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COMPARISONS BETWEEN OLDER MEN AND WOMEN IN THE TRAJECTORY AND BURDEN OF DISABILITY OVER THE COURSE OF NEARLY 14 YEARS

Thomas M. Gill, M.D.^{*}, Evelyn A. Gahbauer, M.D., MPH^{*}, Haiqun Lin, M.D., Ph.D.[†], Ling Han, M.D., Ph.D.^{*}, and Heather G. Allore, Ph.D.^{*}

^{*}Yale School of Medicine, Department of Internal Medicine, New Haven, CT

[†]Yale School of Public Health, Department of Biostatistics, New Haven, CT

Abstract

Objectives—Across the lifespan, women live longer than men but experience higher rates of disability. To more completely evaluate these gender differences, the current study set out to compare the trajectories and burden of disability over an extended period of time between older men and women.

Design—Prospective, longitudinal study with 13.5 years of follow-up.

Setting—Greater New Haven, Connecticut.

Participants—754 persons, aged 70 years or older, who were initially community-living and nondisabled in their basic activities of daily living.

Measurements—Disability in 13 basic, instrumental and mobility activities was assessed during monthly interviews, while demographic and clinical covariates were measured during comprehensive assessments every 18 months.

Results—Five distinct trajectories were identified over successive 18-month intervals: independent, mild disability, mild to moderate disability, moderate disability, and severe disability. Women were more likely than men to experience the moderate and severe disability trajectories, but were less likely to transition from the independent trajectory to a worse disability trajectory during the subsequent 18-month interval. Women were also less likely to die after each of the five trajectories, and these differences were at least marginally significant for all but the independent trajectory. Over the entire duration of follow-up, women suffered from a greater burden of disability than men, but these differences were greatly attenuated after adjustment for the baseline levels of disability.

Conclusions—Gender differences in disability over an extended period of time can be explained, at least in part, by the higher mortality experienced by older men and the higher initial levels of disability among older women. These results suggest the need to take a life-course approach to better understand gender differences in disability.

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Address correspondence to: Thomas M. Gill, M.D., Yale University School of Medicine, Adler, Geriatric Assessment Center, 20 York Street, New Haven, CT 06504, Telephone: (203) 688-9423 Fax: (203) 688-4209 thomas.gill@yale.edu.

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Keywords

disability assessment; longitudinal study; gender differences

INTRODUCTION

Across the lifespan, women live longer than men but experience higher rates of disability. Life expectancy for women exceeds that for men by 5.2 years at birth, 2.8 years at age 65, and 1.1 years at age 85.¹ In contrast, women experience greater disability than men of the same age across a wide range of functional measures, including basic activities of daily living (ADL), instrumental ADLs, such as housework and shopping, and mobility.^{2, 3} The reasons for these differences are not fully understood. We have previously shown that the higher prevalence of ADL disability in older women relative to men is due to a combination of higher incidence and longer duration of disability, resulting from lower rates of recovery and mortality among disabled older women.⁴

To more completely evaluate these gender differences, we set out in the current study to compare the trajectories and burden of disability over time between older men and women, considering a broad array of functional tasks, to include not only basic ADLs, but also instrumental activities of daily living (IADLs) and mobility. We hypothesized that older women would have less favorable trajectories of disability and greater burden of disability as compared with older men. To test this hypothesis, we used data from a unique longitudinal study that includes monthly assessments of disability for nearly 14 years in a large cohort of older persons. To our knowledge, no prior study has compared trajectories or the burden of disability over time between older men and women.

METHODS

Study Population

Participants were members of the Precipitating Events Project, a longitudinal study of community-living persons, aged 70 years or older, who were nondisabled (i.e. required no personal assistance) at baseline in four basic activities of daily living—bathing, dressing, walking inside the house, and transferring from a chair.⁵ Exclusion criteria included significant cognitive impairment with no available proxy,⁶ inability to speak English, diagnosis of a terminal illness with a life expectancy less than 12 months, and a plan to move out of the New Haven area during the next 12 months.

