older Persons

	Comparison (OR, 95% CI) <sup>2</sup>	
	Prefrail vs Robust	Frail vs Robust
Number of chronic diseases		
1–3	2.12 (1.75, 2.57)	5.46 (3.38, 8.80)
4+	5.04 (3.76, 6.77)	40.79 (24.22, 68.70)
Any surgery last 12 months (vs none)	1.87 (1.39, 2.50)	3.03 (2.08, 4.43)
Any fall last 12 Months (vs none)	2.18 (1.84, 2.59)	5.39 (4.37, 6.65)
Self-care disability		
Difficulty but no help	3.80 (3.06, 4.72)	12.50 (9.84, 15.88)
Help	6.17 (4.18, 9.11)	49.01 (33.19, 72.37)
Mobility disability		
Difficulty but no help	3.51 (2.86, 4.31)	12.44 (9.68, 16.01)
Help	10.13 (6.25, 16.42)	124.55 (78.64, 197.26)
Household activities disability		
Difficulty but no help	2.76 (2.24, 3.41)	8.04 (5.98, 10.82)
Help	4.79 (3.75, 6.13)	42.39 (32.56, 55.19)
Overall disability level		
Difficulty with 1 or more but no help	2.85 (2.44, 3.32)	8.72 (6.40, 11.87)
Any help with self-care, mobility, or household activities	5.61 (4.40, 7.14)	66.79 (49.67, 89.81)

Notes: Separate logistic regressions for prefrail vs robust and frail vs robust were conducted for each health characteristic, adjusting for age, gender, race, income, and census division. Reference categories are: 0 for number of chronic diseases; none for surgery and falls; no difficulty for self-care, mobility, or household activities disability indicators; no difficulty with any activities for overall disability. OR = odds ratio.

In sensitivity analyses assessing differences between our results and previous frailty prevalence estimates, the overall frailty prevalence estimate changed by only 0.8% upon excluding persons in residential care (to 14.5%). Changes were less than 1% in all demographic subcategories. Similarly estimates differed negligibly when incorporating multiple imputation, versus not. In contrast, upon applying the CHS cutpoints for frailty (13) rather than cutpoints derived herein, estimates of frailty prevalence increased from 15.3% to 27.5%.

## Discussion

Fifteen percent of older adults in the United States are frail based on the nationally representative data presented here. We observed steep age-related increases in frailty prevalence, from 9% in persons aged 65–69 to 38% of those aged 90 or older. Among persons not in nursing homes, those living in residential care settings are twice as likely to be frail as generally—a statistic not previously presented. Sizable race and income disparities in frailty prevalence, and regional differences, were observed. Adverse health and functioning outcomes were two to many times more common among frail versus robust individuals.

Clinical applications of frailty assessment are emerging, for example that frailty can improve screening for risk of adverse postsurgical events (18,32). Our findings support the likely value of advancing such applications. Excess disease and adverse health events are present among frail and prefrail older adults. Frailty is a strong predictor of disability and high multimorbidity, but a considerable proportion of frail persons are free of these, consistent with conceptualizing frailty as an underlying physiological process and not merely an outcome or marker of disease and disability. Of note: in the previous year, over half of frail persons had a fall, over one-third had fallen multiple times, and two-fifths had been hospitalized. Falls are associated with considerably higher costs in the Medicare population (33), and inpatient hospital care remains the largest component of Medicare spending (34). Interventions targeted to frail persons may be effective and yield cost savings.

