

# Temporal Trends in Self-Reported Functional Limitations and Physical Disability Among the Community-Dwelling Elderly Population: The Framingham Heart Study

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National surveys and epidemiological studies have reported a significant decline in self-reported functional limitations and physical disability among older adults.<sup>1–7</sup> Despite consensus among reports, uncertainty exists with regard to the magnitude, rate, and specific characteristics of the disability decline.<sup>5,6,8</sup> Variations in study samples, evolving measures of functional limitation and disability, and differences in study questions and responses contribute to the inconsistencies in disability trends.<sup>5,6</sup> Furthermore, disparities exist in the improvement in function, with marked variations according to age, gender, race, and socioeconomic and educational attainment.<sup>1,9,10</sup> Compared with men, women report greater difficulty with physical function and less recovery from disability.<sup>1</sup> Surveys have reported that declines in functional limitations occurred only among women<sup>11</sup> or were larger among women than among men,<sup>12</sup> whereas others note that disability declines were about the same among women and men.<sup>3,13</sup> Thus, it remains unclear if the disability gaps between men and women have narrowed or remained stable over time.<sup>4</sup>

The causes for the improved disability trends are not well understood. One possible explanation is the “compression of morbidity” hypothesis, whereby disease and disability are postponed until the end of the lifespan.<sup>14,15</sup> However, the consequences of an increase in life expectancy in the United States in relation to the overall health of older adults continue to be debated. Other divergent paradigms have been proposed to describe the possible health-related consequences of living longer, including a rise in chronic disease and disability<sup>16</sup> and a dynamic equilibrium whereby declines in mortality result in increases in chronic disease with lesser severity and disability.<sup>17,18</sup>

**Objectives.** We sought to determine change in the prevalence of functional limitations and physical disability among the community-dwelling elderly population across 3 decades.

**Methods.** We studied original participants of the Framingham Heart Study, aged 79 to 88 years, at examination 15 (1977–1979; 177 women, 103 men), examination 20 (1988–1990; 159 women, 98 men) and examination 25 (1997–1999; 174 women, 119 men). Self-reported functional limitation was defined using the Nagi scale, and physical disability was defined using the Rosow-Breslau and Katz scales.

**Results.** Functional limitations declined across examinations from 74.6% to 60.5% to 37.9% ( $P < .001$ ) among women and from 54.2% to 37.8% to 27.8% ( $P < .001$ ) among men. Physical disability declined from 74.5% to 48.5% to 34.6% ( $P < .001$ ) among women and 42.3% to 33.3% to 22.8% ( $P = .009$ ) among men. Among women, improvements in functional limitations ( $P = .05$ ) were greater from examination 20 to 25, whereas for physical disability ( $P = .02$ ), improvements were greater from examination 15 to 20. Improvements in function were constant across the 3 examinations in men.

**Conclusions.** Among community-dwelling elders, the prevalence of functional limitations and physical disability declined significantly in both women and men from the 1970s to the 1990s. This may in part be due to improvements in technological devices used to maintain independence. Further work is needed to identify the underlining causes of the decline so preventative measures can be established that promote independence for the elderly population. (*Am J Public Health*. 2008;98:1256–1262. doi:10.2105/AJPH.2007.128132)

We obtained self-reported information on functional limitations and physical disability among surviving members of the original cohort of the Framingham Heart Study in late life (aged 79–88 years) who attended research examinations over 3 points in time from the 1970s to the 1990s. We hypothesized that the prevalence of functional limitations and physical disability would decline over time among elders, with a greater decline among women than among men. Our study cohort is particularly well suited for this investigation, because the Framingham Disability Study<sup>19</sup> introduced questionnaires to measure self-reported functional limitations and physical disability beginning in 1976 that were repeated on successive examinations. Moreover, this cohort has been well characterized for over 50 years, with

documentation of validated medical conditions and measurement of risk factors.

## METHODS

### Study Setting and Participants

The Framingham Heart Study was initiated in 1948 when 5209 participants, aged 28 to 62 years, were enrolled in a prospective cardiovascular disease study.<sup>20,21</sup> Since the study inception, participants have been examined biennially, including a standardized physician-administered medical history and physical examination, electrocardiogram, noninvasive testing, and measurement of lipids and glucose. Written informed consent was obtained from each of the participants.