The assembly of the cohort, which took place between March 1998 and October 1999, has been described in detail elsewhere.^{5, 7} In brief, potential participants were identified from a computerized list of 3,157 age-eligible members of a large health plan in greater New Haven, Connecticut. Based on our initial sample size calculations, persons with slow gait speed (i.e., require >10 seconds to walk back and forth over a 10-ft (3-m) course as quickly as possible) were oversampled. Eligibility was determined during a screening telephone interview and was confirmed during an in-home assessment. Only 4.6% of persons contacted refused screening, and 754 (75.2%) of the 1002 eligible members agreed to participate in the project. Persons who refused to participate did not differ significantly from those who were enrolled in terms of age or gender. The study protocol was approved by the Yale Human Investigation Committee, and all participants provided verbal informed consent.

Data Collection

Comprehensive home-based assessments were completed at baseline and subsequently at 18-month intervals for 144 months (with the exception of 126 months), while telephone interviews were completed monthly through June 30, 2011. For participants who had significant cognitive impairment or were otherwise unavailable, we interviewed a proxy informant, using a rigorous protocol, with demonstrated reliability and validity, as described in an earlier report.⁶ Deaths were ascertained by review of the local obituaries and/or from an informant during a subsequent telephone interview, with a completion rate of 100%. Five hundred fourteen (68.2%) participants died after a median follow-up of 82 months, while 38 (5.0%) dropped out of the study after a median follow-up of 27 months. Data were otherwise available for 99.2% of the 74,883 monthly interviews. Median survival was greater in women than men (123 vs. 104 months; $P=0.006$), but drop-outs did not differ significantly by gender (5.7% in women vs. 3.8% in men; $P=0.38$).

Assessment of Disability—Complete details regarding the assessment of disability, including the use of proxy respondents and formal tests of reliability and accuracy, are provided elsewhere.^{6–8} During the monthly interviews, we asked participants, “At the present time, do you need help from another person to (complete the task)?” for each of the four basic activities, five instrumental activities (shopping, housework, meal preparation, taking medications, and managing finances), and three mobility activities (walk a quarter mile, climb a flight of stairs, and lift and carry ten pounds). For these 12 activities, disability was operationalized as the need for personal assistance. Participants were also asked about a fourth mobility activity, “Have you driven a car during the past month?” Participants who responded “No” were deemed to have stopped driving. To maintain consistency with the other activities, these participants were classified as being “disabled” in driving that month.⁸ The primary outcome included the number of disabilities in all 13 basic, instrumental and mobility activities. To address the small amount of missing data on disability, we used multiple imputation with 100 random draws per missing observation.⁹

Assessment of Covariates—During each of the comprehensive assessments, data were collected on several covariates, including demographic characteristics, physical frailty, defined on the basis of slow gait speed,¹⁰ cognitive status as assessed by the Folstein Mini-Mental State Examination (MMSE),¹¹ depressive symptoms as assessed by the Center for Epidemiologic Studies Depression (CES-D) Scale,¹² body mass index (BMI),¹³ habitual physical activity as assessed by the Physical Activity Scale for the Elderly (PASE),¹⁴ and 9 self-reported, physician-diagnosed chronic conditions: hypertension, myocardial infarction, congestive heart failure, stroke, diabetes mellitus, arthritis, hip fracture, chronic lung disease, and cancer. Data on these covariates were 100% complete at baseline and greater than 95% complete during the subsequent comprehensive assessments. Participants were considered to be cognitively impaired if they scored less than 24 on the MMSE,¹¹ to have high depressive symptoms if they scored 16 or greater on the CES-D,¹² to be obese if their BMI was 30 kg/m or greater,¹³ and to have low physical activity if they scored 64 for men and 52 for women on the PASE, denoting the worse quintile of scores among the first 356 enrolled participants, who had been selected randomly from our source population of health plan members, as previously described.¹⁰

Statistical Analysis

Two (0.3%) members of the cohort died before their first monthly interview, leaving 752 participants in the analytic sample. Relevant baseline characteristics were compared between men and women using the chi-square test for categorical variables and one-way ANOVA for continuous variables.

To identify distinct trajectories of disability, we used a generalized growth mixture model with random effects.^{15, 16} We modelled the total disability score, ranging from 0 to 13, as a Poisson random variable in each month over eight consecutive 18-month intervals, with both linear and quadratic terms for time (i.e. month), as well as a person-specific random effect within each trajectory. The probability of membership for each trajectory was estimated using polytomous logistic regression, conditional on the main independent variable, gender (men versus women), and a set of seven demographic and clinical covariates that have been linked to disability in prior studies:¹⁷ race/ethnicity (Non-Hispanic white versus other) and years of education, which were both fixed, and age, living situation (alone versus with others), number of chronic conditions, cognitive impairment, and physical frailty, which were all time-varying.

