Do Elderly Women Have More Physical Disability than Men Do?

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This study investigated whether the commonly observed higher prevalence of physical disability among women is due to higher incidence rates or to other factors such as selective mortality or poor recovery. Methods included observed measures of prevalent lower body physical disability and potential risk factors at baseline (1989–1991) and 4-year follow-up of 2,025 community-dwelling adults aged 55 years and older in Marin County, California. Incidence, recovery, and mortality rates were determined at the follow-up examination. Results indicated that women had higher age-specific and age-adjusted prevalence rates at both examinations (odds ratios = 1.66 and 1.60, p< 0.001) but that incidence rates were not significantly different (odds ratio = 1.12, 95% confidence interval: 0.77, 1.64). In the classic formulation, prevalence = incidence × duration, the higher prevalence rates in women could not be due to a higher incidence rate, but could be explained by longer duration due to lower recovery and mortality rates in women. Incident physical disability was predicted by prevalent chronic illnesses, poor vision, obesity, physical inactivity, poor memory, fewer social activities, and higher depression scores, but not by sex. Prevention efforts should concentrate on reducing known risk factors in both men and women and on promoting higher recovery rates among women. Am J Epidemiol 1999; 150:834–42.

Many studies of physical disability among the elderly have found higher prevalence rates among women when using measures of activities of daily living (ADLs) (1–5), instrumental activities of daily living (IADLs) (5, 6), and a variety of other measures (3, 7, 8). These higher prevalence rates of disability among older women have been attributed to differential reporting of physical disability by sex (1, 4), the presence of more nonfatal chronic conditions among women (11, 12), and sex differences in muscle mass. Amid such speculation about sex differences in prevalence, few studies have tested the adequacy of these explanations or attempted a systematic understanding of how sex differences in incidence, recovery, and death may each contribute to differences in prevalence. Recovery rates are known to be substantial (6, 11, 13, 14) and have been found to differ by sex for some dimensions of functioning (15). Like cross-sectional studies of physical disability, many prospective studies of physical disability have assessed physical disability only through self-report (15–18) and, hence, were unable to control for reporting biases (4).

The purpose of our study was to seek a dynamic understanding of sex differences in prevalent disability by examining prevalence, incidence, and recovery rates in the same community-dwelling population and to interpret any differences in the light of the risk factor profiles for each sex. Observed measures of lower-body physical disability were the primary tool for measuring disability. Consistent with the *International Classification of Impairments, Disabilities, and Handicaps* (19), we define disability as the lack of ability to perform an activity in a normal manner (which the Nagi scheme calls “functional limitation,” reserving the term “disability” for inability to perform socially defined roles or tasks) (12). Continuous-time Markov models (20–22) were used to construct annualized incidence rates of physical disability which were adjusted for death and recovery rates.

MATERIALS AND METHODS

Study population

Our study population was a cohort of 2,025 community-dwelling residents of Marin County, California, first examined in 1989–1991 and described earlier.
All respondents were age 55 years or older at baseline, 95 percent were non-Hispanic white, and 76 percent of the men and 51 percent of the women had yearly incomes over $15,000 (23, 24). Age-stratified sampling yielded approximately 500 respondents in each of the four age groups (55–64, 65–74, 75–84, and ≥85 years). Seventy-five percent of the original cohort was alive and available for reinterview in 1993–1995.

Lower-body physical disability

Lower-body disability was primarily measured by observed physical performance. Lower-body strength was assessed by observation of the participant’s ability to complete five chair stands from a seated position within 60 seconds. Lower-body mobility was assessed by observation of the participant’s ability to walk 100 feet in 60 seconds, corresponding to an average speed attained by approximately two thirds of the subjects in three Established Populations for the Epidemiologic Study of the Elderly (10), although less than half the pace required to cross signaled intersections (25). Since effective daily physical function requires both strength and mobility, lower-body physical disability was defined as failure to satisfactorily complete one or both tests. In addition, 50 first examination and 31 second examination participants who refused to perform one or both tests were considered disabled because they reported in a supplemental set of questions “a lot of difficulty” or “don’t do on doctor’s orders” in walking up and down a flight of stairs or in walking a half mile. Respondents who reported an ability to do these activities without a lot of difficulty and who passed one test and refused the other (16 at examination 1 and nine at examination 2) or who refused both tests (13 at examination 1 and four at examination 2) were considered nondisabled. These procedures resulted in more than 80 percent of subjects who refused one or both tests being classed as disabled (127 of 156 for examination 1 and 60 of 73 at examination 2).