Because we were interested in studying trends in late-life disability, we restricted our

study sample to participants aged 79 to 88 years. The age restriction ensured age comparability across time points, minimizing any confounding effects of age and permitting adequate numbers of both men and women at a given age across the time points. We did not study younger ages, because improvements in disability have been reported for adults aged 55 to 70 years.<sup>22</sup> Participants with dementia were excluded to enhance the accuracy of the disability data, because the data are self-reported. Original cohort examinations 15 (August 1977–November 1979), 20 (January 1988–June 1990), and 25 (October 1997–November 1999) were chosen for study, because examinations 14 and 15 were the first time functional data were collected and the subsequent examinations were conducted at approximately 10-year intervals. Finally, collection of physical function data at examination 15 was limited to noninstitutionalized participants; therefore, we restricted our sample to participants attending a clinic examination. Hence, our final study sample consisted of 3 different groups of participants, aged 79 to 88 years, 1 group for each chosen examination time point. (An additional table of data on the original Framingham cohort attending index examinations 15, 20, and 25 provides the details of eligibility and exclusion for the final study sample and is available as a supplement to the online version of this article at <http://www.ajph.org>.)

### Assessment of Functional Limitations and Physical Disability

In our study, we defined functional limitations based on the physical performance scale adapted from Nagi<sup>20</sup> and physical disability with the modified Katz Activity of Daily Living (ADL)<sup>22</sup> scale and the Rosow-Breslau functional health scale.<sup>21</sup> These self-reported measures have been used in other large population-based studies with high test–retest reliability, permitting use in longitudinal analyses.<sup>1,23–27</sup> Technicians interviewed each participant by asking standardized questions and recording response choices at each examination. The script used for the Katz ADL scale was modified from examination 15 (“Other than when you might have been in the hospital, was there any time during the past 12 months in which you needed help from another person or from

some special equipment or device?”) to exams 20 and 25 (“During the course of a normal day, can you do the following activities independently or do you need human assistance or use of a device?”). Functional limitation was considered present if a participant reported more than a little difficulty on any of the 7 items of the Nagi scale: pulling or pushing large objects, like a living room chair; either stooping, crouching, or kneeling; reaching or extending arms above shoulder level; reaching or extending arms below shoulder level; either writing or handling or fingering small objects; standing in one place for long periods; and sitting for at least 1 hour. Response choices included no difficulty, a little difficulty, some difficulty, a lot of difficulty, or don’t do under doctor’s orders and unable to do (examinations 20 and 25).

For physical disability determination, we used the Rosow-Breslau functional health scale to document the following 3 gross-mobility tasks: walk 0.5 mile, walk up and down stairs to second floor, and do heavy work around the house. Participants reported whether they were able or unable to do these tasks without help. At examination 25, the question of walking up and down 1 flight of stairs was asked with the modified Katz ADL scale. The modified Katz ADL scale included the following 5 items: bathing, dressing, eating, getting from bed to chair, and walking across a small room. On examinations 20 and 25, getting from bed to chair was changed to transferring (getting in and out of a chair), and walking across a small room was changed to walking on a level surface for about 50 yards. Participants reported the following: no help needed (independent), needed help from special equipment or device, needed help from another person, or needed help from both a person and special equipment. Disability was defined at each examination as requiring human assistance. If the participant reported not performing the activity during a normal day, then the response was set to missing.

### Chronic Medical Conditions and Health Behaviors

Hypertension was defined as a blood pressure of 140/90 mm Hg or greater or use of antihypertensive medication. Body mass index was calculated as weight in kilograms

divided by height in meters squared. Diabetes was defined by a casual blood glucose of 200 mg/dL or greater, or use of insulin or oral hypoglycemic agents. An end point committee comprised of 3 senior investigators (or a panel of study neurologists) adjudicated cardiovascular outcomes with all available medical records, employing standardized criteria in place since study inception.<sup>28</sup> The Center for Epidemiological Studies depression scale (CES-D) was administered to participants at examinations 22 and 25. Depressive symptoms were considered present if the CES-D score was 16 or higher.<sup>29</sup>

A current cigarette smoker was defined as regular smoking in the year preceding the examination. Participants were asked if they drank beer, wine, or liquor at least once per month, and the number of drinks on an average week was recorded. Chronic obstructive pulmonary disease (COPD) was considered present if the ratio of the forced expiratory volume at 1 second per forced vital capacity was less than 70% of predicted. At examination 25, spirometry was not performed and the diagnosis of COPD was defined by the physician opinion of chronic bronchitis or chronic symptoms (cough, sputum production). Marital status was updated at all examinations.