We fit a series of growth mixture models with the number of trajectory classes varying from 1 to 7, and chose the best-fitting model based on the lowest Bayesian Information Criteria (BIC) value among all the converged candidate models.^{15, 18} Models that attempted to fit additional covariates, including depressive symptoms, BMI, and physical activity, did not converge. The adequacy of the final model was evaluated using the average posterior probabilities of class membership; a value of 0.9 or higher is considered an excellent fit, while a value less than 0.7 is considered a poor fit.¹⁹

The overall membership probability for a trajectory class was calculated as the total number of person-intervals assigned to a specific trajectory among the total number of observed person-intervals. Participants were assigned to a specific trajectory based on the maximum estimated probability of membership for each 18-month interval. Gender-specific distributions of the trajectories for each 18-month interval were depicted graphically but were not compared statistically, given the large number of comparisons.

Based on the parameter estimates from the growth mixture model, which included the seven fixed and time-varying covariates, we calculated relative risks and 95% confidence intervals (CI) for the effect of being female versus male on the membership probabilities of each trajectory class relative to the independent (or least disabled) trajectory class over the entire follow-up period.

Next, we calculated gender-specific probabilities for transitions between each of the trajectory classes from one 18-month interval to the next over the entire follow-up period, by dividing the number of members in each trajectory at interval $t + 1$ by the number of members in the relevant starting trajectory at interval t for men and women, respectively. To facilitate statistical comparisons, we defined three types of transitions: (1) decline: moving to a worse disability trajectory; (2) recovery: moving to a better disability trajectory; and (3) death: dying during the next 18-month interval. We subsequently fit a generalized logit model to determine the effect of gender on these three types of transitions, analyzed as a nominal outcome, relative to staying in the same trajectory.²⁰ Odds ratios and 95% CI were estimated simultaneously for the starting trajectory classes. The models were adjusted for the presence of depressive symptoms, low physical activity, and obesity, as time-varying covariates, but not for the other seven covariates since they were used to define the trajectory classes.

Finally, we calculated the disability burden for men and women, respectively, for each 18-month interval, focusing on total disability and, subsequently, on the basic, instrumental and mobility activities, respectively. To account for differences in the duration of follow-up, we defined disability burden as the ratio of the sum of the relevant monthly disability scores during an 18-month interval divided by the total number of months observed for that interval. For each disability outcome, a generalized estimating equations (GEE) Poisson

model was used to evaluate the effect of gender on disability burden over the entire duration of follow-up.²⁰ The first adjusted model included all ten of the fixed and time-varying covariates (i.e. the original seven along with depressive symptoms, low physical activity, and obesity), while the second included the relevant baseline disability score, in addition to the ten fixed and time-varying covariates.

All statistical tests were 2-tailed, and all analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC).

RESULTS

Table 1 provides the baseline characteristics of the 265 men and 487 women in our analytic sample. The men were more highly educated, while the women had higher levels of disability in instrumental and mobility activities and were more likely to live alone, be physically frail, have depressive symptoms, and be obese. There were no gender differences according to age, race/ethnicity, number of chronic conditions, cognitive impairment, or low physical activity.

Based on a total disability score ranging from 0 to 13, five distinct functional trajectories were identified over the 18-month intervals: independent, mild disability, mild to moderate disability, moderate disability, and severe disability, as shown in Figure 1. While the disability scores were essentially flat for the independent and mild disability trajectories, they increased modestly over the subsequent 18 months for the moderate and severe disability trajectories. For the mild to moderate disability trajectory, the disability score was comparable to that in the mild disability trajectory at the start of the interval, but increased markedly over the subsequent 18 months such that it was only modestly lower than the score in the moderate disability trajectory at the end of the interval. The most common functional trajectory was mild disability (31.9% of the 18-month intervals), followed by independent (25.1%), moderate disability (16.9%), severe disability (15.7%), and mild to moderate disability (10.5%).

