

# Longitudinal Study of Physical Ability in the Oldest-Old

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**Abstract:** Based on 1984 data from the Longitudinal Study on Aging, one-third of White persons aged 80 or older living in the community (N = 1,791) were defined as having no difficulty in walking 1/4 of a mile, in lifting 10 pounds, in climbing 10 steps without resting, or in stooping, crouching or kneeling. Physical ability was associated with lower risk of death over two years mean follow-up; Relative odds (RO) = .4 (95 percent confidence interval = .4, .6) and in survivors, lower utilization of hospitals RO = .4 (CI = .3, .7), physicians RO = .6 (CI = .5, .8) and nursing homes RO = .3 (CI = .2, .5) compared with those having difficulty on any of the four functional measures included in the definition of physical ability.

Fifty percent of the women and 42 percent of the men physically

able at the time of the baseline survey in 1984 remained physically able at follow-up. Continued physical ability in this group was associated with never having had cardiovascular disease RO = 2.1, (CI = 1.2, 3.7), never having had arthritic complaints RO = 1.9 (CI = 1.2, 2.7), a body mass index less than the 75th percentile (RO = 1.8 (CI = 1.2, 2.9), younger age (for each decade of age, RO = 2.0 (CI = 1.1, 3.6), and higher level of education (greater than 13 years versus 0-6 years) RO = 2.4 (CI = 1.2, 4.7). These correlates include factors amenable to preventive measures and highlight the need to consider the heterogeneity of the oldest-old in formulating programs aimed at prevention and postponement of disability. (*Am J Public Health* 1989; 79:698-702.)

## Introduction

Increased attention is being focused on the fastest growing segment of the United States population, the oldest old.<sup>1</sup> Much of this attention concerns disability,<sup>2,3</sup> use of health services,<sup>4,5</sup> and risks of institutionalization.<sup>6,7</sup> Recently, more optimistic views of old age have been proposed by those focusing on "successful aging"<sup>8</sup> who suggest that environmental and physiologic modifiers of biological aging can be identified which may be amenable to preventive strategies even among the oldest-old. However, few studies exist describing the correlates of "successful aging" or the factors which may govern transition from health to disability for the oldest-old.

Data from a longitudinal follow-up of those persons age 80 or older participating in the Supplement on Aging to the 1984 National Health Interview Survey conducted by the National Center for Health Statistics were analyzed to address three areas pertinent to public health policy for the oldest-old:

1. What proportion of persons aged 80 or older in the community could be considered physically able and what is the change in the proportion physically able over time?
2. What is the relation of physical ability at baseline to morbidity and mortality over time?
3. Can we identify correlates of maintained physical ability which would be amenable to health promotion in the oldest-old?

## Methods

### Study Population

The National Health Interview Survey (NHIS) is a continuing survey of civilian noninstitutionalized persons in the United States which includes information on health

status, health care utilization, health conditions, and disability. In 1984, the Supplement on Aging, specifically directed toward persons age 55 or older,<sup>9</sup> was added to NHIS; 96 percent of eligible persons participated. Special efforts were made to achieve complete self-response from all supplement respondents; of those for whom data were obtained, 89.8 percent were self-respondents. Permission was obtained to link with administrative records maintained by the National Center for Health Statistics. In 1986, a follow-up was undertaken of all persons aged 80 or older and approximately half of those aged 70-79 who participated in the Supplement on Aging. Vital status was ascertained for potential respondents.<sup>10</sup> Those alive at follow-up were reinterviewed over the phone with questions excerpted from the original survey instrument. Again efforts were made to obtain self responses; 74.3 percent of interviews were self-responses.

Our study population is drawn from the 2,090 persons aged 80 or older in 1984 who participated in the Supplement on Aging. Blacks and races other than Whites were excluded as numbers were few. Of the original 1,932 White persons, 1,776 were either reinterviewed or known to be dead as of the 1986 follow-up. Fifteen persons who were not interviewed at follow-up but who were known to be alive in institutions were included. This resulted in a final study population of 1,791 White persons aged 80 or older: 1,214 women and 577 men.

### Study Outcomes

Physical ability at both baseline and follow-up was defined as no difficulty in any of four measures which have been associated with assessment of ability to work.<sup>11</sup> These four measures included having no difficulty in walking 1/4 of a mile, in stooping, crouching or kneeling, in lifting 10 pounds, or in walking up 10 steps without resting. Only individuals with no difficulty on all four of these measures were considered physically able. Individuals missing data on any of the four functional measures were grouped with the comparison group as were those persons not interviewed but known to be living in nursing homes (missing values ranged from 1.6 percent for walking to 7 percent for lifting in the baseline interview and from 3 percent for stooping to 5 percent for climbing steps in the follow-up interview).

