Published in final edited form as:
J Epidemiol Community Health. 2010 January ; 64(1): 63–67. doi:10.1136/jech.2008.078428.

"Socioeconomic Status is associated with Frailty: the Women's Health and Aging Studies"

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Abstract

Background—Frailty is a common risk factor for morbidity and mortality in older adults. Although both low socioeconomic status (SES) and frailty are important sources of vulnerability, there is limited research examining their relationship. We sought to determine 1) the extent to which low SES was associated with increased odds of frailty and 2) whether race was associated with frailty, independent of SES.

Methods—We conducted a cross-sectional analysis of the Women's Health and Aging Studies using multivariable ordinal logistic regression modeling to estimate the relationship between SES measures with frailty status in 727 older women. Control variables included race, age, smoking status, insurance status, and co-morbidities.

Results—Ten per cent of the sample were frail, 46% were intermediately frail, and 44% were robust. In adjusted models, older women with less than a high school degree had a threefold greater odds of frailty compared to their more educated counterparts. Those with less than $10,000 yearly income had two times greater odds of frailty than their wealthier counterparts. These findings are independent of age, race, health insurance status, co morbidity, and smoking status. African Americans were more likely to be frail than Caucasians ($p<0.01$). However, after adjusting for education, race was not associated with frailty. The effect of race was confounded by socioeconomic position.

Conclusions—In this population-based sample, odds of frailty were increased for those of low education or income regardless of race. The growing population of older adults with low levels of education and income render these findings important.

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The authors have no financial relationships to disclose. Competing interests: None declared

Keywords

gerontology; social epidemiology; health disparities; socioeconomic status; older adults

Introduction

The association between low socioeconomic status (SES) and poor health has been well documented (1-4). A potentially important risk factor for many poor health outcomes among older adults is geriatric frailty. Defined as a state of increased vulnerability, geriatric frailty is associated with higher risk of hospitalizations, nursing home placement, and death (5). Little research has investigated the relationship between low SES and frailty.

Frailty is a clinically identifiable, prevalent, geriatric syndrome that Fried defines as a combination of weakness, exhaustion, lack of activity, weight loss/underweight and slow walking speed (6,7). There is considerable clinical, biological, epidemiological, and genetic research interest in the origins of this prevalent syndrome of frailty (8).

While the genetic and biologic research into frailty is burgeoning, there has been a dearth of research on the possible etiologic relationship between sociologic factors and frailty. This is particularly important as the population of older adults with low education is increasing faster than those older adults who are more educated (9). Developing a better understanding of the sociologic factors is particularly relevant now as health disparities research has advanced to investigate the ways in which low SES “gets under the skin” (10) and plays a role in the development of health disparities (11-13). There have been limited studies on the independent contribution of low SES to frailty. One study, of a cohort in Hong Kong, found that those of low SES had higher risk for frailty (14). Another study, by Hirsch et al found that SES was not related to odds for frailty in a study designed to examine race and frailty (15). A third study, found that low income and low education were predictive of self-reported frailty (5).

Due to the conflicting results, the primary objective of this study was to examine the association between SES and frailty in a cohort of older women. Specifically, we hypothesized that low SES is associated with frailty, independent of smoking status, race, insurance status, and co-morbidities. Our secondary objective was to determine whether the relationship between SES and frailty varies by race.

Methods

Study Population and Measures

Data were from the Women’s Health and Aging Studies (WHAS) I and II, two prospective population-based cohort studies that recruited community-dwelling older women, complementary with respect to physical function status from the same Medicare eligibility sampling frame. Participants in WHAS I were eligible if they were women 65 or older, had difficulty in 2 or more areas of physical function (thus representing the 1/3 most disabled older women in the community), and had a Mini-Mental State Examination of at least 18. Participants in WHAS II were eligible if they were women between 70 and 79 years of age, had difficulty in at most 1 area of physical function (thus drawn from among the 2/3’s least disabled), and had at least a 24 on the Mini-Mental State Examination. WHAS participants were randomly selected from a Medicare sampling frame from 12 zip codes of Eastern Baltimore City and Baltimore County. Baseline assessments were performed in 1992-1995 in WHAS I and 1994-1996 in WHAS II. Seventy one percent of the 1,409 women who were screened and eligible for WHAS I and 49.5% of the 880 women who were screened and eligible for WHAS II agreed to participate. WHAS II used telephone recruitment rather than face-to-face

recruitment which likely accounts for the lower participation rate. Detailed information on combining both samples and studies using the combined samples can be found elsewhere (7, 16-19). The Johns Hopkins Medical Institutional Review Board approved the research protocols. Each participant provided written informed consent.

