

SPECIAL ARTICLE

# Gradient of Disability across the Socioeconomic Spectrum in the United States

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## ABSTRACT

### BACKGROUND

Although the relationship between extreme poverty and poor health among older adults has long been recognized, less attention has been devoted to investigating whether a gradient in disability exists in the United States among persons with middle-class and upper-class incomes. We attempted to determine whether a gradient in functional limitation exists across the full spectrum of income among persons 55 years of age or older.

### METHODS

We obtained data from the Census 2000 Supplementary Survey, which used the methods and questionnaire of the American Community Survey, a nationally representative survey of 890,698 households with a response rate of 95 percent. Our sample included 149,000 men and 186,675 women who were at least 55 years of age, of whom 32,680 men and 48,111 women reported having a functional limitation (a long-lasting condition that substantially limited one or more basic physical activities, such as climbing stairs or lifting).

### RESULTS

A social-class gradient was observed for both men and women between the ages of 55 and 84, a gradient that held true even at the upper rungs of the socioeconomic ladder. For example, in comparison to persons between the ages of 55 and 64 who lived at 700 percent of the poverty line or above, persons of the same age but below the poverty line had six times the odds of reporting a functional limitation. With increasing income, the odds ratio declined. A significant gradient was present up to, but not beyond, the age of 85 years.

### CONCLUSIONS

Our findings suggest that functional limitation in Americans between the ages of 55 and 84 years is inversely related to social class across the full spectrum of the socioeconomic gradient.

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EVIDENCE OF A STRONG INVERSE SOCIAL-class gradient in the rates of illness and death has been well established in Europe and North America,<sup>1-10</sup> whether social status is measured in terms of income, education, or occupational status.<sup>3,6,9,10</sup> Still unsettled, however, is the question of whether a gradient in the rate of disability in later life exists across the full spectrum of income, or whether, as some studies have suggested,<sup>11</sup> the association between disability and age is limited to persons in lower-income and middle-income groups.

Addressing this question is critical, because although the rate of disability declined an estimated 1 to 2 percent annually during the last two decades of the 20th century,<sup>12</sup> the rate of decline was

smaller among those in the poorest socioeconomic groups.<sup>13</sup> Furthermore, the absolute number of disabled older adults is expected to increase substantially during the next 20 years.<sup>14,15</sup> Because disability is the final common pathway of many chronic health conditions and reflects not only the presence but also the severity and effect of these conditions, understanding disability and its relationship to social class in later life is important.

The rates of illness, disability, and death are clearly highest among the poorest older adults. However, the Whitehall study of British civil servants demonstrated that even among those at the highest ranks of civil service, persons at the top of the social ladder are healthier than those one level below.<sup>2,3</sup> The Whitehall study also showed that the

**Table 1. Characteristics of 335,675 Respondents.**

Variable	Men (N=149,000)	Women (N=186,675)
<b>Demographic characteristic</b>		
Sex — %	44.4	55.6
Age — no.		
55–64 yr	64,697	71,910
65–74 yr	48,616	58,897
75–84 yr	29,127	42,351
≥85 yr	6,560	13,517
Poverty line — no. (unweighted %)*		
<100%	10,032 (6.7)	20,002 (10.7)
100–149%	10,723 (7.2)	20,242 (10.8)
150–199%	12,138 (8.1)	19,061 (10.2)
200–299%	25,824 (17.3)	34,464 (18.5)
300–399%	22,703 (15.2)	26,817 (14.4)
400–499%	17,341 (11.6)	19,192 (10.3)
500–599%	12,972 (8.7)	13,281 (7.1)
600–699%	9,231 (6.2)	9,054 (4.9)
≥700%	28,036 (18.8)	24,562 (13.2)
Race or ethnic group — no.		
Hispanic	7,254	9,252
Black non-Hispanic	9,740	14,532
White non-Hispanic	126,419	156,116
Other	5,587	6,775
Educational status — no.		
<High-school graduate	37,599	49,267
High-school graduate†	42,857	67,963
<College graduate	31,750	40,479
≥College graduate	36,794	28,966

employment grade of a civil servant at midlife (low, medium, or high) was related inversely to functional limitation almost three decades later.<sup>7</sup> However, research using income, rather than occupational rank, as the measure of socioeconomic status has not examined disability over the full spectrum of income.<sup>4,11</sup>