### Statistical Analysis

The gender-specific prevalence of chronic medical conditions, health behaviors, sociodemographic characteristics, as well as the prevalence of functional limitation or physical disability for each item of the Nagi, Rosow-Breslau, and modified Katz scales were calculated as mean value for continuous variables and percentage for dichotomous variables at each examination studied. Next, we conducted gender-specific analyses adjusted for age, with examination (15, 20, and 25) as the exposure variable, to investigate time trends in functional limitations and physical disability. Analyses were as follows: (1) linear regression (PROC GLM in SAS<sup>30</sup>) was used to calculate the least square means and the 95% confidence intervals for the number of items on the Nagi scale reported as a limitation, and on the number of items on the Rosow-Breslau and modified Katz scale reported as an impairment; and (2) logistic regression (PROC

LOGISTIC in SAS) was used to calculate the proportion of participants reporting a functional limitation and physical disability. We also created a summary measure of functional limitations and physical disability, taking into account all items of the 3 scales.

Next, we set out to determine whether the magnitude of absolute change in functional limitations and physical disability varied between men and women and between examination periods (examination 15 through examination 20 vs examination 20 through examination 25) by comparing differences in mean numbers of

items with limitation or impairment (PROC GLM, *z* tests). Because women were noted to report higher levels of functional limitation and physical disability than were men, the absolute decline and, thus, improvement in function and disability might be expected to be greater among women. We therefore tested for any difference in the relative decline in functional limitation and physical disability between men and women by using asymptotic normal theory applied to gender-specific logistic regression slopes. All analyses were conducted with SAS/STAT version 9.1.<sup>30</sup>

## RESULTS

Chronic medical conditions, health behaviors, and sociodemographic characteristics of the sample at each examination are shown in Table 1. The prevalence of obesity increased across examinations, particularly among men, as did the prevalence of cardiovascular disease (men only) and cancer, whereas the prevalence of COPD declined in concert with the decline in prevalence of current cigarette smoking. The prevalence of at least 1 health condition remained constant at about

**TABLE 1—Characteristics of Community-Dwelling Elderly Men and Women: Original Cohort, Framingham Heart Study, Framingham, Massachusetts, 1977-1999**

	Women			Men		
	Examination 15 (1977-1979)	Examination 20 (1988-1990)	Examination 25 (1997-1999)	Examination 15 (1977-1979)	Examination 20 (1988-1990)	Examination 25 (1997-1999)
Total, no.	177	159	174	103	98	119
Chronic medical conditions						
Mean age, y	82.2	81.9	82.2	81.6	82.1	82.3
Hypertension, <sup>a</sup> %	76.1	81.1	83.3	56.4	85.7	76.5
Hypertension treatment, %	47.9	63.5	60.3	33.0	61.2	55.9
Total cholesterol $\geq$ 240 mg/dL or Rx, %	38.3	24.5	32.8	12.9	11.7	22.9
Diabetes, <sup>b</sup> %	9.8	8.2	5.7	7.4	13.3	10.1
Obesity (BMI $\geq$ 30 kg/m <sup>2</sup> ), %	12.4	15.5	20.7	2.2	12.4	15.3
Cardiovascular disease, <sup>c</sup> %	37.9	28.3	29.3	41.7	44.9	55.5
Cancer, %	11.3	14.5	19.0	15.5	16.3	24.4
Chronic obstructive pulmonary disease, %	9.9	9.6	5.7	18.5	12.5	10.3
Hip fracture, %	5.1	8.8	6.9	1.9	1.0	1.7
Depressive symptoms, <sup>d</sup> %	NA	16.7	10.4	NA	6.1	7.0
At least 1 medical condition, <sup>e</sup> %	52.7	52.2	51.1	63.0	58.7	75.2
Health behaviors						
Current cigarette smoker, %	4.9	5.7	4.0	15.3	4.1	5.1
Alcohol intake, no. drinks/wk	1.9	3.6	2.5	6.1	6.4	5.4
Marital status, %						
Married	17.8	19.0	30.2	73.4	80.9	73.7
Widowed	69.9	63.3	59.3	22.3	14.9	21.2
Single	10.4	12.0	8.7	2.1	2.1	3.4
Divorced	1.9	5.7	1.8	2.2	2.1	1.7
Education, high school or greater, %	53.2	58.3	78.5	46.5	54.3	76.3
Living situation, lives alone, %	NA	72.2	46.2	NA	17.3	19.3
Work status, currently working, %	2.3	6.3	6.3	12.6	14.3	16.0
Subjective health, good or excellent, %	66.9	80.5	79.2	80.0	76.5	84.0