Sampling weights

Data were weighted in all analyses to account for sampling design and to correct for non participation. The weights were calculated for each participant based on the probability of selection into the study (16). These probabilities varied based on disability status, age, and race. The sampling weights allow reference to the entire population of community-dwelling older women in and around Baltimore, MD.

Measures

Measurement of Frailty

Frailty status, our outcome measure, was defined as frail, intermediately frail, or robust using standardized criteria (6,7) relating to weight loss/underweight, slow walking speed, weakness, self-reported exhaustion, and low physical activity (see Fried et al, 2001 for categorization details). Weight loss/underweight was determined by ≥10 per cent weight loss since age 60 or body mass index of less than 18.5. The lowest quintile of customary pace walking speed was measured in meters per second across 4 meters. Grip strength was measured using a Jamar Dynamometer. Exhaustion was measured by whether a participant had a positive answer to any of the following three items: description of low energy level (defined as less than 3 on a 0-10 Likert scale with 0 being “no energy” and 10 being “the most energy you have ever had”), description of being unusually tired in the last month, or unusually weak in the last month. Energy expenditure was measured with the Minnesota Leisure Time Activity Questionnaire; participants who reported 90 or fewer kcals expended per week based on six activities such as walking and household chores were defined to exhibit low energy expenditure (20). Participants were considered *frail* if they were positive for three of more of the above characteristics. Participants were considered *intermediately frail* if they had 1-2 of the same characteristics and *robust* if they had none. This categorization has been validated in prior work (6,7).

Socioeconomic status—We measured SES using education, and household income. Education was grouped as <12, 12, or >12 years. Income was reported by participants. There were missing data for income (107 of the total 727). These missing data were imputed by a composite hot deck method using a regression with variables such as poverty status, receipt of Medicaid, age, race, and number in household to predict income (21). We divided income into three categories of equal numbers of participants. These income cut-offs were <$10,000 per year, ≥ to $10,000 while < $22,250, and ≥ $22,250.

Covariates—Covariates included a range of factors that have been associated with both SES and frailty: race, age, insurance status, smoking history, and numbers of chronic diseases. Race was coded as Black or White based on participant self-report. Age was measured in years and restricted to 70-79 (the age range of WHAS II). Smoking history was classified into the following three categories: never smoked, former smoker, and current smoker. Insurance status was measured as Medicare Part A only (uninsured except for hospitalization), Medicare/Medicaid, or Medicare plus private health insurance. These three categorizations correspond to uninsured, insured for public providers, and completely insured to see any health care provider. Diseases and conditions were adjudicated by two physicians based on exam, medication list, radiographs, blood tests, and medical records (16). Number of chronic diseases or conditions was measured as 0,1,2, or greater than or equal to 3 of the following: angina,

myocardial infarction, congestive heart failure, degenerative disc disease, spinal stenosis, hip fracture and osteoporosis; osteoarthritis of the knee, hip and hand, and rheumatoid arthritis; stroke, Parkinson's disease, pulmonary disease, diabetes mellitus, peripheral arterial disease and cancer.

Analysis—We first calculated descriptive statistics for each of the key variables. To examine our first hypothesis, that SES is associated with frailty status, we used ordinal logistic regression with weights to correct for the sampling design. This approach models cumulative odds of frailty as a function of predictors. We tested each SES indicator (education, and income) separately with frailty as the outcome. The unadjusted models tested the odds of being frail compared to intermediately frail**,** and robust. The adjusted models tested the odds of being frail compared to intermediately frail and robust including age, race, insurance status (commercial plus Medicare vs. Medicare/Medicaid vs. Medicare only), smoking status, and co-morbidity count. To test our secondary objective, that race is not related to frailty independent of SES, we used two separate ordinal logistic regression models with controls for income, and for education, respectively. The proportional odds assumption was tested using a nested model approach comparing the ordinal logistic model with multinomial logistic regression (22). All analyses used Stata version 9.0 (College Station, TX).

Results

Baseline characteristics of participants are displayed in Table 1. Ten per cent of the women in the sample were frail, 46% were intermediately frail, and 44% were robust. Forty one percent of women had less than a high school education and 76% of the women reported their race as Caucasian. The mean income was $21, 967 with 80% of participants having between $5,500 and $45,000. Sixty nine percent of women had zero or one chronic medical condition.

There were significant differences in the prevalence of frailty by race. The prevalence of frailty among African American elders was higher than among Caucasians (13% versus 9%, $p < 0.05$). Black women were disproportionately represented in the group of those who had not completed high school (composing 38 % of the population not completing high school but only 24% of the study population).