To explore the relationship between disability and social class in older adults, we chose to examine functional limitation because it is more closely related to intrinsic problems caused directly by disease, disuse, and aging than are more basic activities of daily living (ADL), such as difficulty with eating and bathing. Older adults who can afford to modify their bathrooms and make them more accessible, for example, will reduce their bathing disability without substantially altering their functional limitation. Therefore, the relationship of socioeconomic status with functional limitation can be studied with less concern about the

confounding effect of a more difficult environment than would be the case in a study of ADL. Furthermore, because functional limitation is far more common than a limitation in ADL,<sup>16</sup> we can more effectively study the young end of the age spectrum of older adults with the use of the former measure. We examined a data set of more than 335,000 respondents to explore the socioeconomic gradient in functional limitation among older Americans.

## METHODS

### STUDY POPULATION

The Census 2000 Supplementary Survey, which used the methods and questionnaire of the American Community Survey (C2SS/ACS), used a representative 0.6 percent sample of the U.S. population who are not living in institutions or other group quarters. The majority of participants responded

**Table 1. (Continued.)**

Variable	Men (N = 149,000)	Women (N = 186,675)
<b>Prevalence of functional limitation</b>		
55–64 yr		
No.	10,269	12,042
Percentage of age group		
Unweighted	15.9	16.7
Weighted†‡	16.2	17.2
65–74 yr		
No.	10,335	13,495
Percentage of age group		
Unweighted	21.3	22.9
Weighted†‡	21.7	23.5
75–84 yr		
No.	8,992	14,918
Percentage of age group		
Unweighted	30.9	35.2
Weighted†‡	31.3	36.0
≥85 yr		
No.	3,084	7,656
Percentage of age group		
Unweighted	47.0	56.6
Weighted†‡	47.5	57.9

\* Percentages may not total 100 because of rounding.

† Respondents had either graduated from high school or earned a general equivalency diploma (GED).

‡ Responses were weighted for sampling probability and nonresponse.

to a mailed questionnaire. Follow-up with nonrespondents was done by telephone interview. One in three of the remaining nonrespondents was targeted for door-to-door interviews. The overall response rate was 95.1 percent.<sup>17</sup>

This study compared the levels of functional limitation of respondents who were 55 years of age or older according to family poverty-level status. The total unweighted number of respondents was 335,675, of whom 149,000 were men and 186,675 were women (Table 1). This large sample size afforded excellent power for the generation of stable estimates. The smallest cell size was 270, for males who were 85 years of age or older and living at 600 to 699 percent of the poverty line.

#### MEASURES

Several measures included in the C2SS/ACS held special relevance for this study and are used as follows. Functional limitation was defined as a long-lasting condition that substantially limited one or more basic physical activities, such as walking, climbing stairs, reaching, lifting, or carrying. Respondents were defined as having a limitation in ADL if they had a physical, mental, or emotional condition lasting six months or more that made it difficult to “dress, bathe, or get around inside the home.” Both types of limitations had imputation rates of 5 percent.<sup>17</sup>

Four age categories were created (55 to 64, 65 to 74, 75 to 84, and 85 years or older). Household income was based on a summation of income in the previous 12 months for all household members from a comprehensive list of eight sources, including wages and salaries, Social Security, welfare payments, and pensions and dividends. Twenty-four percent of respondents had imputed data for at least one of the income variables, with the highest imputation rate (16 percent) for wages and salaries.<sup>17</sup> The family poverty index reported family income as a percentage of the poverty line and adjusted for the number of family members in the household and whether the householder was over the age of 65 years.

We categorized the poverty index into nine categories (less than 100 percent of the poverty line, 100 to 149 percent, 150 to 199 percent, 200 to 299 percent, 300 to 399 percent, 400 to 499 percent, 500 to 599 percent, 600 to 699 percent, and 700 percent or more). The poverty threshold in 2000 was \$8,259 for a person who was 65 years of age

or older who lived alone and \$17,761 for a four-person household.<sup>18</sup> Thus, our reference category — 700 percent or more of the poverty line — began at \$57,813 for an older adult living alone and grew to \$124,327 for a four-person household. Education was divided into four categories: grade 11 or less, high-school graduate (reference category), some college, and college graduate or postgraduate education. Race or ethnic group was categorized as Hispanic (of any race), black non-Hispanic, white non-Hispanic (reference category), and other non-Hispanic.