Covariables

Other variables measured at baseline were grouped into five categories corresponding roughly to different types of possible causal influence with physical disability.

Health status. This group included several chronic diseases as diagnosed by a doctor (and reported by a respondent), specifically stroke, hypertension, diabetes, myocardial infarction, and cancer. Also included were self-perceived overall health and self-reported presence of arthritis, shortness of breath, having recently had a fall, severe back pain, severe lower-extremity pain, and limitations from vision (coded no, some, and a lot). A combined variable coded from zero to three was used to indicate the number of prevalent conditions from among the three consistently predictive conditions—stroke, arthritis, and shortness of breath.

Health habits. Variables included exercise (activities lasting 20 minutes and sometimes involving perspiration, coded 0, 1–12, and >12 times per month), alcohol consumption (drinks per week), tobacco smoking, and body mass index calculated from reported height and weight.

Demographic. Study variables were marital status, income, years of education, employment status (working/nonworking), and ethnic group (white vs. nonwhite). Annual income was available for 74 percent of the respondents.

Social functioning and support. Measures included living alone, social activities (scored 0–9 for attending in past 6 months: concert, play or sporting event; movie; museum or art gallery; religious services; dance; cards or bingo; meeting of club or organization; auction or yard sale; other), social isolation (few close friends or relatives, as in Kaplan et al. (26)), days out of the house per week (“How many days, on average...did you spend anywhere outside the house (apartment) during the last month? This could be time spent in your yard”), involvement in organized group activities (voluntary associations or religious services), and doing volunteer work.

Psychologic. Measures included depression (Center for Epidemiologic Studies Depression Scale) (27), a poor score (≤2 of 6 immediate or 0 of 6 delayed recall) on the East Boston Memory Test (28, 29), and self-reported general health.

Statistical analyses

Univariate. Age-adjusted prevalence rates of physical disability at examinations 1 and 2 were calculated separately by sex by using the 1990 US Census combined-sex population distribution to assign weights to four strata defined by the age groups 55–64, 65–74, 75–84, and ≥85 years. Age-adjusted total incidence and recovery rates were calculated by adjusting to estimated 1990 US combined-sex nondisabled and disabled population distributions, respectively, obtained by multiplying examination 1 prevalence rates (table 2) by US Census age- and sex-specific population totals. The same method was used to obtain separate age-adjusted annual incidence and recovery rates, as well as means and percentage prevalences of potential risk factors for disabled and nondisabled respondents. Confidence intervals and hypothesis tests for sex differences in incidence and recovery rates from physical disability as well as percentage prevalences of binary
covariates used age-adjusted logistic regression models. Tests for sex differences between means of continuous covariates used linear regression models with age. Tests for interaction between sex and physical disability in predicting prevalence of covariates used interaction terms in the corresponding logistic or linear regressions.

**Markov models.** Annual age-specific incidence rates were obtained for each sex by combining examination 1 to examination 2 age-specific incidence, recovery, and death rates using continuous-time Markov models (20). At any given time, each respondent was conceptualized as belonging to one of the three distinct states of 1) health (i.e., nondisabled), 2) disability, or 3) death. Individuals were modeled as moving between these three states according to instantaneous transition probability "intensities," which operate much like hazard rates in the well-known proportional hazards model. In Markov models, unlike proportional hazards models, transition probabilities (hazards) are assumed to be constant over time (In statistical language, Markov and proportional hazard models estimate incidence density, whereas logistic models estimate cumulative incidence). For each of the eight strata defined by age and sex, a separate Markov model was estimated that imposed no assumptions upon transition probabilities (i.e., the model was saturated) except that transition rates were constrained to be nonnegative, and no transitions out of death were permitted. Each model used four parameters: the instantaneous transition rates (constant hazards) for incidence, recovery, death among nondisabled, and death among disabled.

The parameters of each Markov model were estimated using S-Plus software (30) by applying maximum likelihood estimation to each examination 1 to examination 2 contingency table under the assumption that the stratum-specific average follow-up time applied to all individuals. Maximum likelihood methods provide consistent estimates of Markov parameters and permit computation of standard errors (21). Exact solutions were obtained for seven of the eight strata using methods described in Chiang (20). Because of a small count in one cell, iterative maximization of the likelihood function was used for one stratum to obtain a solution satisfying the constraint that all transition intensities must be nonnegative.