Note. BMI = body mass index; NA = not available, data not collected; Rx = medication treatment.

<sup>a</sup>Hypertension was defined as blood pressure at 140/90 mm Hg or greater or on antihypertensive medication treatment.

<sup>b</sup>Diabetes was defined as causal blood glucose of 200 mg/dL or greater or treatment with oral hypoglycemic agent or insulin.

<sup>c</sup>Cardiovascular disease included coronary heart disease, stroke, transient ischemic attack, congestive heart failure, or intermittent claudication.

<sup>d</sup>Depressive symptoms were assessed at examinations 22 and 25 with the Center for Epidemiological Studies Depression scale. A score of 16 or greater defined the presence of depressive symptoms.

<sup>e</sup>Medical conditions included any of the following 5 conditions: diabetes, cardiovascular disease, cancer, chronic obstructive pulmonary disease, and hip fracture.

**TABLE 2—Self-Reported Prevalence of Functional Limitation or Physical Disability Among Community-Dwelling Elderly Men and Women: Original Cohort, Framingham Heart Study, Framingham, Massachusetts, 1977–1999**

Scale and Scale Items	Women			Men		
	Examination 15 (n = 177), %	Examination 20 (n = 159), %	Examination 25 (n = 174), %	Examination 15 (n = 103), %	Examination 20 (n = 98), %	Examination 25 (n = 119), %
<b>Nagi physical performance scale</b>						
Pulling or pushing large objects	40.6	31.6	18.3	14.7	11.2	6.7
Either stooping, crouching, or kneeling	48.3	47.8	18.5	23.5	18.4	17.6
Reaching or extending arms above shoulder level	9.7	14.6	7.5	5.9	8.2	4.2
Reaching or extending arms below shoulder level	4.5	3.8	1.1	1.0	2.0	0.8
Writing, handling, or fingering small objects	17.5	11.9	5.7	15.5	11.2	10.1
Standing in place for long periods say 15 min	39.0	29.7	15.9	22.3	16.3	12.2
Sitting for at least 1 hour	9.7	5.0	4.0	9.9	6.1	0.8
<b>Rosow-Breslau functional health scale</b>						
Heavy work around the house	65.5	39.0	30.5	35.9	31.6	19.3
Walks up and down stairs to second floor <sup>a</sup>	26.0	7.5	6.9	6.8	2.0	0.0
Walk one half mile	39.5	25.2	16.7	16.5	11.2	14.3
<b>Modified Katz Activities of Daily Living scale</b>						
Bathing/personal grooming	15.3	2.5	2.9	4.9	2.0	0.0
Dressing	1.7	1.9	3.4	2.9	3.1	0.8
Eating	0.0	0.0	1.1	0.0	2.0	0.8
Getting from a bed to a chair <sup>b</sup>	0.0	1.3	2.9	1.0	3.1	0.0
Walking across small room <sup>b</sup>	4.5	1.3	0.6	0.0	1.0	0.8
Any special equipment or device use	7.9	13.2	28.2	3.9	4.1	17.6

Note. The mean age of the cohort was 82 years. Disability was defined as human assistance needed, minimally dependent, or dependent on the modified Katz Activities of Daily Living Scale and as unable to do so on the Rosow-Breslau functional health scale. Using the Nagi physical performance scale a functional limitation was defined as some difficulty, a lot of difficulty, unable to do, or do not do on physician order.