Continuing research can refine frailty measurement. Percentile-based cutpoints developed to define PFP criteria in our study were markedly lower than their counterparts from the widely used CHS. Differences in study samples contribute (NHATS is nationally representative), but of largest impact was the inclusion of persons who could not complete walking speed and grip strength tests for health/safety reasons. We made this inclusion for three reasons. To score performance as “0” (“low”) when inability to perform is rooted in poor health or safety concerns has face validity and follows recommended practice (24,25). We did not treat health/safety-related inability to perform as “missing” because such missingness surely is associated with performance capacity, introducing a likely bias into subsequent criterion estimation. We avoided exclusion because we sought to draw inferences that were nationally representative for a stably defined population of older adults. Our scoring method may characterize some individuals as “frail” who could have performed highly if tested, and the use of percentile-based cutpoints bears further consideration: Research to optimize or tailor cutpoints for clinical relevance (35) is needed. The availability of frailty indicators in a large nationally representative sample of older people provides a basis for these next steps.

Our findings are based on cross-sectional data, hence are limited because the direction of relationships between frailty and adverse health indicators cannot be determined. Some studies, however, have demonstrated a substantially heightened risk of incident adverse outcomes among the frail and prefrail as compared to the robust (13,14). We therefore consider the potential of frailty measures for identifying high-risk subsets to be high. Missing data are a second limitation, ranging to 9% for walking speed. We multiply imputed these. This approach cannot protect against all biases introduced by missing data but generally provides better protection than eliminating individuals from analyses, while maintaining validity of inferences through its “multiplicity.”

In addition to persons who are frail, persons who are prefrail are a large percentage of U.S. older adults, warranting further investigation regarding progression to frailty and factors that may protect against progression. Lower income persons and racial/ethnic



minorities experience substantially elevated frailty prevalence—particularly concerning frailty as a state of increased vulnerability to adverse health outcomes. Then, these individuals have excess vulnerability together with limited resources with which to compensate (36), thus are at risk for synergistically elevated health disparities. Regional differences in frailty have not been examined previously. Explaining regional variation in health care spending is ongoing (37), and the frailty variation observed here may contribute. Our data also contain encouraging news: nearly two-thirds of the oldest old in the United States, outside nursing homes, are not frail. These data confirm that rapid decline is not inevitable after the mid-80s. Of particular interest is the identification of factors that contribute to remaining robust in advanced old age.

In conclusion, our findings support the importance of frailty in late-life health etiology. They bolster evidence for deploying frailty measures as clinical tools to identify at-risk older adults in whom interventions might be targeted. The comprehensive national picture they provide identifies subsets of older people at heightened risk for a prevalent adverse health state. Pursuit of findings regarding frailty disparities, risks among prefrail persons, and the substantial fraction of oldest-old who remain nonfrail has potential to reduce disparities and extend the span of robust health in older adults.

## Supplementary Material

Supplementary material can be found at: <http://biomedgerontology.oxfordjournals.org/>

## Funding

This work was supported by the National Institute on Aging (U01-AG032947, P30-AG021334, and K01AG031332 to C.L.S.) and the National Institute of Diabetes and Digestive and Kidney Diseases (K23DK093583 to R.R.K.) at the National Institutes of Health.