The ordinal logistic regression analysis (Table 2) demonstrates that the measures of socioeconomic status were significantly associated with frailty. In univariate analyses, those with less than 12 years of education had a relative odds for frailty of 3.51 (95% CI = 1.99-1.54) compared to those with more than 12 years of education. Lower income was associated with greater odds of frailty (OR 2.69, 95%CI= 1.84 - 1.93). Race was not a significant correlate of frailty when in the same model with any SES measure.

To further determine the relationship between socioeconomic status and frailty, we adjusted for potential variables that are associated with both socioeconomic status and frailty: smoking status, insurance status, and disease count. The association between SES indicators and frailty remained significant when adjusted for these potential confounders. Compared to those with more than a high school degree, the relative odds of being frail for those with less than a high school degree were 3.01 (95% CI = 1.99 -4.54). The relative odds of frailty for those with income less than $10,000 was 2.01 (95% CI = 1.28 -3.16) compared to those with income > $22,500. Because of the significant differences in education by race as well as the potential difference in quality and quantity of education received by women of different races when this cohort was young (23), we tested whether there was an interaction between race and years completed of school; this interaction term was not significant.

We conducted a sensitivity analyses to determine whether our results would be altered by the categorization of frailty. In these analyses, we grouped participants who were robust and intermediately frail together to perform a binary logistic regression. This analysis provided similar results to those of the ordinal logistic regression models. Those with less education and lower income were more likely to be frail compared to their more advantaged counterparts. The relative odds of frailty was 3.01 for those with less than a high school degree compared to those with more than a high school degree (95% CI 1.99 - 4.54) in the fully adjusted model. The relative odds of frailty for those with less than $10,000 income per year was 2.01 (95% CI: 1.28 - 3.16) compared to those with a yearly income of > $22,500 in the full model.

Discussion

In this group of older community-dwelling women, there was a significant association between SES and frailty. This association was present irrespective of the measure of SES and remained strong despite controlling for age, race, chronic disease, insurance status, and smoking status. Based on findings of Braveman et al (24), we analyzed measures of SES separately. In our study, frailty was not related to race which is in contrast to a study by Hirsch et al that examined the independent effect of race on odds of frailty and found that race was a significant frailty predictor independent of SES (25). One possible reason for this different finding is that the Cardiovascular Health Study has both men and women participants while our study was restricted to women. The association between race and frailty may differ by sex **or** their finding could be affected by residual confounding.

In other respects, this study extends the findings of others. Woods et al found that income and education were risk factors for frailty in The Women's Health Initiative (5). The current study complements this finding using the objective measures in the Fried frailty definition, which the Women's Health Initiative was not able to use. Other large U.S. cohorts have examined predictors of frailty. The descriptive tables contained in these studies demonstrate that participants with low education and income are disproportionately represented in the frail groups (6,26-28). However, these studies have not examined the contribution of SES factors to frailty independent of other covariates. In contrast to our findings, Hirsch et al found that neither education nor income was related to frailty in the Cardiovascular Health Study cohort (15).

There are several biological mechanisms that could elicit the relationship between low SES and frailty. SES has been linked to inflammation (29,30), decreased physical tone (31), decreased serotonin(32), and altered biological risk profiles (33). These same factors may be implicated in the origins of frailty as well. For example, researchers have posited that chronic inflammation may be a key factor in frailty (18,28), which has also been suggested to mediate the relationship between SES and morbidity due to chronically sustained psychosocial stressors (11). SES may also be linked to frailty status through decreased physical activity (34), which may lead to exhaustion and sarcopenia (35), which are key features of the frailty syndrome. SES may be linked to frailty through poor nutrition as those of low SES have decreased access to micronutrients (36) and those with lower levels of micronutrients are more likely to become frail (37).

As a second sensitivity analysis, we examined whether neighborhood SES (a composite of median income, wealth, education, and proportion of residents with executive, managerial, or professional specialty occupations) (38,39) was associated with frailty status. We used generalized estimating equations to account for the fact that individual's SES is nested within neighborhood hood SES. Neighborhood SES was a significant but weaker correlate of frailty status when adjusted for age and race (OR of 1.26: 95% CI=1.03, 1.54). Neighborhood SES no longer significantly associated with frailty (OR = 1.18; 95% CI, 0.97 – 1.45) once additional

individual level covariates (smoking status, insurance status, disease burden) were added to the model.