<sup>a</sup>At examination 25, this question was asked as part of the modified Katz Activities of Daily Living scale.

<sup>b</sup>At examinations 20 and 25, the question was changed to “transferring (getting in and out of a chair)” and “walking on a level surface about 50 yards.”

50% for women, whereas among men, the prevalence of at least 1 health condition changed across the 3 examination periods, from 63.0% to 58.7% to 75.2%. Striking differences in marital status among men and women were noted. Thus, less than 20% of men reported living alone, and 72.2% of women at examination 20 and 46.2% of women at examination 25 lived alone. Most participants reported their health to be good or excellent.

Women reported greater functional limitations and physical disability for almost all items of the Nagi physical performance scale, the Rosow-Breslau functional health scale, and the modified Katz ADL scale at all examinations (Table 2). Of note, the magnitude of the difference between men and women in the self-reported prevalence of disability or functional limitation for some scale items narrowed over time. For example, at examination 15, 39.5% of women and 16.5% of men

reported inability to walk 0.5 miles; however, at examination 25, 16.7% of women and 14.3% of men were unable to do so. The use of special equipment or devices increased across exams among both women and men.

Gender-specific trends in functional limitations and physical disability adjusted for age are shown in Table 3. A significant decline in functional limitations and disability was observed in both women and men. For example, at examination 15, 74.6% of women reported at least 1 functional limitation on the Nagi physical performance scale compared with 60.5% of women at examination 20 and 37.9% of women at examination 25 ( $P < .001$ ). Corresponding reports among men at examinations 15, 20, and 25 were 54.2%, 37.8%, and 27.8% ( $P < .001$ ), respectively. Likewise, self-reported physical disability assessed with the Rosow-Breslau and modified Katz ADL scales declined across the 3 examination time periods, from 74.5% to 48.5% to

34.6% ( $P < .001$ ), respectively, among women and 42.3% to 33.3% to 22.8% ( $P = .009$ ) among men. The mean number of scale items reported with a limitation or impairment also decreased across exams among both men and women. By examination 25, 63.6% of men and 50.9% of women reported that they were free of any functional limitations and physical disability. Repeating the analyses, adjusting for chronic medical conditions defined by the presence or absence of cardiovascular disease, cancer, diabetes, and hip fracture with a score from 0 to 4 did not change the trends.

Next, we examined whether the magnitude of the decline in limitations and physical disability differed between men and women and whether the decline differed across time, comparing the change that occurred between examinations 15 and 20 to that that occurred between examinations 20 and 25 in terms of the number of reported scale items with limitation or impairment. Women started with

**TABLE 3—Gender-Specific Trends in Self-Reported Functional Limitations and Physical Disability Among Community-Dwelling Elderly Men and Women, Adjusted for Age: Original Cohort, Framingham Heart Study Framingham, Massachusetts, 1977–1999**

Physical Function Scale	Women			P	Men			P
	Examination 15 (n=177)	Examination 20 (n=159)	Examination 25 (n=174)		Examination 15 (n=103)	Examination 20 (n=98)	Examination 25 (n=119)	
Functional limitation, Nagj scale								
No. of items with limitation, mean (95% CI)	1.67 (1.46, 1.88)	1.45 (1.23, 1.67)	0.70 (0.48, 0.91)	<.001	0.93 (0.71, 1.14)	0.73 (0.51, 0.96)	0.53 (0.32, 0.73)	.03
Any difficulty on the scale, % (95% CI)	74.6 (66.7, 81.1)	60.5 (51.5, 68.8)	37.9 (29.9, 46.5)	<.001	54.2 (43.1, 65.0)	37.8 (27.6, 49.2)	27.8 (19.6, 37.9)	<.001
Physical disability, Rosow-Breslau, and Katz ADL scales, mean (95% CI)								
No. of items with impairment, mean (95% CI)	1.52 (1.34, 1.70)	0.81 (0.62, 1.00)	0.64 (0.46, 0.82)	<.001	0.71 (0.52, 0.90)	0.55 (0.36, 0.75)	0.35 (0.17, 0.52)	.02
Any difficulty on the scales, % (95% CI)	74.5 (66.7, 80.9)	48.5 (39.8, 57.2)	34.6 (27.0, 43.0)	<.001	42.3 (31.9, 53.3)	33.3 (23.7, 44.4)	22.8 (15.4, 32.3)	.009
Summary, all 3 scales								
No. of items with limitation or impairment, mean (95% CI)	3.19 (2.86, 3.52)	2.26 (1.91, 2.61)	1.34 (1.00, 1.67)	<.001	1.64 (1.28, 2.00)	1.29 (0.92, 1.66)	0.87 (0.54, 1.20)	.009
Any difficulty on the scales, % (95% CI)	88.1 (81.9, 92.4)	69.6 (60.8, 77.0)	49.1 (40.4, 57.9)	<.001	63.9 (52.9, 73.5)	48.8 (37.7, 59.8)	36.4 (27.1, 46.9)	<.001