Annualized incidence and recovery rates were calculated for all eight strata by using the fitted intensities to calculate 1-year transition probabilities, and sex-specific age-adjusted annual incidence and recovery rates were formed by adjusting to the (combined-sex) estimated 1990 US nondisabled and disabled populations, respectively.

The stratum-specific intensities were used to test the self-consistency of the fitted transition intensities at younger ages with observed prevalences at older ages. Zero disability was assumed before age 55 years, and stratum-specific fitted intensities were used to construct projected prevalences for each sex at ages 60, 70, 80, and 90 years, which were then compared with observed stratum-specific prevalences at examinations 1 and 2.

**Multivariate.** Adjusted models for incidence and recovery were formed independently. Two separate series of six multivariate logistic models were constructed as follows. The first model analyzed incident physical disability as a function of age and sex. The second model was constructed by introducing health status variables and dropping any nonsignificant new variables one by one until a model was obtained in which all newly introduced variables were significant ($p < 0.10$). Further models were then constructed analogously by progressively introducing and selectively retaining variables of significance in the following categories (in this order): health habits, social support, and psychologic characteristics. Optimal form of variables with plausible alternative coding schemes (including quadratic coding for continuous variables) was determined at the time they were introduced into the multivariate model. Appropriate summary variables were also constructed at this time (e.g., a variable giving, on a scale of 0–3, the number of the chronic conditions of stroke, arthritis, and shortness of breath).

The impact of including baseline borderline physical disability among the risk factors was assessed by adding it to the full multivariate incidence model. Finally, the possibility that the equal presence of a risk factor might impact one sex more strongly than the other was tested by inserting interaction terms between sex and each multivariate predictor into the full multivariate models.

**RESULTS**

Table 1 summarizes the numbers of respondents at the first and second examinations according to sex and lower-body disability status. Among 1,982 first examination participants, 285 (14 percent) were lost to follow-up and 304 (15 percent) died. Loss to follow-up was higher for women, especially among the disabled. The 285 respondents who were lost to follow-up included 75 (26 percent) who were unavailable, 95 (33 percent) who refused reinterview, and 115 (40 percent) who lacked an outcome measure at the second examination (most were proxy, telephone, or mail interviews); these proportions varied little by sex or examination 1 disability status. The death rate was higher among the disabled for both sexes (39 percent for men and 25 per-
TABLE 1. Numbers of subjects with and numbers without lower-body physical disability at examinations 1 and 2 and percentages by types of changes between examinations, by sex, Marin County, California, 1989-1995

<table>
<thead>
<tr>
<th></th>
<th>No. at follow-up</th>
<th>Lost to follow-up (%)</th>
<th>Deceased (%)</th>
<th>No. at examination 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Not disabled</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>652</td>
<td>728</td>
<td>12.6</td>
<td>7.1</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td>11.0</td>
<td>5.2</td>
</tr>
<tr>
<td>Disabled</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>193</td>
<td>409</td>
<td>9.4</td>
<td>18.1</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td>39.4</td>
<td>25.4</td>
</tr>
<tr>
<td>Total</td>
<td>1,982</td>
<td>1,393</td>
<td>14.4</td>
<td>15.3</td>
</tr>
</tbody>
</table>

percent for women) than for the nondisabled (11 and 7 percent, respectively). The female death rates were significantly lower after adjustment for age and baseline disability status (relative hazard = 0.52, 95 percent confidence interval (CI): 0.41, 0.65).

Table 2 shows age-specific and age-adjusted prevalence rates of lower-body disability at the first and second examinations. Prevalence rates of disability were 30–50 percent higher for women than for men at each examination, due mainly to large differences among older age groups. This sex differential was significant both at the first examination (odds ratio, female vs. male \(OR_{PM} = 1.66\), 95 percent CI: 1.31, 2.09, \(p = 0.0001\)) and the second examination (\(OR_{PM} = 1.60\), 95 percent CI: 1.20, 2.12, \(p = 0.001\)). The age-specific and age-adjusted rates were generally slightly lower at the follow-up examination. At each examination, about one tenth of the disabled completed the walking but failed the chair stands (8 percent at examination 1 and 12 percent at examination 2), and a larger proportion completed the chair stands but failed the walking (40 and 38 percent, respectively).