All missing data in the C2SS/ACS were imputed by the U.S. Census with the use of a “hot deck” allocation technique, in which missing values were imputed from records of geographically close subjects matched for age, race, sex, and other relevant characteristics.<sup>19</sup>

#### STATISTICAL ANALYSIS

The respondents were first divided into categories according to sex and four age groups, resulting in eight age–sex groups. For each of these groups, the percentage of respondents with functional limitation was calculated for each of the nine poverty-index categories. In addition, for each age–sex group, a logistic-regression analysis was performed with functional limitation as the dichotomous dependent variable and the family poverty index, race, and education as the independent variables. These analyses were replicated with a limitation in ADL as the outcome variable.

Odds ratios and 95 percent confidence intervals were generated for functional limitation for each family poverty level, as compared with the reference level. To assess the effect of imputations, the imputed incomes of respondents were removed from the analysis, and the described procedure was replicated. Weighted percentages and the logistic regression were generated with the use of a weighting variable designed by the U.S. Census Bureau. This variable represents the probability of selection, including noninterview adjustments and controlling for the number of 2000 Census housing units and population level.<sup>20</sup>

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## RESULTS

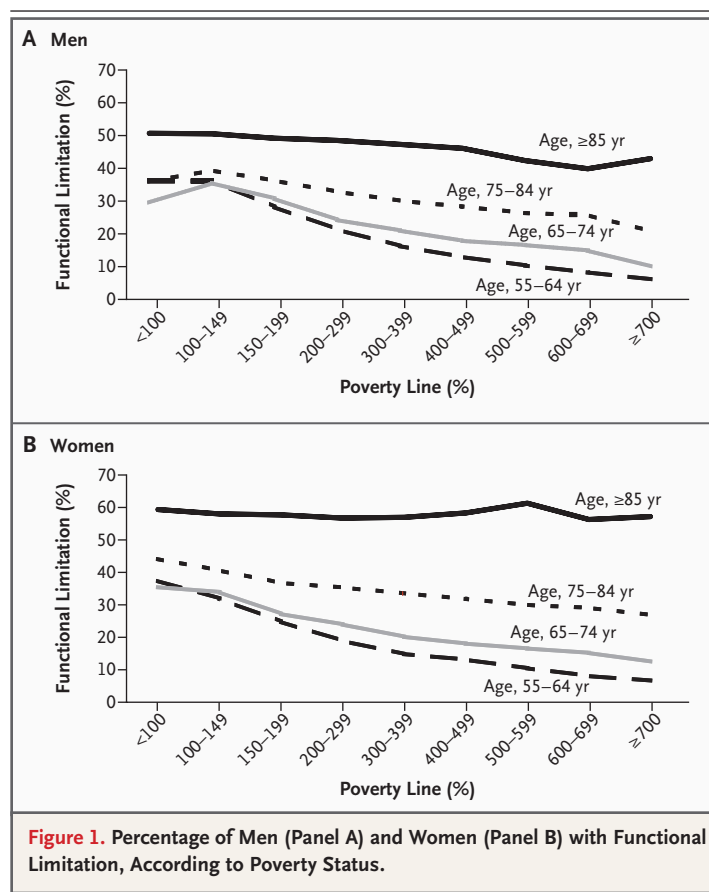
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A total of 80,791 respondents (32,680 men and 48,111 women) had functional limitation. The prevalence of functional limitation rose steeply

with increasing age (Table 1). With increasing income, there was a clear downward gradient in the percentage of both men and women with functional limitation in the three younger age groups but not in the group 85 years of age or older (Fig. 1A and 1B). The slope was steepest in the youngest cohort and became progressively flatter for each successive age bracket. When the level of education rather than the family poverty level was used as the indicator of socioeconomic status, a downward gradient was visible across all four age groups, including the group of persons 85 years of age or older (Fig. 2A and 2B).

In the logistic-regression analyses of functional limitation, each age–sex group under the age of 85 years showed an overall downward gradient, showing that the odds of having a functional limitation decreased with distance above the poverty line (Fig. 3). The exceptions to this overall trend were a slightly lower odds ratio for functional limitation among men between the ages of 65 and 84 years in the poverty category than among those in the near-poverty category (100 to 199 percent). The slope was steepest in the youngest age group. In comparison to respondents between the ages of 55 and 64 who were living at or above 700 percent of the poverty line, respondents of the same age who were living in poverty had six times the odds of reporting functional limitation, with very little difference between men and women (odds ratio for men, 6.22; 95 percent confidence interval, 5.70 to 6.81; odds ratio for women, 6.19; 95 percent confidence interval, 5.68 to 6.75). With increasing income, the odds of reporting functional limitation declined but were still significantly higher than those of the wealthiest respondents. For respondents under the age of 85 years, even those at 600 to 699 percent of the poverty line had significantly elevated odds ratios, as compared with those at 700 percent and higher in five of the six age–sex groups.