Note. ADL = Activity of Daily Living; CI = confidence interval. Analysis adjusted for age.

greater limitations and disability compared with men (Table 3) and experienced a greater absolute decline in both functional limitations ( $P=.008$ ) and physical disability ( $P=.005$ ) than did men. However, the relative difference in the decline determined by examining the proportion of women versus men reporting any difficulty on the scale was significantly different only for physical disability ( $P=.03$ ). Absolute improvements in both functional limitations and physical disability were constant across the examination time periods (examinations 15 through 20 and examinations 20 through 25) among men. Among women, there was a greater improvement in functional limitation between examinations 20 and 25 compared with that between examinations 15 and 20 ( $P=.05$ ), whereas the improvement in physical disability was more marked between examinations 15 and 20 compared with that between examinations 20 and 25 ( $P=.02$ ).

## DISCUSSION

In our sample of community-dwelling elderly people, we found a significant decline in self-reported functional limitations and physical disability in both women and men over 3 examinations occurring from the late 1970s to the late 1990s. At examination 25

(1997–1999), more than half of men and women were free of both functional limitations and disability. This finding suggests continued progress when compared with a report by Liao et al., in which 42% of men and 34% of women 70 years and older were found to be physically robust, without any limitations or disabilities.<sup>31</sup>

In our study, women reported a greater burden of functional limitations and physical disability than did men. Hence, the absolute decline in both limitations and disability was significantly greater among women than among men; however, the relative difference in the magnitude of decline was significantly different between men and women only for physical disability. Moreover, the absolute improvement in function and disability was constant over the examinations in men, whereas among women, the improvement in disability was greater between examinations 15 and 20 (late 1970s to late 1980s) than between examinations 20 and 25 (late 1980s to late 1990s). These findings are in contrast to national survey data, which suggest that the disability decline has accelerated in more recent years.<sup>32,33</sup> In accordance with those reports, the magnitude of improvement in functional limitations among women was greatest at more recent examinations. The decline in disability in our study may, in part, be related

to the notable increase in the use of special equipment and devices that facilitate greater independence. This finding is consistent with other reports that noted an increase in the proportion of the community-dwelling elderly population who used equipment to bathe.<sup>5</sup> Our work highlights the importance of studying gender-specific trends in disability, as well as the need for careful attention to the specific measures used to define disability to determine whether any improvements include all types of limitations and impairments.

It is noteworthy that, among men, the decline in physical disability and improvement in functional limitations occurred despite an increase in the prevalence of chronic medical conditions, whereas among women, the improvements occurred in the absence of a change in the prevalence of chronic medical conditions. Our findings in men may be related to improvements in diagnosis and treatment of chronic conditions that occurred over time. Successful prevention and postponement of disablement in the elderly depend, in part, on efforts at early diagnosis of illness and subsequent focused interventions.<sup>34</sup> As in our study, national survey data demonstrated an increase in self-reported medical conditions over 2 points in time (1984 and 1994), yet many of the conditions had less of a debilitating effect.<sup>18</sup> We extended this knowledge by



focusing on older adults (mean age=82 years), including not only functional limitations, but also physical disability measures. In addition, rather than relying on self-reported medical conditions, the conditions in our study were directly measured or validated with medical records. We acknowledge that the number of medical conditions in our study was not exhaustive. Ferrucci et al. have raised the hypothesis that there may be gender-related differences in the lifetime prevalence of lethal versus disabling diseases.<sup>35</sup> Hence, it is possible that, among women, important disabling conditions not included in our study have become less debilitating over time.<sup>18</sup>