Figure 2 shows the gender-specific distributions of the functional trajectories for each 18-month interval over the 13.5-year follow-up period. For baseline to 18 months, the independent trajectory was more common in men, while the other four disability trajectories were more common in women, although the magnitude of these latter differences was relatively small. The prevalence of the independent trajectory dropped markedly in men between the first and second intervals, resulting in a lower rate than in women, and then tended to decrease, albeit with some variability, over the subsequent intervals. In women, a monotonic decrease was observed, although the drop in prevalence was not as marked between the first and second intervals. While comparable between 37 and 72 months, the prevalence of the independent trajectory was consistently lower in women than men after 72 months. For each of the nine intervals, the severe disability trajectory was more common in women than men, with the largest difference in prevalence observed for the last interval, i.e. 145 to 162 months. Similar results were observed for the moderate disability trajectory except that men had a greater prevalence than women for the last interval. For each interval except the first, the mild disability trajectory was more common in men than women, although this difference was small for the last interval. For the mild to moderate trajectory, differences in prevalence between men and women were generally small and inconsistent.

In a longitudinal analysis that accounted for age, race, education, living situation, number of chronic conditions, cognitive impairment, and physical frailty, the moderate disability and severe disability trajectories were more common, relative to the independent trajectory, in women than men over the entire follow-up period, with relative risks (95% CI) of 1.66

(1.18–2.33) and 2.98 (2.02–4.39), respectively. There were no gender differences for the mild disability and mild to moderate disability trajectories, as reflected by the corresponding relative risks of 1.04 (0.84–1.30) and 1.05 (0.76–1.44).

Table 2 shows the gender-specific probabilities for transitions between each of the trajectory classes from one 18-month interval to the next over the entire follow-up period. The transition probabilities from mild disability were comparable in men and women. Otherwise, women were more likely than men to remain in the independent trajectory, largely because they were less likely to transition to mild disability. Women were more likely to transition from the “mild to moderate” trajectory to the moderate trajectory and to remain in the moderate and severe trajectories, respectively, largely because they were less likely than men to subsequently die from these trajectory classes. For both men and women, recovery from a more severe to less severe trajectory class was relatively uncommon, with no probability greater than 7.9% (men for transition from mild disability to independent). No participant recovered to the independent trajectory from either moderate or severe disability, and very few participants recovered to a less severe trajectory class from severe disability. Transitions to death, although relatively uncommon from the independent and mild disability trajectories, were observed commonly from the other three trajectories, with probabilities as high as 48.7% from the severe disability trajectory in men.

In the multivariable analysis, as shown in Table 3, women were less likely than men to transition from the independent trajectory to a worse disability trajectory during the subsequent 18-month interval. Women were also less likely than men to recover to a better disability trajectory from the mild and mild to moderate disability trajectories, respectively, although these differences did not achieve statistical significance. Finally, for each of the functional trajectories, women were less likely than men to die in the subsequent interval, and these differences were at least marginally significant for all but the independent trajectory.

As shown in Table 4, the burden of total disability, based on all 13 activities, was greater among women than men for each of the 18-month intervals, with the largest differences observed for the last four intervals. In a multivariable analysis, which accounted for the ten fixed and time-varying covariates, women had a 15% greater burden of disability than men over the entire duration of follow-up, as denoted by an adjusted relative risk of 1.15 (1.07–1.25). However, when baseline disability was included in the model, the gender effect was diminished and no longer statistically significant, as denoted by an adjusted relative risk of 1.06 (0.98–1.15). Comparable results were observed for the basic, instrumental, and mobility activities, respectively (available upon request).

DISCUSSION

In this prospective longitudinal study, which included monthly assessments of 13 basic, instrumental, and mobility activities, we identified five distinct trajectories of disability over intervals of 18 months, and we compared these trajectories and the overall burden of disability over the course of 13.5 years between older men and women. Four major findings warrant comment. First, women were more likely than men to experience trajectories that were characterized by moderate and severe levels of disability, respectively. Second, women were less likely than men to transition from the independent trajectory, which was characterized by very low levels of disability, to a worse disability trajectory during the subsequent 18-month interval. Third, for both men and women, recovery from a more severe to less severe disability trajectory was relatively uncommon. Fourth, over the entire duration of follow-up, women suffered from a greater burden of disability than men in basic, instrumental, and mobility activities, respectively, but these differences were greatly

attenuated after adjustment for the baseline levels of disability. Collectively, these findings provide new insights into differences in the course of disability between older men and women.