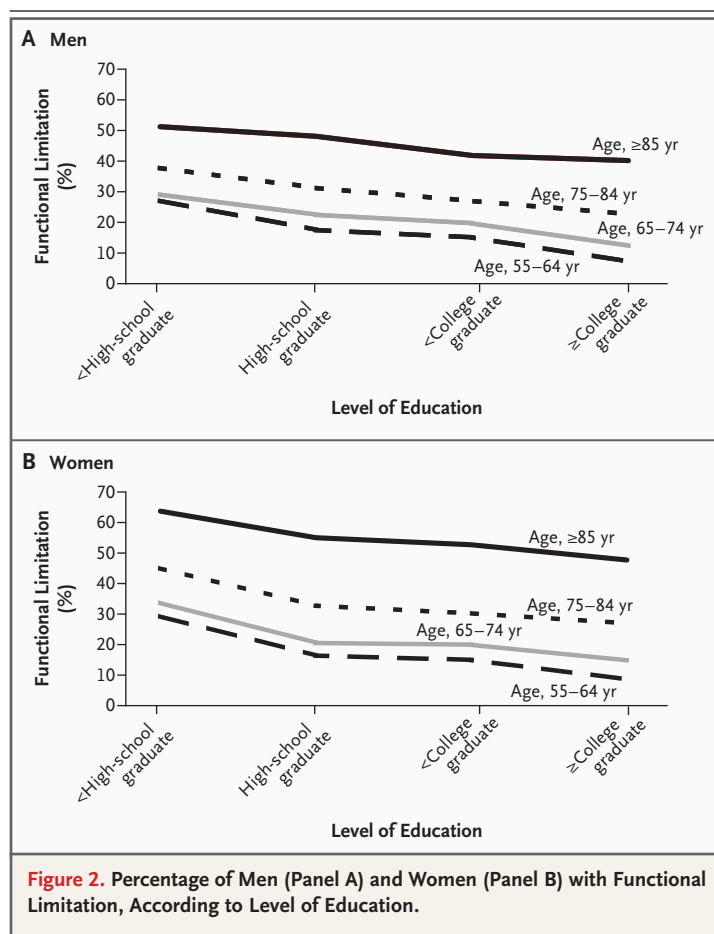
Parallel analyses that were performed on the basis of an alternative disability outcome of a limitation in ADL, such as eating or bathing, yielded a similar downward gradient for men between the ages of 55 and 84 years and women between the ages of 55 and 74 years (analyses not shown). When respondents with imputed income data were removed from the analyses for both functional limitation and a limitation in ADL, results were similar (see the Supplementary Appen-



dix, available with the full text of this article at [www.nejm.org](http://www.nejm.org)).

## DISCUSSION

Social class has been described as “the ignored determinant of the nation’s health.”<sup>6</sup> Our study examined functional health status in Americans who were 55 years of age or older across the full socioeconomic spectrum. Our findings support the existence of a social-class gradient up to the age of 85 years, showing that respondents with higher incomes have lower levels of functional limitation, regardless of how far removed they are from the poverty level. The much steeper downward slope of the gradient that is visible for younger respondents (between the ages of 55 and 64 years) indicates that each additional increment of income is associated with a greater relative decline in the rate of functional limitation among younger respondents than among older respondents. The emer-



gence of similar findings when educational level was used in place of the family poverty index further supports our finding of a social-class gradient in disability. This finding is particularly important in light of the generally modest correlations between income measures and education that have been shown in studies to date.<sup>21</sup>

A perplexing finding of this study was that the odds ratios for functional limitation in men between the ages of 65 and 84 years were slightly lower for those who were living in poverty than for those living in near poverty. Further research should investigate whether this finding can be replicated in other data sets and, if so, whether it is associated with differential access to health care, the physical demands of current or former occupations, or other factors.