Mortality at follow-up was defined as death validated by a match with the National Death Index<sup>12</sup> for deaths through August 31, 1986 or report of death for 13 people for whom

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information for a match was lacking. Death certificate information was not available. There were 338 deaths.

Three morbidity outcomes were defined for those alive and reinterviewed at follow-up. Hospital utilization was defined as two or more hospitalizations in the 12 months prior to reinterview in 1986. About 10 percent of the survivors had two or more hospitalizations; 5 percent were missing information on this variable. Nursing home utilization was defined as any nursing home utilization between the baseline interview in 1984 and reinterview in 1986. About 10 percent of the survivors had been or were presently in nursing homes and 3 percent were missing information on this variable. Heavy physician utilization was defined as six or more visits to the physician in the 12 months prior to reinterview (75th percentile). Twenty-five percent of the survivors reported six or more visits; 10 percent had missing data. Analyses presented in this paper exclude those with missing information on these morbidity outcomes.

To examine morbidity and mortality end points in relation to functional status, participants were classified into five mutually exclusive categories based on baseline functional status. The physically able group, the highest level of function, was used as the group against which risks were calculated. The four other categories included: those who received help from another person with one or more Activities of Daily Living (ADL) including bathing or showering, dressing, eating, getting in or out of bed or chair, walking, getting outside, using or getting to a toilet; those who had difficulty with Activities of Daily Living but did not receive help from another person; those who had no difficulty with Activities of Daily Living but did have difficulty with Instrumental Activities of Daily Living (IADL), i.e., preparing our meals, shopping for personal items, managing money, using the telephone, doing heavy housework, doing light housework; and those who were not physically able but had no difficulty on Activities of Daily Living or Instrumental Activities of Daily Living.

#### Change in Function

Those reporting a change in function for health or physical problem for difficulty walking a quarter of a mile or difficulty climbing 10 steps at follow-up were asked to define the main cause of change in function. These causes were compared for those physically able and the comparison group at baseline.

#### Correlates of Physical Ability

Variables examined in longitudinal relation to continued physical ability among those physically able at baseline included age, sex, social function (defined as phone contact with friends or neighbors within two weeks of interview), absence of hearing problems (defined as being deaf in one or both ears or having trouble hearing), absence of vision problems (defined as being blind in one or both eyes or having trouble seeing), no difficulty chewing, never having had hypertension, never having had diabetes, never having had arthritis or rheumatism, and never having had cardiovascular disease (stroke, heart attack, angina or other heart condition). Those responding "don't know" for any particular condition were considered to be free of the condition (less than 2 percent for any particular condition). Completed years of education were included as a categorical variable of 0-6 years, 7-8 years, 9-12 years and 13 years or more with 0-6 years as the comparison group. Missing values (2.5 percent) were imputed to the mean (8 years of education). Body mass index (weight in kilograms/height in meters squared) at

baseline was calculated from reported weight and reported height and was included in the model as sex-specific quartiles of body mass index with the heaviest quartile as the comparison group. Missing values (less than 1 percent) were imputed to the mean for each sex, (23.7 kg/m<sup>2</sup> for men and 23.6 kg/m<sup>2</sup> for women).

#### Statistical Methods

The design effects, which represent the effect on the variance of using a clustered rather than a simple random sample, were small for each sex in this sample<sup>9</sup>; the inclusion of age in the models reduced the design effects further. The analyses in this paper are not adjusted for the complex sample design.

Logistic regression models were used to derive estimates of effect for analyses related to physical ability or to morbidity outcomes in those surviving from baseline to follow-up. All analyses were adjusted for age (as a continuous variable) and sex. Potential confounding by length of follow-up was controlled for by inclusion of a time variable calculated by subtracting the date of initial interview from date of follow-up interview. For analyses related to death, proportional hazards models were calculated with follow-up time defined as time from baseline interview to time of follow-up interview or date of death from National Death Index match. Mean follow-up time was 1.9 years. Survival analyses were not performed for risk factors for death among only those physically able at baseline due to the small number of deaths. Estimates of risk were derived from the coefficients in logistic or proportional hazards models and 95 percent confidence intervals were calculated.<sup>13</sup>

The independent variables were designed to express the association of a positive outcome with the unexposed state of a risk factor since the outcome in these analyses was physical ability—a positive outcome. For example, the relationship of physical ability to hypertension was assessed by contrasting risk in never hypertensives against risk in hypertensives, contrary to the customary expression of relative risk in epidemiologic studies.