Our study has the following limitations. This study is limited by its cross-sectional design. We cannot infer causality due to the cross-sectional design but reverse causation seems unlikely. Education is particularly resistant to reverse causation in older adults as it is usually attained in early life. Our study includes only African-Americans and whites. It is unclear whether these findings might apply to other races or ethnicities. Strengths of the current study include a population-based sample, objective and subjective measures of the frailty components, and three different related measures of socioeconomic status.

Summary

The current findings suggest that education and income are related to frailty. Whether the relationship is causal remains to be tested. We also found that the effect of race on frailty is confounded by socioeconomic position. The overall findings are important because the population of older adults with low education is increasing.

What is already known on this subject:

Low socioeconomic status and frailty are both risk factors for illness and mortality in older adults. It has not been known if they are related to each other using objective measures of frailty.

What does this study add?

Odds of frailty are increased for those of low socioeconomic status independent of age, race, insurance or smoking status, and co-morbidities.

Acknowledgments

This work was supported by National Institutes of Nursing grants 1F31NR009470-01, 1-T32 NR07968-01, National Institutes of Aging grants R01 AG11703, 1R37AG1990502, 1KL2RR025006-01 from the National Center for Research Resources (NCRR),the John A. Hartford Foundation Building Academic Geriatric Nursing Capacity Scholars Program and by the Johns Hopkins Older Americans Independence Center (1P50AG 021334-01).

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Table 1
Descriptive characteristics of Women's Health and Aging Studies by frailty status

	Overall (N=727)	Frail (N=74)	Intermediately Frail (N=345)	Robust (N=303)
Mean Education in years (SE)	11.64(.20)	9.5(.39)	11.21(.38)	12.58(.20)
Mean Income, in dollars (SE)	$21,699(743)	$16,554(2600)	$20,506(1061)	$24,114(1134)
Mean age (SE)	74.2(0.12)	74.7 (0.34)	74.1 (0.14)	74.8(0.16)
% African American	24	12.1	49	38.9
Insurance				
%Fully insured	78	61	70	88
%Public Providers	13	24.7	16.9	6.4
%Uninsured beyond hospital admissions	10	14.6	12.8	6.0
Mean # of co-morbidities (SE)	1.20 (.05)	1.6 (0.11)	1.3(.06)	0.88 (.05)
Smoking status				
% Never	51	51	46	59
% Former	37	44	41	32
%Current	12	13	13	19

Table 2

Crude and adjusted odds ratios for the relation between socioeconomic status measures and frailty among participants in the Women's Health and Aging Studies (N=727)

Variables	Unadjusted		Adjusted	
Education Models:	Odds Ratio	(95% CI)	Odds Ratio	95%CI
<12 years	3.51	2.42, 5.08)	3.01	(1.99, 4.54)
12 years	1.06	(0.70,1.60)	1.08	(0.70, 1.65)
> 12 years	1.0 (ref)		1.0 (ref)	
Uninsured*			2.37	(1.42, 3.96)
Public providers			2.04	1.20, 3.49)
Fully insured			1.0 (ref)	
3 or more co-morbidities‡			2.98	(1.78, 5.01)
2 co-morbidities			2	(1.26, 3.20)
1 co-morbidity			1.53	(1.04, 2.24)
0 co-morbidities			1.0 (ref)	
Current smoker			1.69	(1.02, 2.83)
Former smoker			1.69	(1.21, 2.38)
Never smoker			1.0 (ref)	
Age			1.06	1.00, 1.12)
Race			0.68	(0.45,1.04)
Income Models (107 imputed)				
Income < $10,000	2.69	(1.84, 3.93)	2.01	(1.28, 3.16)
≥ 10,000 and ≤22,250	1.29	(0.89, 1.88)	1.18	(0.80, 1.74)
Income >22,250	1.0 (ref)		1.0 (ref)	
Uninsured*			2.48	1.49, 4.16)
Public Providers			2.09	(1.23, 3.56)
Fully insured			1.0 (ref)	
3 or more co-morbidities			3.16	(1.88, 5.29)
2 co-morbidities			1.91	(1.21, 3.03)
1 co-morbidity			1.57	(1.07, 2.29)
0 co-morbidities			1.0 (ref)	
Current smoker			1.86	(1.12, 3.10)
Former smoker			1.68	(1.20, 2.37)
Never smoker			1.0 (ref)	
Age			1.06	(1.00, 1.13)
Race			0.98	(0.64, 1.48)

Race is Black vs. White

*Education is <12 years, 12, or >12

*Uninsured = Medicare hospitalization coverage only, Medicaid/Medicare, Medicare plus out patient coverage