Table 3 shows the incidence rates for physical disability among nondisabled examination 1 participants and recovery rates from physical disability among disabled examination 1 participants during the 4-year period between examinations. The incidence rates increase dramatically by age for both sexes. While the age-specific and age-adjusted rates were slightly higher for women than for men, the differences were not statistically significant (\(OR_{PM} = 1.12\), 95 percent CI: 0.77, 1.64). Age-specific recovery rates decreased with age and were significantly higher for men than for women in each age group (\(OR_{PM} = 0.51\), 95 percent CI: 0.29, 0.90).

Table 4 displays annual age-specific incidence rates obtained through combining examination 1 to examination 2 age-specific incidence, recovery, and death rates, as described in Materials and Methods. The rates in table 4 adjust for incident cases who recovered or died before examination 2 and are therefore higher.

TABLE 2. Prevalence rates (In percent) of lower body physical disability at examinations 1 and 2 by age and sex, Marin County, California, 1989-1995

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Baseline (examination 1)</th>
<th>Follow-up (examination 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. at risk</td>
<td>Male</td>
</tr>
<tr>
<td>55-64</td>
<td>207</td>
<td>228</td>
</tr>
<tr>
<td>65-74</td>
<td>250</td>
<td>304</td>
</tr>
<tr>
<td>75-84</td>
<td>229</td>
<td>283</td>
</tr>
<tr>
<td></td>
<td>159</td>
<td>322</td>
</tr>
<tr>
<td>Age-adjusted* total</td>
<td>845</td>
<td>1,137</td>
</tr>
</tbody>
</table>

* Age-adjusted to the 1990 US Census.
The prevalence rates of potential risk factors for physical disability at examination 1 are shown in table 5. Women had significantly lower rates of obesity (body mass index > 26) and alcohol consumption and significantly higher amounts of social activity. Men generally had higher rates of exercise and outside activity, significantly lower rates of chronic illness and vision difficulty, and significantly lower depression scores. Among respondents who were disabled at baseline and “at risk” for recovery, two of these sex differences were significantly modified. The male advantage in depression was smaller ($p < 0.1$) among disabled individuals and was no longer statistically significant. In contrast, the male advantage for outside activity was even more pronounced ($p < 0.001$) among disabled respondents.

Table 6 shows the multivariate adjusted models of risk factors that predicted incidence and recovery. Sex was not a significant predictor in either model. Total number of chronic diseases was associated with both incidence and recovery in the expected directions. Other factors significantly or marginally associated with both incidence and recovery included age, poor vision, and depression. In addition, lack of exercise, few social activities, obesity, and poor memory were all significantly associated with incidence. Outside activities and alcohol were associated only with recovery. Rather surprisingly, high alcohol consumption was strongly positively associated (odds ratio $= 4.83$, $p = 0.01$) with recovery. No variable significantly interacted with sex in either model, and no quadratic term of a continuous variable was significant in either model. When, in separate analyses (not shown), borderline disability at baseline was added to the incidence models, no predictor substantially changed its coefficient or $p$ value except for

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Annual age-specific incidence rates for lower-body physical disability obtained through combining incidence, recovery, and death rates (using Markov models), Marin County, California, 1989–1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>Male</td>
</tr>
<tr>
<td>55–64</td>
<td>1.6</td>
</tr>
<tr>
<td>65–74</td>
<td>3.0</td>
</tr>
<tr>
<td>75–84</td>
<td>9.9</td>
</tr>
<tr>
<td>≥85</td>
<td>20.2</td>
</tr>
<tr>
<td>Age-adjusted* total</td>
<td>3.8</td>
</tr>
</tbody>
</table>

* Age-adjusted using 1990 US Census (see Materials and Methods).

than the annual incidence rates in table 3. As seen in table 4, men and women have virtually identical adjusted annual incidence rates up to age 85 years, and the differences are not statistically significant. The adjusted annual age-specific recovery rates were higher for men (55.3, 16.5, 7.3, and 5.0 percent from youngest to oldest) than for women (13.6, 13.5, 7.7, and 3.7 percent) in all but the age group 75–84 years. The adjusted annual death rates were higher for men than for women among all ages of nondisabled (1.5, 2.8, 4.9, and 9.0 percent for men and 1.1, 1.7, 4.2, and 5.5 percent for women) and among all but the youngest disabled (0.5, 4.8, 22.8, and 28.9 percent for men and 4.2, 1.8, 9.9, and 17.9 percent for women).