## References

- Morley JE, Vellas B, van Kan GA, et al. Frailty consensus: A call to action. *J Am Med Dir Assoc*. 2013;14(6):392–397. doi:10.1016/j.jamda.2013.03.022
- Saliba D, Elliott M, Rubenstein LZ, et al. The Vulnerable Elders Survey: A tool for identifying vulnerable older people in the community. *J Am Geriatr Soc*. 2001;49(12):1691–1699. doi:10.1046/j.1532-5415.2001.49281.x
- Strawbridge WJ, Shema SJ, Balfour JL, Higby HR, Kaplan GA. Antecedents of frailty over three decades in an older cohort. *J Gerontol B Psychol Sci Soc Sci*. 1998;53(1):S9–16. doi:10.1093/geronb/53B.1.S9
- Rockwood K, Mitnitski A. Frailty in relation to the accumulation of deficits. *J Gerontol A Biol Sci Med Sci*. 2007;62(7):722–727.
- Binder EF, Schechtman KB, Ehsani AA, et al. Effects of exercise training on frailty in community-dwelling older adults: Results of a randomized, controlled trial. *J Am Geriatr Soc*. 2002;50(12):1921–1928. doi:10.1046/j.1532-5415.2002.50601.x
- Brown M, Sinacore DR, Binder EF, Kohrt WM. Physical and performance measures for the identification of mild to moderate frailty. *J Gerontol A Biol Sci Med Sci*. 2000;55(6):M350–M355. doi:10.1093/gerona/55.6.M350
- Ensrud KE, Ewing SK, Taylor BC, et al. Comparison of 2 frailty indexes for prediction of falls, disability, fractures, and death in older women. *Arch Intern Med*. 2008;168(4):382–389. doi:10.1001/archinternmed.2007.113
- Gill TM, Baker DI, Gottschalk M, Peduzzi PN, Allore H, Byers A. A program to prevent functional decline in physically frail, elderly persons who live at home. *N Engl J Med*. 2002;347(13):1068–1074. doi:10.1056/NEJMoA020423
- Jones DM, Song X, Rockwood K. Operationalizing a frailty index from a standardized comprehensive geriatric assessment. *J Am Geriatr Soc*. 2004;52(11):1929–1933. doi:10.1111/j.1532-5415.2004.52521.x
- Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. *J Am Geriatr Soc*. 1991;39(1):46–52. doi:10.1111/j.1532-5415.1991.tb05905.x
- Steverink N, Slaets JJP, Schuurmans H, Lis M. van. Measuring frailty: Development and testing of the Groningen Frailty Indicator (GFI). *Gerontologist*. 2001;41 (special issue 1):236–237.
- Winograd CH, Gerety MB, Chung M, Goldstein MK, Dominguez F Jr, Val-lone R. Screening for frailty: Criteria and predictors of outcomes. *J Am Geriatr Soc*. 1991;39(8):778–784. doi:10.1111/j.1532-5415.1991.tb02700.x
- Fried LP, Tangen CM, Walston J, et al.; Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: Evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001;56(3):M146–M156. doi:10.1093/gerona/56.3.M146
- Bande-en-Roche K, Xue QL, Ferrucci L, et al. Phenotype of frailty: Characterization in the women's health and aging studies. *J Gerontol A Biol Sci Med Sci*. 2006;61(3):262–266.
- Xue QL, Walston JD, Fried LP, Beamer BA. Prediction of risk of falling, physical disability, and frailty by rate of decline in grip strength: The women's health and aging study. *Arch Intern Med*. 2011;171(12):1119–1121. doi:10.1001/archinternmed.2011.252
- Ensrud KE, Ewing SK, Taylor BC, et al.; Study of Osteoporotic Fractures Research Group. Frailty and risk of falls, fracture, and mortality in older women: The study of osteoporotic fractures. *J Gerontol A Biol Sci Med Sci*. 2007;62(7):744–751.
- Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. *J Am Coll Surg*. 2010;210(6):901–908. doi:10.1016/j.jamcollsurg.2010.01.028
- McAdams-DeMarco MA, Suresh S, Law A, et al. Frailty and falls among adult patients undergoing chronic hemodialysis: A prospective cohort study. *BMC Nephrol*. 2013;14:224. doi:10.1186/1471-2369-14-224
- Collard RM, Boter H, Schoevers RA, Oude Voshaar RC. Prevalence of frailty in community-dwelling older persons: A systematic review. *J Am Geriatr Soc*. 2012;60(8):1487–1492. doi:10.1111/j.1532-5415.2012.04054.x
- Cawthon PM, Marshall LM, Michael Y, et al.; Osteoporotic Fractures in Men Research Group. Frailty in older men: Prevalence, progression, and relationship with mortality. *J Am Geriatr Soc*. 2007;55(8):1216–1223. doi:10.1111/j.1532-5415.2007.01259.x
- Santos-Eggimann B, Cuénoud P, Spagnoli J, Junod J. Prevalence of frailty in middle-aged and older community-dwelling Europeans living in 10 countries. *J Gerontol A Biol Sci Med Sci*. 2009;64(6):675–681. doi:10.1093/gerona/glp012
- DeNavas-Walt C, Proctor BD, Smith JC, U.S. Census Bureau. Current Population Reports, P60-245, *Income, Poverty, and Health Insurance Coverage in the United States: 2012*. Washington, DC: U.S. Government Printing Office; 2013.
- Kasper JD, Freedman VA. National Health and Aging Trends Study (NHATS) User Guide Rounds 1 & 2. 2013. [www.nhats.org](http://www.nhats.org). Accessed March 29, 2014.
- Kasper JD, Freedman VA, Niefeld MR. Construction of Performance-Based Summary Measures of Physical Capacity in the National Health and Aging Trends Study. NHATS Technical Paper #4. 2012. [www.nhats.org](http://www.nhats.org). Accessed August 5, 2014.
- Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol*. 1994;49(2):M85–M94.
- Montaquila J, Freedman VA, Kasper JD. National Health and Aging Trends Study Round 1 Income Imputation. NHATS Technical Paper #3. 2012. [www.nhats.org](http://www.nhats.org). Accessed March 29, 2014.
- Miller DR, Rogers WH, Kazis LE, Spiro A 3rd, Ren XS, Haffer SC. Patients' self-report of diseases in the Medicare Health Outcomes Survey based on comparisons with linked survey and medical data from the Veterans Health Administration. *J Ambul Care Manage*. 2008;31(2):161–177. doi:10.1097/01.JAC.0000314707.88160.9c
- Galvin JE, Roe CM, Xiong C, Morris JC. Validity and reliability of the AD8 informant interview in dementia. *Neurology*. 2006;67(11):1942–1948. doi:10.1212/01.wnl.0000247042.15547.eb