Some of the observed differences in disability trajectories were likely attributable to the distinct mortality experiences of older men and women. Relative to their male counterparts, women were less likely to die after each of the five trajectories (independent, mild disability, mild-moderate disability, moderate disability, and severe disability), and these differences were at least marginally significant for all but the independent trajectory. Because they were less likely to die, women were more likely than men to remain in each of the trajectories.

We found no gender differences in the likelihood of recovering from a more severe to less severe disability trajectory. This could be due, at least in part, to the low probabilities of recovery observed in the current study, which diminished power to detect statistically significant differences. These low probabilities stand in stark contrast to the high rates of recovery that have been demonstrated from one month to the next in previous studies.^{4, 7, 21} Although fairly dynamic over short periods of time,²² functional status appears to be considerably more stable over longer periods of time in both older men and women, with most transitions occurring, in the absence of death, to an adjacent trajectory representing worsening disability.

A large number of studies have evaluated gender differences in the prevalence and incidence of disability,^{2-4, 23, 24} but no prior study, to our knowledge, has compared trajectories of disability or the burden of disability over time between older men and women. The availability of monthly data on functional status allowed us to identify five distinct trajectories, characterized by progressively worse levels of disability, ranging from independent to severe disability. Each of the disability trajectories has considerable face validity, and the fit to the observed data was excellent. The trajectories were defined over 18-month intervals to take advantage of longitudinal data that were available on key demographic and clinical factors, including age, race, education, living situation, number of chronic conditions, cognitive impairment, and physical frailty, that were used to help define the trajectories. The most common trajectories were independent and mild disability. The probabilities of the other three trajectories, which were characterized by higher levels of disability, were likely diminished by the competing risk of death.

While most prior studies have evaluated gender differences in disability at only a single point in time or over only a small number of follow-up interviews,^{2, 23, 24} the current study included monthly assessments of basic, instrumental, and mobility activities for nearly 14 years. This allowed us to more completely characterize the burden of disability over an extended period of time. We found that the disability burden tended to increase progressively during each 18-month interval for both men and women, despite attrition from competing mortality, but was consistently higher for women than men. These differences persisted in a sophisticated longitudinal analysis that serially adjusted for a large number of potential confounders, but were diminished and no longer statistically significant after further adjustment for the baseline levels of disability, which were higher in women.

In trying to reconcile our results, it appears that the gender differences in disability that were observed over an extended period of time can be explained, at least in part, by two phenomena, namely, the higher mortality experienced by older men than women and the higher levels of disability among older women than men at the outset of the study. Based on this latter finding, gender differences in disability likely start earlier in life, suggesting the need for a life-course approach that can evaluate changes in functional status from middle age (or perhaps even younger) to old age.²⁵

Important strengths of our study, in addition to the novel focus on trajectories and burden of disability, include the long duration of follow-up, low rate of attrition for reasons other than death, and completeness of data collection. Nonetheless, several limitations warrant comment. First, because disability in basic ADLs was an exclusion criterion, the proportions of men and women assigned to the independent trajectory were considerably higher during the first 18-month interval than during the subsequent intervals, likely explaining the large reductions in these proportions between the first and second 18-month intervals. Second, while depressive symptoms, BMI, and physical activity were included as covariates in models that evaluated disability burden and transitions between disability trajectories, respectively, they could not be included in the model that defined the five disability trajectories because the resulting model did not converge. Third, given the complexity of defining and subsequently evaluating the disability trajectories, we did not attempt to thoroughly explore potential reasons for the gender differences observed in the current study. This will be the focus of future research. Finally, because our study participants were members of a single health plan in a small urban area and were oversampled for slow gait speed, our results may not be generalizable to older persons in other settings. However, the demographic characteristics of our cohort did reflect those of older persons in New Haven County, Connecticut, which are similar to the characteristics of the U.S. population as a whole, with the exception of race or ethnic group (38). The generalizability of our results is enhanced by our high participation rate, which was greater than 75%.

In summary, the current study provides new information on gender differences in the long-term course of disability and suggests the need to take a life-course approach to better understand the disparity in disability between older women and men.