Interactions with sex were observed for hearing problems ( $p = .03$ ) and the social function ( $p = .08$ ) variable. Final models included sex-specific indicator terms for these variables. No other significant interactions by sex were noted ( $P$  values ranged from .23 to .94); therefore, data are presented for men and women combined.

## Results

### Physical Ability at Baseline

In 1984, 33 percent of 1,791 noninstitutionalized White persons aged 80 or older, 44 percent of the men and 28 percent of the women, met the definition of physical ability (Figure 1). The order of difficulty for the four items included in the definition of physical ability was similar for men and women, although women were more likely to have difficulty on each item. Sixty-seven percent of all White persons aged 80 or older living in the community had no difficulty lifting 10 pounds, 57 percent had no difficulty climbing up 10 steps, 49 percent had no difficulty walking 1/4 of a mile, and 47 percent had no difficulty with stooping, crouching or kneeling.

Seventy-six percent of the physically able had had no hospitalizations and fewer than six doctor visits in the 12 months prior to baseline interview versus 55 percent of the comparison group, reflecting the better overall health status of the physically able persons. About 2 percent of the physically able had two or more hospitalizations in the 12

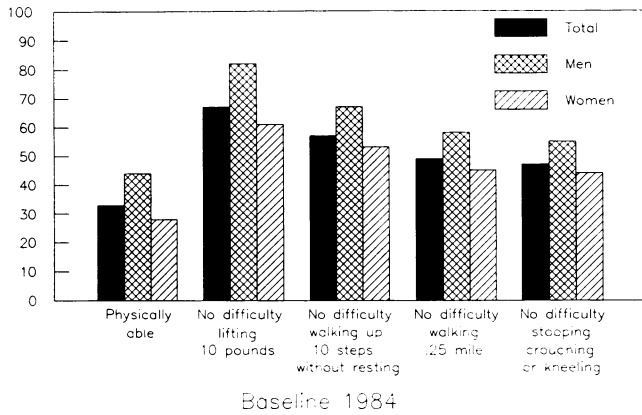


FIGURE 1—Physical Ability of Noninstitutionalized White Persons, Age 80 or Older

months prior to the baseline interview contrasted with 10 percent in the comparison group.

**Longitudinal Follow-up**

Fifty percent of the women and forty-two percent of the men who were physically able at baseline continued to meet the criteria for physical ability at follow-up (Table 1). The proportion of the comparison group dead by follow-up was twice that of the physically able group. Of the 1,453 persons alive at follow-up, 25 percent were physically able, 33 percent of the men and 22 percent of the women.

Cardiovascular conditions were the main problem reported to cause change in ability to walk 1/4 of a mile or in the ability to climb 10 steps among those physically able in 1984 (Table 2). Cardiovascular problems and multiple conditions were about equally important in terms of accounting for change in the comparison group.

Those receiving help with any ADL at baseline interview were four times more likely to die. Among the survivors, they were six times more likely to have used a nursing home during the following two years and at least twice as likely to have two or more hospitalizations or to have had six or more physicians visits in the year prior to reinterview than those physically able in 1984 (Table 3). Although risks of each outcome decreased as level of functional ability increased, even those only nonrobust without ADL or IADL difficulty were at increased risk in comparison with the physically able particularly for hospitalizations or nursing home admissions. When all those with missing data were considered as low

TABLE 1—Change in Physical Ability from Baseline to Follow-up

Status at Baseline	n	Status at Follow-up		
		Physically Able (percent)	Other (percent)	Dead (percent)
<b>Men</b>				
Physically able	251	42	43	15
Comparison	326	11	57	32
<b>Women</b>				
Physically able	343	50	43	7
Comparison	871	7	74	19
<b>Total</b>	<b>1,791</b>	<b>368</b>	<b>1,085</b>	<b>338</b>

TABLE 2—Main Problem Causing Change in Function

Problems	Change in Walking 1/4 Mile		Change in Climbing 10 Steps	
	Physically Able N = 84	Comparison N = 331	Physically Able N = 42	Comparison N = 263
	(Percent)			
Cardiovascular†	26	17	31	19
Multiple conditions	14	19	14*	21
Old age	14	14	14*	13
Arthritis	12	14	5*	14
Fall or hip fracture	14	11	14*	12
Other	20	25	22	21

\*Less than 10 respondents in cell.  
†Includes reports of circulatory disease, heart condition, hypertension, or stroke.

users of services, outcome results were substantially the same.