The observed age-specific incidence, recovery, and death rates were also used to calculate projected age-specific prevalence rates. These equilibrium age-specific prevalence rates (2.7, 10.7, 30.0, and 56.4 percent for men and 5.6, 13.9, 37.6, and 71.5 percent for women) were quite similar to the observed age-specific prevalence rates shown in table 2.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Age-adjusted§ mean or prevalence (in percent) of selected risk factors among respondents at baseline, by lower-body physical disability status and sex, Marin County, California, 1989–1991</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk factor</td>
<td>No disability</td>
</tr>
<tr>
<td></td>
<td>Males $(n = 652)$</td>
</tr>
<tr>
<td>No. of chronic illnesses</td>
<td>0.24</td>
</tr>
<tr>
<td>Vision difficulties (some) (%)</td>
<td>7</td>
</tr>
<tr>
<td>No exercise (%)</td>
<td>19</td>
</tr>
<tr>
<td>Obesity (BMI &gt; 26) (%)</td>
<td>34</td>
</tr>
<tr>
<td>High alcohol drinker (%)</td>
<td>28</td>
</tr>
<tr>
<td>Outside activities (days/week)‡</td>
<td>6.8</td>
</tr>
<tr>
<td>Social activities</td>
<td>4.7</td>
</tr>
<tr>
<td>Poor memory (%)</td>
<td>1</td>
</tr>
<tr>
<td>Depression (CES-D† score)‡</td>
<td>3.9</td>
</tr>
</tbody>
</table>

§ Age-adjusted using 1990 US Census (see Materials and Methods).

† $p < 0.1$ for sex difference.
‡ $p < 0.1$ for interaction of sex and disability status.
§ Includes stroke, arthritis, and shortness of breath.
BMI, body mass index; CES-D, Center for Epidemiologic Studies Depression Scale.
TABLE 6. Odds ratios and 95% confidence intervals relating sex and selected variables to incidence and recovery from physical disability in final multivariate models, Marin County, California, 1989–1995

<table>
<thead>
<tr>
<th>Variable</th>
<th>Incidence of PD†</th>
<th>Recovery from PD</th>
<th>OR†</th>
<th>95% CI†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (female)</td>
<td>0.92</td>
<td>0.70</td>
<td>0.70</td>
<td>0.37, 1.31</td>
</tr>
<tr>
<td>Age (decade)</td>
<td>2.62</td>
<td>0.43</td>
<td>0.43</td>
<td>0.32, 0.59***</td>
</tr>
<tr>
<td>No. of chronic illnesses§</td>
<td>1.58</td>
<td>0.59</td>
<td>0.59</td>
<td>0.38, 0.91*</td>
</tr>
<tr>
<td>Vision problems (a lot/some/none)</td>
<td>1.56</td>
<td>0.40</td>
<td>0.40</td>
<td>0.14, 1.14†</td>
</tr>
<tr>
<td>Exercise (times/month)</td>
<td>0.97</td>
<td>1.89</td>
<td>1.89</td>
<td>1.20, 2.97**</td>
</tr>
<tr>
<td>Obesity (BMI‡ &gt; 26)</td>
<td>1.89</td>
<td>0.86</td>
<td>0.86</td>
<td>0.77, 0.95**</td>
</tr>
<tr>
<td>High alcohol (≥12 drinks/week)</td>
<td></td>
<td></td>
<td>4.63</td>
<td>1.86, 12.56**</td>
</tr>
<tr>
<td>Outside activities</td>
<td></td>
<td></td>
<td>1.40</td>
<td>1.09, 1.80***</td>
</tr>
<tr>
<td>Social activities</td>
<td>0.86</td>
<td>0.70</td>
<td>0.70</td>
<td>0.60, 1.40</td>
</tr>
<tr>
<td>Poor memory</td>
<td>1.51</td>
<td>1.02</td>
<td>1.02</td>
<td>0.94, 0.99**</td>
</tr>
<tr>
<td>Depression (CES-D‡ score)</td>
<td>1.05</td>
<td>0.95</td>
<td>0.95</td>
<td>0.90, 0.99*</td>
</tr>
</tbody>
</table>

* p < 0.05; ** p < 0.01; *** p < 0.001.
† p < 0.1.
‡ PD, physical disability; OR, odds ratio; CI, confidence interval; BMI, body mass index; CES-D, Center for Epidemiologic Studies Depression Scale.
§ Includes stroke, arthritis, and shortness of breath.

number of chronic illnesses, which dropped to nonsignificance.