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References

1. Kung H-C, Hoyert DL, Xu J, Murphy SL. Deaths: final data for 2005. *Natl Vital Stat Rep*. 2008; 56:1–120. [PubMed: 18512336]
2. Newman AB, Brach JS. Gender gap in longevity and disability in older persons. *Epidemiol Rev*. 2001; 23:343–350. [PubMed: 12192741]
3. Leveille SG, Penninx BW, Melzer D, Izmirlian G, Guralnik JM. Sex differences in the prevalence of mobility disability in old age: the dynamics of incidence, recovery, and mortality. *J Gerontol B Psychol Sci Soc Sci*. 2000; 55B:S41–S50. [PubMed: 10728129]
4. Hardy SE, Allore HG, Guo Z, Gill TM. Explaining the effect of gender on functional transitions in older persons. *Gerontology*. 2008; 54:79–86. [PubMed: 18230952]
5. Gill TM, Desai MM, Gahbauer EA, Holford TR, Williams CS. Restricted activity among community-living older persons: incidence, precipitants, and health care utilization. *Ann Intern Med*. 2001; 135:313–321. [PubMed: 11529694]
6. Gill TM, Hardy SE, Williams CS. Underestimation of disability among community-living older persons. *J Am Geriatr Soc*. 2002; 50:1492–1497. [PubMed: 12383145]

7. Hardy SE, Gill TM. Recovery from disability among community-dwelling older persons. *JAMA*. 2004; 291:1596–1602. [PubMed: 15069047]
8. Gill TM, Gahbauer EA, Murphy TE, Han L, Allore HG. Risk factors and precipitants of long-term disability in community mobility: a cohort study of older persons. *Ann Intern Med*. 2012; 156:131–140. [PubMed: 22250144]
9. Gill TM, Guo Z, Allore HG. Subtypes of disability in older persons over the course of nearly 8 years. *J Am Geriatr Soc*. 2008; 56:436–443. [PubMed: 18194225]
10. Gill TM, Gahbauer EA, Allore HG, Han L. Transitions between frailty states among community-living older persons. *Arch Intern Med*. 2006; 166:418–423. [PubMed: 16505261]
11. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state" A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975; 12:189–198. [PubMed: 1202204]
12. Kohout FJ, Berkman LF, Evans DA, Cornoni-Huntley J. Two shorter forms of the CES-D Depression Symptoms Index. *J Aging Health*. 1993; 5:179–193. [PubMed: 10125443]
13. Gill TM, Allore HG, Han L. Bathing disability and the risk of long-term admission to a nursing home. *J Gerontol A Biol Sci Med Sci*. 2006; 61:821–825. [PubMed: 16912099]
14. Washburn RA, McAuley E, Katula J, Mihalko SL, Boileau RA. The physical activity scale for the elderly (PASE): evidence for validity. *J Clin Epidemiol*. 1999; 52:643–651. [PubMed: 10391658]
15. Muthén, B. Latent variable analysis: growth mixture modeling and related techniques for longitudinal data. In: Kaplan, D., editor. *The Sage handbook of quantitative methodology for the social sciences*. Thousand Oaks, CA: Sage Publications; 2004.
16. Hedeker, D.; Gibbons, RD. *Longitudinal Data Analysis*. New York: John Wiley & Sons; 2006.
17. Stuck AE, Walthert JM, Nikolaus T, Bula CJ, Hohmann C, Beck JC. Risk factors for functional status decline in community-living elderly people: a systematic literature review. *Soc Sci Med*. 1999; 48:445–469. [PubMed: 10075171]
18. Jones BL, Nagin DS, Roeder K. A SAS procedure based on mixed models for estimating developmental trajectories. *Sociological Methods and Research*. 2001; 29:374–393.
19. Nagin, DS. *Group-based modeling of development*. Cambridge, MA: Harvard University Press; 2005. p. 201
20. McCulloch, CE.; Searle, SR. *Generalized, linear and mixed models*. New York, NY: John Wiley & Sons, Inc; 2001. p. 358
21. Hardy SE, Gill TM. Factors associated with recovery of independence among newly disabled older persons. *Arch Intern Med*. 2005; 165:106–112. [PubMed: 15642885]
22. Hardy SE, Dubin JA, Holford TR, Gill TM. Transitions between states of disability and independence among older persons. *Am J Epidemiol*. 2005; 161:575–584. [PubMed: 15746474]
23. Rodrigues MAP, Facchini LA, Thume E, Maia F. Gender and incidence of functional disability in the elderly: a systematic review. *Cad Saude Publica*. 2009; 25(Suppl 3):S464–S476. [PubMed: 20027393]
24. Louie GH, Ward MM. Sex disparities in self-reported physical functioning: true differences, reporting bias, or incomplete adjustment for confounding? *J Am Geriatr Soc*. 2010; 58:1117–1122. [PubMed: 20487076]
25. Kuh D, Ben-Shlomo Y, Lynch J, Hallqvist J, Power C. Life course epidemiology. *J Epidemiol Community Health*. 2003; 57:778–783. [PubMed: 14573579]