This study adds to the existing knowledge base through its analysis of the relationship between socioeconomic status and health status in a large sample of older Americans and its use of functional status, rather than the rates of illness and

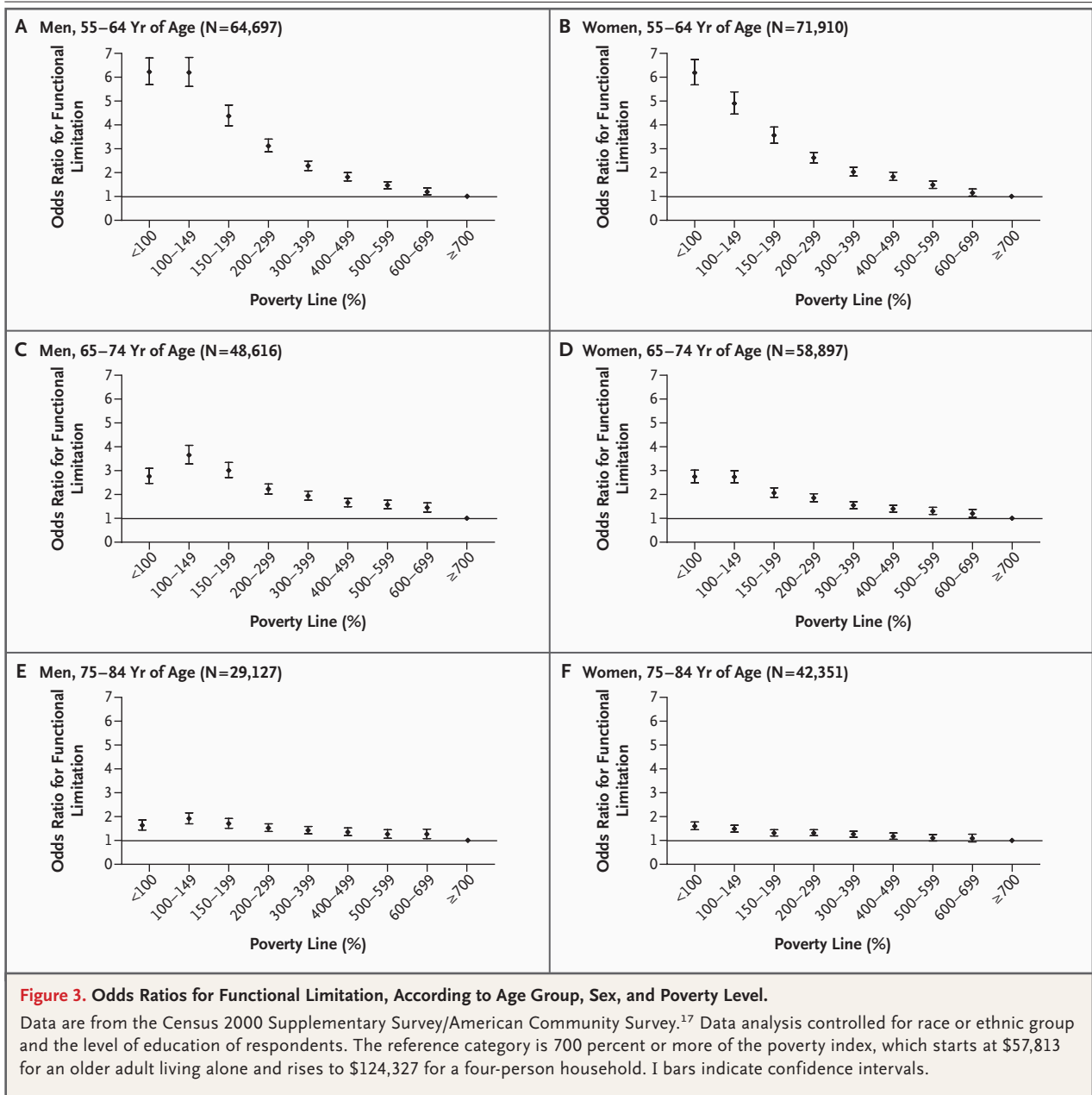
death, as the outcome variable. Many chronic diseases affect functional status,<sup>6,22</sup> which in turn is a useful construct for summarizing the effect of multiple conditions, health-related behavior, and the aging process itself.