The significantly higher recovery rate for men (OR_PdM = 0.51, p = 0.02) in the age-adjusted logistic model was reduced slightly to OR_PdM = 0.52 (95 percent CI: 0.29, 0.93, p = 0.03) by inclusion of health status variables. Introduction of alcohol consumption into the recovery model reduced the relation to nonsignificance. Removal of alcohol from the final recovery model caused sex to resume its significance as a predictor of recovery (OR_PdM = 0.54, 95 percent CI: 0.30, 0.98; additional analysis not shown).

DISCUSSION

Sex differences

The use of observed measures of lower-body physical disability in a community-dwelling older population showed that prevalence rates were significantly higher for women than for men at both the baseline and the follow-up examinations. However, incidence rates were not significantly different between men and women. Reference to the classical formulation, prevalence = incidence × duration, indicates that if differences in incidence rates alone cannot account for differences in prevalence rates, then sex differences in duration of disability must be an important determinant of the prevalence of disability (see appendix 1). This concept is consistent with the findings of this study that both recovery and death rates were significantly lower for women than for men.

The finding of higher prevalence rates of lower-body disability among women is consistent with a large body of previous work, most of it utilizing self-reported measures. Among studies using observed physical performance measures, our study is consistent with the findings of both Bild et al. (5) and Guralnik et al. (10), showing that women had less ability either to do five chair stands or to walk short distances, but differs from findings by Kelly-Hayes et al. (4) of no sex differences in walking ability.

Several studies have measured change in lower-body disability as embedded in summary indices that combine it with other items from among ADL, IADL, or other disability scales. Our results are consistent with the findings of Manton (6) of no sex difference in incident disability measured using total number of ADLs and with several findings of no sex difference in disability change as measured by summary indices (17, 31, 32). Other studies using summary indices found higher incidence rates among men (33) or among women (34, 35). When mobility-related disability was examined alone, higher incidence rates among women were found by Crimmins and Saito (15), Beckett et al. (36), and Clark et al. (37). Beckett et al. found that women were significantly more likely to report disability as measured according to the Rosow-Breslau Functional Health Scale (38) in each of four different populations, Crimmins and Saito found that women were significantly more at risk for reported incidence of difficulty in walking a quarter mile and walking up 10 stairs without rest, and Clark et al. found that women were more likely to report new difficulty in climbing a flight of stairs without rest or walking one or several blocks.

The study by Crimmins and Saito provided perspective by examining a large range of disabilities, prospectively measuring changes in reported function-
ing across many dimensions of activity. They found that women had higher disability incidence rates on some dimensions and men on other dimensions. Women had consistently higher incident disability in activities of the "wider world...requiring more stamina and range of motion" (15, p. 5) as measured by the Nagi scale (39), while men had higher incidence rates in ADLs and IADLs (15). For walking conceptualized as an ADL activity rather than as the quarter mile Nagi measure, Crimmins and Saito found that men were more likely than women (OR_{m/w} = 0.72) to develop difficulties. Our finding of near-equal incidence rates despite a superior male risk-factor profile is consistent with Verbrugge's findings that greater prevalence in women than in men of health problems of all kinds was reversed when favorable male risk profiles were controlled, revealing a possible underlying male biological disadvantage (40).

Recovery rate sex differences found in our study are consistent with the findings of Beckett et al. of significantly higher age-adjusted male recovery from mobility difficulties in each of four populations (36). However, they contradict findings in other studies of no sex differences in recovery from mobility problems (15, 37) or from disability assessed with a combined measure (34).

**Predictors of Incidence**

Several risk factors were independently prospectively associated with incidence or recovery, with most showing significant differences in prevalence between men and women. Six of these differences favored men (fewer chronic conditions, more exercise, more outside activity, less vision difficulty, less depression, and more alcohol consumption), while two favored women (less obesity and more social activity).