**Correlates of Continued Physical Ability**

Never having had cardiovascular disease and never having had arthritis at the baseline were associated with almost twice the likelihood of continued physical ability as was a body mass index below the 75th percentile (25.4 kg/m<sup>2</sup> for men and 25.2 kg/m<sup>2</sup> for women) (Table 4). Men were more likely to remain physically able. The same multivariate models showed higher education and younger age also were associated with continued physical ability. Several other characteristics were consistent with continued physical ability (no hearing problems in women, speaking on the phone with friends or neighbors in the two weeks prior to interview for women, no difficulty chewing, and no hypertension) although the confidence intervals for these variables did not exclude 1.0. When these analyses were recalculated considering those physically able individuals lost to follow-up (n = 41) as either physically able at follow-up or not, results were unchanged.

**Discussion**

Based on data from a national survey of noninstitutionalized older persons, about one-third of White persons age 80 or older living in the community had a high level of functional capability. This functional capability, which we call physical ability, appears to be associated with good health and low risk of morbidity and mortality over short-term follow-up.

Continued physical ability among those physically able at baseline was associated with lack of cardiovascular disease or arthritis, and moderate body weight. The prominence of cardiovascular disease and arthritis in these analyses was similar to data from other surveys<sup>14,15</sup> as well as data on bed disability, hospital utilization, and physician contacts.<sup>16</sup> Little data exist on the relationship between weight and morbidity for the oldest-old. It would be useful to evaluate our findings in a data set with measured weight and height. Our ability to explore other issues related to transitions in health status will be enhanced when linkages of the Longitudinal Study of Aging and Medicare records are in place and cause-specific mortality data are available from death certificates.

Although others have studied good health or longevity as an outcome in old age,<sup>17,18</sup> there have been few studies of longitudinal correlates of high level function among the oldest-old. A recent paper from the Framingham Heart Study

**TABLE 3—Morbidity and Mortality Risks by Level of Function†**

Status at Baseline	Death N = 338	Among Survivors		
		Any Nursing Home Admission N = 152	Two or more Hospitalizations in Prior Year N = 150	Six or more Physician Visits in Prior Year N = 368
Receive help ADL	4.4 (3.2, 6.1)	6.7 (3.8, 12.8)	3.3 (1.9, 5.5)	2.3 (1.6, 3.4)
Difficulty ADL—no help	1.9 (1.3, 2.7)	3.7 (2.0, 7.4)	2.0 (1.1, 3.4)	1.3 (0.9, 1.9)
Any difficulty IADL	2.2 (1.4, 3.3)	2.8 (1.4, 5.6)	2.5 (1.4, 4.5)	1.6 (1.0, 2.3)
Not physically able—no ADL or IADL	1.5 (1.0, 2.2)	2.2 (1.1, 4.1)	2.1 (1.2, 3.5)	1.3 (0.9, 1.9)
Physically able—no ADL or IADL	-1.0-	-1.0-	-1.0-	1.0

†Adjusted for age and sex (95 percent confidence intervals).

**TABLE 4—Correlates of Continued Physical Ability at Follow-up**

Variables	Relative Odds (95% confidence intervals) N = 513
Age 80 vs age 90	2.0 (1.1, 3.6)
Male vs female	3.2 (1.2, 8.6)
Education (years completed)	
0–6 years	1.0
7–8 years	2.2 (1.2, 4.0)
9–12 years	2.1 (1.2, 3.8)
13+ years	2.4 (1.2, 4.7)
Social contact—men	0.7 (0.4, 1.4)
Social contact—women	1.7 (0.8, 3.6)
No vision problems	1.1 (0.6, 2.1)
No hearing problems—men	0.6 (0.4, 1.2)
No hearing problems—women	1.5 (0.9, 2.5)
No difficulty chewing	1.3 (0.8, 2.4)
Never had hypertension	1.5 (1.0, 2.1)
Never had cardiovascular disease	2.1 (1.2, 3.7)
Never had arthritis	1.9 (1.2, 2.7)
Body mass index	
less than 25th percentile	1.8 (1.0, 3.2)
25–49th percentile	1.7 (1.0, 2.9)
50–74th percentile	2.1 (1.2, 3.6)
greater than 75th percentile	1.0

