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Abstract

Introduction

Successful aging has many dimensions, which may manifest differently in men and women and at different ages. We sought to characterize one-year transitions in 12 measures of successful aging among a large cohort of older adults.

Methods

We analyzed twelve different measures of health in the Cardiovascular Health Study: self-rated health, ADLs, IADLs, depression, cognition, timed walk, number of days spent in bed, number of blocks walked, extremity strength, recent hospitalizations, feelings about life as a whole, and life satisfaction. We dichotomized responses for each variable into “healthy” or “sick”, and estimated the prevalence of the healthy state and the probability of transitioning from one state to another, or dying, during yearly intervals. We compared men and women, and three age groups (65-74, 75-84, and 85-94).

Findings

All measures of successful aging showed similar results, except for hospitalizations and cognition. Most participants remained healthy even into advanced ages, although health declined for all measures. Men had a higher death rate than women, regardless of health status, and were also more likely to be healthy.

Discussion

The results suggest a qualitatively different experience of successful aging between men and women, with men showing a more "square" mortality curve. Men did not simply "age faster" than women.

Conclusion

Men and women age differently with regard to health status, with consistency among various health measures.

(Abstract: 223 words)

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(31 References)

Introduction

Changes in health status, symptoms, and functioning during aging defy simple description. Despite the inevitability of death, no orchestrated or predictable decrements or types of sickness uniformly precede it, and individuals vary widely in how and how successfully they age. Certain groups may experience aging and health differently from others. The most obvious instance is gender: older men and women have different lifespans,[1,2] functional trajectories,[3] risks factors for disease,[4] chronic and acute diseases,[5,6] and use of medical treatments.[7] Explanations for these differences in various aspects of successful aging between men and women include unequal distribution of chronic conditions, health behaviors like smoking, differential effects of diseases on mortality, and alternate measures of health.[8]

There is utility in characterizing the changes in health status that occur with advancing age in men and women, by measuring different manifestations of successful aging rather than just mortality rates. First, evidence from research can help to counter ageist or sexist stereotypes, which may influence social expectations, clinical care, and application of treatments.[9] Second, interventions to reduce morbidity and mortality can be better targeted by understanding the prevalence, persistence, and resolution of sickness in different populations. Third, observational results can inform both the theory of successful aging and research into the biology of aging. For instance, research has suggested that that men "age faster" than women,[10] yet this observation has not received much scrutiny.

We sought to characterize changes in health status among a group of older adults, with particular attention to the differences between men and women. We measured health using 12 different variables which capture different aspects of psychological, physical, and functional status. We hypothesized, for these 12 different manifestations of successful aging, that (1) the prevalence of a healthy state, the probability of remaining healthy, and the probability of returning to a healthy state, decline with increasing age; (2) the probability of becoming or remaining sick and of dying increase with age; and (3) the prevalence and transition probabilities are different for men and women. We first describe some of the key methodological challenges related to categorization, longitudinal data analysis, and death, and propose solutions to these problems. We then report and characterize the transitions among health, sickness, and death based on age and sex.

Key Methodological Challenges:

Several problems attend the analysis of changes in health during aging, and different approaches may generate different results and interpretations. First, health itself is multifactorial and difficult to define and characterize, using either single or composite measures. Second, may fluctuate, and may be variably associated with risk of death. Third, population health status may be estimated either by prevalence or incidence, neither of which independently explains health changes in a population; a higher prevalence of health may result either from a lower likelihood of becoming sick, a higher likelihood of recovery from sickness, or a higher rate of death among the sick. Data "missing" because the person had died is especially important in older-aged cohorts, and there may be "healthy survivor" effects.

We addressed these challenges by (1) examining both prevalence and incidence; (2) calculating and reporting dynamic transitions among health states and death; (3) describing the likelihood of death; and (4) reporting these findings for multiple measures of health The approach we used, transition probability modeling, has been used to examine other changes in health among older adults, including self-rated health,[11] body obesity,[12] and depression.[13]

Transition probability models make the simple assumption that health status measures can be categorized into discrete states, among which individuals might move. The ovals in Figure 1 represent discrete health states, and the arrows show the likelihood of transitioning from one state to another during a single time interval, one year. The number of individuals in each of the states (shown by the ovals) is the relative prevalence of health or sickness in the total population.