Our findings regarding predictors of incidence and recovery are largely consistent with past results. Previous prospective studies have also found that incident disability or poorer function was predicted by chronic conditions (8, 15, 17, 18), including stroke (15, 17, 35), arthritis (15, 35, 37, 41, 42), and lung disease (37, 43). Other studies have also found risks associated with vision problems (15, 35, 37, 44), lack of exercise (17, 35, 37, 45-47), body mass index (8, 18, 37, 46, 47), lack of social support (17), cognitive impairment (4, 18), and depression (17, 43, 47). Relatively few previous studies examined change in physical disability status over time by using observational measures at both time points. Like the studies by Penninx et al. (43) of lower-body disability and by Seeman et al. (33) of a summary measure combining several kinds of disability, our study confirms that many predictors of change in self-reported disability status also predict change in observed disability.

**Predictors of recovery**

Of relatively few population-based studies that have examined recovery from disability (6, 14, 15, 18, 36, 37, 43, 44), even fewer (15, 18, 37, 43, 44) have examined predictors of recovery beyond age and sex. Our finding that chronic illnesses predict poor recovery from disability is consistent with previous findings that poor recovery of mobility was predicted by a summary measure of chronic conditions (18) and by stroke (15), arthritis (37), and lung disease (37). Poor recovery has also been predicted by vision problems (44) and depression (43). Our finding that high alcohol consumption predicted better recovery is consistent with the finding by Clark et al. (37) that a pattern of alcohol abuse predicted recovery.

**Methodology**

This study shows the importance of adjusting for death and recovery rates when comparing incidence rates between different subgroups or different studies. The slight female excess in age-adjusted incidence of disability in our study was almost completely effaced when annual incidence rates were formed by adjusting for death and recovery. If direct measurement of annual incidence rates is unavailable, Markov models may be a valuable tool for adjusting incidence rates measured over longer periods of time to eliminate confounding with recovery and death rates. While these models require the (debatable) assumption that transition rates do not depend upon how long an individual has been in a particular state (e.g., disability), Markov modeling improves upon current procedures that entirely ignore the possibility of unobserved transitions. However, only a small number of previous studies of disability (18, 36) have referenced discrete-time Markov model methodology (48, 49), despite long-standing knowledge that substantial fractions of disabled persons experience recovery of function (6, 13, 15). We know of no previous disability study that used continuous-time Markov models or other discrete state, continuous time-process models (20, 50, 51).

Our study was unable to explain sex differences in recovery rates other than by an unexpected salutary association with high alcohol consumption (≥12 drinks/week). This finding could be due to confounding. Clark et al. (37) found that high alcohol use also predicted incident disability, suggesting that drinkers of a large amount of alcohol may be more subject to episodes of acute or short-term disability, perhaps caused by their drinking, from which they soon recover. Data to assess several alternative explanations for this association were unavailable, including information regarding level of severity, diagnosis of the dis-
ability as acute or chronic, and type of reported cause (11, 15). Future studies could include measures of these and other potentially relevant constructs, such as muscle mass, illness behaviors (40), prior health care (40), and recent changes in disability status (12, 14, 15) to further clarify the nature and cause of sex differences in recovery rates.

Implications

The majority of predictors of incident disability or poor recovery that were identified by this study are potentially subject to modification, including vision difficulty (44), lack of exercise (52), depression (53), obesity (54), and lack of social support (55). Public health efforts to reduce prevalence of all these factors in both sexes should continue. Improved recovery rates for women would support gender equity in health and might be partially attained through improving exercise in females.

In conclusion, the question “Do elderly women have more disability than men?” could be answered yes for prevalence and no for incidence. While women experience more prevalent disability than do men, data from our study suggest these differences are due to a longer duration of female disability related to lower mortality and lower recovery rates due to worse risk factor profiles. Prevention efforts should focus upon reducing or modifying known risk factors for both men and women and promoting better recovery rates among women.

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REFERENCES

27. Radloff LS. The CES-D scale: a self-report depression scale

APPENDIX 1

A lack of significant difference in incidence rates might also be explained by lower statistical power for measurement of incidence than of prevalence. However, for this study (see Results), the 95 percent confidence interval for (female vs. male) sex difference in incidence (OR$_{PM}$ = 1.12, 95 percent CI: 0.77, 1.64) excludes the sex difference in prevalence rates at examination 1 (OR$_{PM}$ = 1.66), arguing strongly against this possibility. Similarly, a 90 percent confidence interval for (female vs. male) sex difference in incidence (90 percent CI: 0.82, 1.54) excludes the sex difference in prevalence rates at examination 2 (OR$_{PM}$ = 1.60), providing further support.