The 2001 World Health Organization International Classification of Functioning, Disability, and Health highlights the importance of environmental and personal factors in the disablement process. For older adults, disability generally refers to the ability to live independently and perform self-care activities. In our sample, the prevalence of self-reported mobility disability was significant among both women and men even at the most recent examination. Gross mobility is often the first area in which older adults report difficulty,<sup>24,36</sup> yet little research has been done to determine how environmental factors influence the process and trajectory of disability.<sup>37</sup> The rise in reported special equipment or device use likely contributed to the improvement; however, other environmental changes, such as home modifications, may have positively influenced the trends. Personal factors, such as gender, age, education, lifestyle habits, and marital status, may also play a role in disability.<sup>38</sup> It is notable that most women in our sample were widowed and reported living alone. Prior work has shown the importance of family and social factors to risk of institutionalization after stroke.<sup>39</sup> These same factors may be operational in the disablement process.

### Limitations

Our study has several limitations that merit comment. We focused on community-dwelling, nondemented elders, and included only participants attending an on-site clinic examination, because participants were not offered examinations in their personal residence or nursing home at the start of this

study (examination 15). The proportion of institutionalized elderly declined during the years of our study.<sup>32</sup> This trend would have resulted in an increase in persons with disability in the community and biased our results toward the null.

All individuals in our sample were White, and thus our results may not pertain to other racial or ethnic groups. The decline in disability in recent years was reported to be greater among the Black population than among the non-Black population.<sup>32</sup> Additionally, our sample is fairly well educated; three quarters of participants at examination 25 had attained a high school or greater education. Educational achievement has been consistently linked to longevity<sup>40</sup> and improvements in late-life function.<sup>4,8,13</sup>

Performance-based measures were not included in the examinations studied for this report. Conceptualizations of disability and individual perceptions of social roles, especially for women, have evolved over time. It is unclear how much of the decline in disability among women in our sample is caused by changing self-perceptions of ability to perform tasks (social desirability) versus other factors, such as innovations in diagnosis and treatment of chronic illness, improvements in health-related behaviors, especially smoking cessation and increased physical activity, and the emergence of alternative living arrangements and expanded use of assistive devices allowing older persons to maintain independence.<sup>6</sup> Finally, we acknowledge that change in the wording of the scale items and response choices may have contributed to the changes in self-reported functional limitations and physical disability in our study.

### Conclusions

We found that for community-dwelling men and women aged 79 to 88 years, the prevalence of functional limitations and physical disability declined significantly over 3 examinations from the late 1970s to the late 1990s. The relative magnitude of the decline in physical disability was greater among women than among men. In contrast to the acceleration in the disability decline in recent years noted in national survey data, the decline in limitations and disability was constant over time in men in our sample, whereas among women, the

decline was greatest in the earlier part of our study (examination 15 to examination 20, late 1970s to late 1980s). The improvement in physical function trends was noted in concert with a marked increase in reported use of special equipment and devices used to maintain independence. Future work is needed to determine the underlying causes contributing to the declines in limitations and disability in old age so that preventative measures can be put in place to promote and maintain independence until the end of life. It remains uncertain whether the improvements in functional limitations and physical disability will continue, given the unfavorable direction of the prevalence of obesity and physical activity in the general population, factors known to predict incident disability<sup>41</sup> and declines in physical performance.<sup>42</sup> ■

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### Contributors

J.M. Murabito conceptualized and designed the study, acquired, analyzed, and interpreted the data, and drafted and revised the article for important intellectual content. M.J. Pencina conceptualized and designed the study, analyzed and interpreted the data, and revised the article for important intellectual content. L. Zhu analyzed and interpreted the data. M. Kelly-Hayes conceptualized and designed the study, acquired, analyzed, and interpreted the data, and revised the article for important intellectual content. P. Shrader analyzed and interpreted the data. R.B. D'Agostino Sr conceptualized and designed the study and acquired, analyzed, and interpreted the data.

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## Human Participant Protection

The institutional review board of Boston University Medical Center approved the content of each Framingham Heart Study examination.

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