Figure 1.

Functional trajectories over the 18-month intervals. The total disability score ranged from 0 to 13 and included four basic activities (bathing, dressing, walking inside house, and transferring from chair), five instrumental activities (shopping, housework, meal preparation, taking medications, and managing finances), and four mobility activities (walking quarter mile, climbing flight of stairs, lifting and carrying ten pounds, and driving). The trajectories were estimated using a generalized growth mixture model with random effects. The probability of membership for each trajectory was estimated using a polytomous logistic regression, conditional on the main independent variable, gender (men versus women), and seven demographic and clinical covariates: race/ethnicity (Non-Hispanic white versus other) and years of education, which were both fixed, and age, living situation (alone versus with others), number of chronic conditions, cognitive impairment, and physical frailty, which were all time-varying. Only 134 (3.0%) of the person-intervals had a probability of their assigned trajectory less than 0.70, with values ranging from 0.37 to 0.69. The proportion of these assignments, representing poor fit, ranged from 1.5% for the Independent trajectory to 5.7% for the Mild to Moderate trajectory.

Figure 2.

Gender-specific distributions of the functional trajectories for each 18-month interval over the 13.5-year follow-up period. Given the large number of comparisons, p-values were not calculated.

Table 1**Baseline Characteristics of Analytic Sample by Gender**

	Men	Women	P Value*
Characteristic	N=265	N=487	
Age, y, mean (SD)	78.6 (5.1)	78.3 (5.3)	0.37
Non-Hispanic white, No. (%)	24 (9.1)	48 (9.9)	0.72
Lives alone, No. (%)	59 (22.3)	239 (49.1)	<0.001
Education, y, mean (SD)	12.3 (3.0)	11.8 (2.8)	0.02
Number of chronic conditions [†] , mean (SD)	1.7 (1.2)	1.8 (1.2)	0.54
Physical frailty [‡] , No. (%)	93 (35.1)	227 (46.6)	<0.01
Cognitive impairment [§] , No. (%)	33 (12.5)	52 (10.7)	0.46
Depressive Symptoms , No. (%)	33 (12.5)	122 (25.1)	<0.01
Low physical activity [¶] , No. (%)	75 (28.3)	155 (31.8)	0.32
Obese [#] , No. (%)	41 (15.5)	124 (25.5)	<0.01
Number of disabilities, mean (SD)			
All thirteen activities	0.99 (1.65)	1.91 (2.24)	<.001
Four basic activities ^{**}	0	0	NA
Five instrumental activities	0.58 (1.03)	0.78 (1.20)	.023
Four mobility activities	0.41 (0.80)	1.12 (1.24)	<.001

* Derived from chi-square test for categorical variables and one-way ANOVA for continuous variables.

[†] Based on 9 self-reported, physician-diagnosed, including hypertension, myocardial infarction, heart failure, stroke, diabetes mellitus, arthritis, hip fracture, chronic lung disease, and cancer.

[‡] Defined on the basis of slow gait speed, as described in the Methods.

[§] Defined as score < 24 on Folstein Mini-Mental State Examination.

^{||} Defined as score ≥ 16 on Center on Epidemiologic Studies Depression (CES-D) Scale.

[¶] Defined as score ≥ 64 for men and ≥ 52 for women on Physical Activity Scale for the Elderly (PASE).

[#] Body mass index ≥ 30.

^{**} Persons were excluded at baseline if they were disabled in one or more basic activities of daily living.