examined good function as an outcome over 21 years of follow-up in a group of 1,474 persons aged 35–68 at baseline.<sup>19</sup> Level of education was the only consistent predictor of good function for both men and women. That study, like ours, used physical function to define the outcome. Correlates of good function were examined in a group presumed to be at a high level of function at baseline. However, the Framingham study contained few very old persons at follow-up (n = 147 for those age 76 or older). Furthermore, their analysis defined long-term risks of good function in old age; our study examined short-term risks of remaining functionally able in very old age. As the US population becomes older, an understanding of how to remain healthy from younger life is critical; however, just as critical is an understanding of remaining as functionally fit as possible in the last years of life.

The consistent finding that level of education is related to good function is of interest despite the differences in study design and our inability to control for behavioral variables (such as cigarette smoking or alcohol consumption) or measured biological variables (such as blood pressure). Education may reflect life-long access to medical care or healthful habits, but may also relate to current practices. Even in old

age, persons of higher educational status report use of more preventive health services than their less educated peers.<sup>20</sup>

Health policy research in aging is frequently directed toward the high cost users of medical care, those who are very ill or those in institutions.<sup>4,7</sup> For health promotion and disease prevention to be most effective in old age, the emphasis may need to shift from the very disabled old to the less disabled population at high risk of developing disability. A recent NIH conference on geriatric assessment highlighted the need for targeted intervention strategies<sup>21</sup>; those with impairments of walking, climbing, stooping, or lifting but without difficulty on ADL or IADL may define such a group with incipient problems. In fact, among those without ADL or IADL problems at baseline in 1984, those non-physically able were at twice the risk of developing a problem with ADL or IADL at follow-up, RO = 2.1 (CI = 1.6, 2.9) compared with the physically able. Our analysis also showed risks of institutionalization, hospital use or death to be greater in this group in comparison to the physically able.

Our criteria were restricted to physical ability because we were interested in defining higher level function to be comparable to Activities of Daily Living and Instrumental Activities of Daily Living, both of which emphasize motor function. There is a need for work to examine and redefine higher level function in old age to include dimensions other than pure physical function.<sup>22</sup>

Despite our intention to choose measures equally applicable to both sexes, women consistently reported more difficulty with each physical activity, the largest difference was observed for difficulty lifting 10 pounds. The interpretation of this difference by sex is unclear but is consistent with other data for the old-old.<sup>23</sup> Whether differences in reported difficulty relate to true differences in physical ability or gender-specific styles of interpretation of these types of questions is unclear.

A potential methodologic problem arises in that a large proportion of persons reported as physically able at baseline no longer met the criteria for physical ability at follow-up and a much smaller percent of those not physically able at baseline were physically able at follow-up. Whether such dramatic changes occur in functional status for populations of very old persons over short periods of time will be clearer as additional follow-up is completed. This finding highlights problems with functional status measures<sup>24,25</sup> as these measures capture not only the “true” measurement of function but variation due to factors such as acute health status and response set. Others have noted that change in functional patterns may be particularly difficult to delineate due to the

subjective nature of the measure.<sup>26</sup> There is a critical need for methodological work to assess measurement of true change in status from other sources of intra-individual variation.

These data suggest a substantial proportion of persons aged 80 or older have no functional impairments and maintain that status over short-term follow-up. Risk factors associated with continued physical ability included weight, arthritis, and cardiovascular disease, factors which may be amenable to intervention. Additional longitudinal follow-up and analysis of medical utilization data will provide the opportunity to continue to examine the relationship of physical ability to morbidity and mortality over time.

#### ACKNOWLEDGMENTS

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## ERRATA

*In*: the Letters Section of the Journal, February 1989 issue, page 233, an author's affiliation was incorrectly listed. Bradley J. Bradford, MD, is Chairman of the Department of Pediatrics at Mercy Hospital of Pittsburgh, Pennsylvania, and Clinical Assistant Professor of Pediatrics at the University of Pittsburgh School of Medicine, *not* Chairman of the Department of Pediatrics at the University.

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*In*: Meade CD, Byrd JC: Patient literacy and the readability of smoking education literature. *Am J Public Health* 1989; 79:204-205. Of the 41 references cited in the text, the last five—numbers 37-41—were inadvertently dropped. They are printed below. The Journal staff regrets the error.

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