A number of explanations for the social gradient in health have been put forward. These explanations should be considered when we examine functional limitation in older persons. Among these factors are a lifelong limitation in access to health and medical care among persons in lower socioeconomic groups, behavioral and environmental factors, and race or ethnic group.<sup>6,22</sup>

Although Medicare has played a critical role in decreasing the disparities in race and income in the access to and use of preventive and therapeutic care among older Americans, marked differences remain.<sup>23</sup> Lower-income beneficiaries, for example, are less likely to be able to afford Medicare's deductibles, coinsurance, and uncovered services, and hence they may not elect to have some procedures that could improve their functional status.<sup>23</sup> Overall, however, differences in access explain only a small portion of the health differences across socioeconomic groups.<sup>6,22</sup>

Risk factors such as smoking and alcohol abuse are more prevalent among lower socioeconomic groups and may partially explain the social gradient in disability. However, the strong inverse relationship between socioeconomic status and health remains even when the latter factors are controlled for in analysis of the data.<sup>4</sup> As House<sup>22</sup> notes, factors related to socioeconomic status "influence and shape individuals' exposure to and experience of virtually all known psychosocial and many biomedical risk factors for health," as well as shaping "exposure to and experience of most diseases."<sup>22</sup> Without discounting the demonstrated effects of race or ethnic group on health,<sup>24,25</sup> by controlling for this factor, our study also was able to show that the economic gradient in disability in midlife and among older Americans operates independently of race or ethnic group.

Our finding of a flattening of the socioeconomic-status gradient in disability at the age of 85 or older is in keeping with other research<sup>9</sup> and may reflect the fact that poorer people die younger, on average, than wealthier ones. Selective survival of hardier poor people who are 85 years of age or older could lead to their having levels of disability similar to those of wealthier people of the same age. Alternatively, this flattening may reflect an



important limitation of the 2000 C2SS/ACS, since the data excluded the population in nursing homes and other group settings. This exclusion is unlikely to play an important role in the younger cohorts, since only 1 percent of people between the ages of 65 and 74 years and 4 percent of those between the ages of 75 and 84 years live in nursing homes. However, it may have a much more substantial effect on the socioeconomic-status gradient in the group that is 85 years of age or older, among whom almost 12 percent of men and

21 percent of women are in nursing homes.<sup>26</sup> In 2000, for example, Medicaid paid for the care for 68 percent of residents of nursing home facilities.<sup>27</sup> Although many middle-class persons “spend down” to the Medicaid poverty level once they are in nursing homes, the overrepresentation of those who are poor when they enter such facilities may affect the relationship between disability and family poverty level in the community, especially in the population that is 85 years of age or older.

An additional limitation of the data involves the

provision of only self-reports of functional limitation, rather than objective performance measures or other clinical assessments. Earlier research<sup>16,28-30</sup> has demonstrated discrepancies between performance measures and self-reports of functional limitation in older persons, suggesting the likelihood of some overreporting and underreporting.

Because we had access only to cross-sectional data, it was impossible to know whether lower income preceded or followed the onset of functional limitation, and reverse causality is an important consideration. However, the majority of disability in old age is acquired later in life. The measure of socioeconomic status that is least vulnerable to reverse causality is education because completion of schooling usually predates, by several decades, the onset of disability. Our finding of a similar downward gradient between educational level and functional limitation, and other research demonstrating that social class in middle age predicts health status in old age,<sup>7</sup> provide support for the hypothesis that, in many cases, lower socioeconomic status precedes the onset of disability.

A further limitation of our study involves its reliance solely on income data rather than on more complex measures of household wealth, which are particularly important in research with older respondents. However, Kington and Smith<sup>11</sup> found that both income and wealth were independent predictors of the probability of having a chronic condition, such as hypertension or arthritis, and of functional disabilities among those who had such conditions.

Finally, our research was limited by the fact that

some of the data were imputed. However, when respondents with imputed income data were removed from the analysis, a similar social-class gradient in disability was evident.

Despite the limitations noted, our study suggests that the socioeconomic-status gradient, which has been well documented with respect to the rates of illness and death, also appears to be strong when functional status in later life is the outcome measure. With almost 85 percent of Americans who are 55 years of age or older living at an income level under 700 percent of the poverty line, this is not simply an issue of very poor people having a disadvantage in health outcomes. Rather, higher risk is demonstrated across a very large proportion of the older population, as compared with the most advantaged. With the aging of the population, achieving the national health goals of increasing health-related quality of life and eliminating health disparities<sup>31</sup> will require paying increased attention to a reduction in disparities in functional status in later life. As this study shows, this need, in turn, suggests the importance of paying greater attention to the “ignored determinant” of health — social class,<sup>6</sup> which is strongly related to functional health across the full range of family income until very late in life.

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