Table 2
Gender-specific Probabilities for Transitions between each of the Trajectory Classes from one 18-month Interval to the Next*

Functional trajectory for interval $t + 1$								
Functional trajectory for interval t		No. of trajectories	Independent	Mild disability	Mild to moderate disability	moderate disability	Severe disability	Died
<i>probability of trajectories for interval t</i>								
Independent	Men	389	.560	.339	.059	.010	.008	.023
	Women	687	.671	.236	.057	.012	.007	.019
Mild disability	Men	545	.079	.637	.145	.083	.020	.037
	Women	813	.054	.648	.166	.079	.031	.022
Mild to moderate disability	Men	145	.007	.062	.166	.317	.193	.255
	Women	298	.010	.040	.201	.453	.161	.134
Moderate disability	Men	174	.000	.017	.012	.460	.253	.259
	Women	528	.000	.011	.023	.564	.282	.119
Severe disability	Men	156	.000	.000	.000	.006	.506	.487
	Women	478	.000	.002	.000	.008	.632	.358

* Over the course of 13.5 years, men contributed 1409 person-intervals, while women contributed 2804 person-intervals. Interval t denotes the starting interval, while interval $t + 1$ denotes the subsequent interval. As described in the Methods, seven covariates (race/ethnicity, years of education, age, living situation, number of chronic conditions, cognitive impairment, and physical frailty) were used to define the trajectory classes. Probabilities were calculated by dividing the number of members in each trajectory at interval $t + 1$ by the number of members in the relevant starting trajectory at interval t for men and women, respectively. Probabilities were calculated separately for transitions to death and may not sum to 1.0 because of rounding.

Adjusted Odds Ratios for Transitions Representing Functional Decline, Functional Recovery and Death for Women Versus Men*

Table 3

Functional trajectory for interval <i>t</i>	Decline at interval <i>t</i> + 1			Recovery at interval <i>t</i> + 1			Death during interval <i>t</i> + 1		
	Odds Ratio	95% CI	P Value	Odds Ratio	95% CI	P Value	Odds Ratio	95% CI	P Value
Independent	0.66	0.51–0.86	0.002	NA	~	~	0.57	0.19–1.70	0.31
Mild disability	1.11	0.86–1.44	0.43	0.70	0.45–1.10	0.13	0.48	0.22–1.05	0.06
Mild to moderate disability	1.03	0.59–1.79	0.93	0.60	0.23–1.53	0.28	0.42	0.21–0.84	0.01
Moderate disability	0.93	0.61–1.41	0.72	1.01	0.36–2.83	0.98	0.45	0.28–0.73	0.001
Severe disability	NA	~	~	1.36	0.16–11.86	0.78	0.61	0.42–0.88	0.01

* The models were adjusted for the presence of depressive symptoms, low physical activity, and obesity, as time-varying covariates, but not for the other seven covariates since they were used to define the trajectory classes, as described in the Methods. Because participants who started in the severe disability or independent trajectories could not decline or recover, respectively, values are not provided from the relevant multivariable model. CI denotes confidence interval.

Table 4

Burden of Total Disability Over Time for Men and Women *

18-month Interval	Men			Women		
	N	Median	IQR	N	Median	IQR
Baseline to 18	265	0.94	0.33–2.33	487	1.44	0.30–3.40
19 to 36	237	1.89	1.00–3.38	444	2.18	0.67–4.71
37 to 54	211	1.83	0.88–3.89	415	2.67	0.89–6.36
55 to 72	181	2.00	1.00–4.50	377	3.28	1.06–7.61
73 to 90	166	2.93	1.07–6.33	327	4.06	1.13–8.20
91 to 108	142	3.00	1.11–7.78	298	4.89	1.38–9.39
109 to 126	116	3.08	1.11–8.44	262	5.33	1.72–10.3
127 to 144	92	3.21	1.22–7.11	209	5.46	1.71–10.3
145 to 162	77	3.70	1.00–7.86	168	5.67	1.93–10.5

* Total disability was defined on the basis of 13 activities: 4 basic, 5 instrumental and 4 mobility. Disability burden was calculated as the ratio of the sum of the relevant monthly disability scores during an 18-month interval divided by the total number of months observed for that interval. IQR denotes interquartile range.