[FIGURE 1]

When evaluated at two time points, there are thus six possible transitions among these states: remaining healthy (P(HtoH)), becoming sick (P(HtoS)), remaining sick (P(StoS)), becoming healthy (P(StoH), dying from a state of health (P(HtoD)), and dying from a state of sickness (P(StoD)). Persons move among those states with certain probabilities, which may vary by age, gender, or other characteristics. The equilibrium - or steady state – prevalence of a system can be calculated directly from the transition probabilities, using the following equation, where the equilibrium prevalence of the healthy state is K/(1+K).[1114]

Equation 1: Relationship between transition probabilities and equilibrium prevalence

$$K = \frac{P(HtoH) - P(StoS)}{2P(HtoS)} + \sqrt{\frac{[P(HtoH) - P(StoS)]^2}{[2P(HtoS)]^2} + \frac{P(StoH)}{P(HtoS)}}$$

We introduce this equation in order to examine how the likelihood of remaining or becoming healthy or sick influences prevalence. The key assumption in this equation is that the likelihood of death between observation times does not differ markedly between the sick and the healthy.

This equation is important because the relationships among various transition probabilities (for instance, the difference between the likelihood of remaining healthy or remaining sick, the numerator of the first term) both determine the equilibrium prevalence, and also help to explain why certain groups, such as men and women, might have differences in prevalence during aging.

Previous Research

Transition probabilities are often used in multi-state life-table calculations and other analyses that model longitudinal health, usually as a means to estimate the number of individuals in sick and healthy states for a variable of interest. The probabilities themselves, however, are rarely published. These have value for understanding the differences between remaining or becoming sick or healthy or of dying, and the consequences of sickness and health in different groups.

Previous analyses have examined transitions for single health measures such as disability, depression, self-rated health, body mass index, ADL, and IADLs.[11-13,15-19] Because of the focus of these studies on a single aspect of health status, and their inconsistent examination of sex and age as predictors, they offer somewhat limited perspectives on the various changes in health status that happen during aging for men and women. To explore changes in health more systematically, and to allow age and sex comparisons, we analyzed the transition probabilities for 12 different health variables commonly used in studies of older adults, with specific attention to the roles of sex and age.

2 Methods

2.1 Data

Data came from the Cardiovascular Health Study (CHS), a population-based longitudinal study of risk factors for heart disease and stroke in 5888 adults aged 65 and older at baseline.[20] Participants were recruited from a random sample of Medicare eligible adults in four U.S. communities, and extensive data were collected during annual clinic visits and telephone calls. The original cohort of 5201 participants, recruited in 1989 and 1990, had up to ten annual clinic examinations. A second cohort of 687 African Americans, enrolled in 1993 and 1994, had up to seven annual examinations. Follow-up was virtually complete for surviving participants.

The twelve variables used in this study were measures of health based on self-report or observation. All were measured annually. Each value was dichotomized into "Healthy" and "Sick", as seen in Table 1, using standard thresholds where available, or assigning cutoffs that seemed reasonable and that resulted in adequate numbers of healthy and sick individuals. Table 1 shows the various definitions of "healthy", with the abbreviation used, the question or test from the CHS survey, and the categories to define sickness and health.

[TABLE 1]

In order to simplify comparisons, age was divided into three categories – 65-74, 75-84, and 85-94 – in accordance with the common definitions of "young old", "old old", and "oldest old". The unit of analysis was the transition pair, defined as two measures of a variable, one year apart, for the same person. Persons could contribute data to more than one age category, using their age at the start of each transition.

Missing data were imputed, after a transformation to recode death as zero health, by interpolating over time between existing data points for each person. Any data that remained missing at the end of a sequence, were extrapolated as an average of the last observed value and of transformed self-rated health (which was measured every 6 months, and is thus well characterized).[21,22] No imputation across participants was performed. All available observations were used, including those that were imputed.