29. Kasper JD, Freedman VA, Spillman B. Classification of Persons by Dementia Status in the National Health and Aging Trends Study. NHATS Technical Paper #5. 2013. [www.nhats.org](http://www.nhats.org). Accessed March 29, 2014.
30. Raghunathan T E, Lepkowski JM, Van Hoewyk J, Solenberger P. A multivariate technique for multiply imputing missing values using a sequence of regression models. *Surv Methodol*. 2001;27:85–95.
31. Montaquila J, Freedman VA, Kasper JD. 2012. National Health and Aging Trends Study Development of Round 1 Survey Weights. NHATS Technical Paper #2. 2012. [www.nhats.org](http://www.nhats.org). Accessed March 29, 2014.
32. McAdams-DeMarco MA, Law A, Salter ML, et al. Frailty and early hospital readmission after kidney transplantation. *Am J Transplant*. 2013;13(8):2091–2095. doi:10.1111/ajt.12300
33. Shumway-Cook A, Ciol MA, Hoffman J, Dudgeon BJ, Yorkston K, Chan L. Falls in the Medicare population: Incidence, associated factors, and impact on health care. *Phys Ther*. 2009;89(4):324–332. doi:10.2522/ptj.20070107
34. Kaiser Family Foundation. Medicare: A Primer. 2010. [kff.org/medicare/issue-brief/medicare-a-primer](http://kff.org/medicare/issue-brief/medicare-a-primer). Accessed August 5, 2014.
35. Alley DE, Shardell MD, Peters KW, et al. Grip strength cutpoints for the identification of clinically relevant weakness. *J Gerontol A Biol Sci Med Sci*. 2014;69(5):559–566. doi:10.1093/gerona/glu011
36. Olshansky SJ, Antonucci T, Berkman L, et al. Differences in life expectancy due to race and educational differences are widening, and many may not catch up. *Health Aff (Millwood)*. 2012;31(8):1803–1813. doi:10.1377/hlthaff.2011.0746
37. Institute of Medicine (U.S.). *Committee on Geographic Variation in Health Care and Promotion of High-Value Care*. Washington, DC: The National Academies Press; 2013.