2.2 Analysis

The prevalence of the healthy state of each variable in each wave was calculated as the percent of living persons who were healthy. The one-year probabilities of transitioning from state to state were estimated from crosstabulation of data collected one year apart. All cases where a beginning state and a starting state were available were used, for all 5888 participants. General patterns by age and sex groups were described. We estimated one-year transition probabilities for participants starting in each health state (sick or healthy): remaining healthy ((p(HtoH)); becoming sick (p(HtoS)); dying from a healthy state (p(HtoD)); remaining sick (p(StoS)); becoming healthy (p(StoH)); and dying from a state of sickness (p(StoD)). These transition probabilities, shown in Figure 1, were constructed as a simple fraction: (# moving to other state or remaining in state) / (# in the state at the starting time point). Calculations were performed separately for each age/sex grouping. The associations of the measured prevalence values with age and sex were tested using cross-sectional time series logistic regression (the xtlogit command in Stata). This form of generalized estimating equation accounts for participants contributing multiple observations.

We carried out separate analyses for men and women of the same age group, and estimated the statistical significance of the difference using generalized estimating equations. For each of the 12 health measures, we compared prevalence and incidence of between adjacent age groups (i.e. age 65-74 compared to 75-84; and age 75-84 compared to 85-94). We ascertained steeper (non-linear) decline with age by comparing the change between the younger and middle age categories with that between the middle and older.

Analyses were conducted in Stata (Statacorp, College Station, Texas, version 11.2).

3 Findings

45,297 transition pairs (starting and ending state, separated by one year) from the 5888 participants were analyzed. During the study, 1684 participants died. For the whole sample, 13.5% of observations were missing and imputed, with some variability across the 12 domains of health. The median number of imputed observations per participant was one.

3.1 Prevalence of Health

The first two lines of Table 2 show the number of observations (transition pairs) in each group, and the mean age, by age category and sex. Mean age did not differ significantly in each category for men and women. The next 12 lines show the prevalence of a healthy state for each variable. For example, for HOSP, 91.3% of the women aged 65-74 were “healthy”, defined as “having no hospital days”. For men in the same age range, the prevalence of a healthy state was 88.0%. Over the three age groups, women’s prevalence for HOSP declined from 91.3% to 87.8% to 84.9%.

[TABLE 2]

The prevalences for healthy and sick activities of daily living are shown in Figure 2. "Healthy" was defined as having no difficulties with activities of daily living, and "sick" as having one ore more difficulties. This figure helps illustrate both how transitions and prevalence change over time and differ between men and women, and also how relatively small differences in transitions accumulate into more pronounced differences in prevalence. The two heaviest lines represent the healthy prevalence (proportion of the living who had no ADL difficulties), with a solid line for males and a dotted line for females. The prevalence is quite high for the youngest group (about 90%) and declines over time. The slope becomes steeper with age; that is, the line is non-linear. The healthy prevalence is higher for men than for women, and the difference becomes larger with age, indicating an accelerating or non-linear decline. The lowermost two lines represent the probability of recovering from the sick state (having ADL difficulties) to be in the healthy state (no ADL difficulties) one year later, labeled as P(StoH). The probability is initially near 0.4, declines approximately linearly with age, and is higher for women than for men. The two topmost lines in the graph represent the probability of staying in the healthy state, P(HtoH). This probability is initially about 0.9, declines with age, and is higher for men than for women.

[FIGURE 2]

Prevalence in Men and Women: The bolded entries in Table 2 show the situations where women or men had a significantly higher prevalence of a healthy state. Women were significantly healthier than men only for HOSP and COG. Men had a significantly higher prevalence of a healthy state than women for all the other domains and age groups, except for three where there was no significant difference.

Prevalence by Age: All of the prevalence values in Table 2 declined with age; the prevalence values were significantly lower at each subsequent age group compared with the younger one. We also performed tests of the age effects, which are not shown in table, but are reported in the text. There was a significantly steeper (non-linear) decline for all the domains of health except HOSP and SRH (both men and women); SPL for men; and BLK for women.

3.2 Transitions probabilities for healthy persons

Table 3 shows the transition probabilities for persons who were initially in the healthy state. For instance, for HOSP, age 65-74, women who were healthy (without a hospital stay in the first year) had a 0.92 probability of remaining healthy (not having a hospital stay in the next year), a 0.08 probability of becoming sick (having a hospital stay), and a 0.01 probability of dying.

These probabilities add to 1.0. The bold entries in the upper and lower tables represent probabilities that where women or men remained significantly healthier.

[TABLE 3]

P(HtoH), remaining healthy: Of the 36 comparisons (combined over age group and health variable), women were significantly more likely than men to remain healthy in eight comparisons; men were more likely in 14. In the remaining 14 comparisons, there was no significant difference. The probability of remaining healthy declined with age for all domains. There was a steeper (non-linear) decline for all domains except BLK, for both men and women.

P(HtoS), becoming sick: Women were significantly less likely than men to become sick in eight of the domains; men were less likely in 22; the remaining six did not significantly differ. There was a significant decline with age for all the domains except BLK. There was a steeper (non-linear) decline for ADL, FLW, EXSTR, TWLK, IADL, and COG for both men and women. Men showed a steeper (non-linear) decline also for HOSP, BED, and DEP; women showed this decline for SPL.

P(HtoD), dying from a healthy state: P(HtoD) was always higher for men, no matter how the healthy state was defined, except for the 85-94 age category for IADL, COG, and BLK. The probability of dying from a healthy state increased significantly with age. This probability showed a steeper (non-linear) decline with age for all domains except COG and BLK for men; for women, it was significant for all domains except COG, BLK, SPL, EXSTR, and TWLK.

3.3 **Transition Probabilities for Sick Persons**

Table 4 shows the transition probabilities for persons who were initially in the sick state. The bolded entries indicate probabilities of remaining in or recovery from sickness, or probability of death, that were significantly healthier in women (in the top of the table) or in men (in the bottom).

[TABLE 4]

P(StoH), recovery from a sick state: Across all three age groups for all the domains of health, women were significantly more likely than men to recover in six cases; men were more likely to recover in 12. The remaining 18 did not differ significantly. The probability of recovering health always declined with age. It did not show a steeper (non-linear) decline with age in any of the cases.

P(StoS), remaining sick: Men were less likely to remain in a sick state than women in 23 of the 36 groups defined by domain and age. In no cases were women significantly less likely than men to remain sick. The remaining 13 did not differ significantly. The probability of remaining sick did not decline consistently with advancing age groups. For SPL, TWLK, IADL, COG, and BLK, the 75-84 year-old group was significantly more likely to remain sick than the 65-74 year-old group, for both men and women. Only for TWLK and COG was the 85-94 year-old group more likely to remain sick than the 75-84 year-old group. There was no evidence of steeper (non-linear) decline for any of the health variables.

P(StoD), dying from a sick state: For every health variable, women were always significantly less likely to die from a state of sickness than men were. P(StoD) always increased with age. For women, there was a steeper (nonlinear) decline with advancing age in all domains except HOSP. For men, the only domains with such decline were SRH, COG, and BLK.

4 Discussion

4.1 Overview

This analysis, unlike previous approaches that have focused on one or a few domains of health, examined the prevalence of and transitions in 12 measures of successful aging among a cohort of older adults. The twelve health-related variables included measures of physical and mental health, quality of life, and health behaviors. Some were self-reported, and some were measured through objective tests. Some were subjective single item questions while others were based on structured responses. Despite these differences, most of the measures of successful aging performed in very similar ways with regard to their associations with age and sex.

Overall, the trends in prevalence show both a high rate of health throughout aging, and consistent incremental declines during it. First, the prevalence of health shown in Table 2 (and Figure 2) is quite high, even at advanced ages: 85-94 year-old individuals showed quite high rates of emotional and functional health, as well as the belief that life is worthwhile (with about 85% of participants healthy in this domain). Second, health declined with advancing age across all the domains: there were no areas that were spared the effects of aging. Some aspects of declined more dramatically, especially the functional measures of cognition, timed walk, and blocks walked. Although these were all measured on different scales, it is meaningful that, for those variables, the proportion of participants who were healthy in the oldest group was less than half the proportion in the youngest group. In a positive light, the majority of men and women aged 85-94 in this community cohort had no hospital days, no bed days, no ADL difficulties, were not depressed, had high self-rated health, and felt that life was worthwhile. The probabilities of dying from a healthy state (Table 4) were quite low for both men and women. These findings are a testament to overall healthy aging among this group.

Prevalence and Incidence by Sex and Age

As described in Equation 1, the equilibrium prevalence of a healthy state depends on the probabilities of transition into and out of health and sickness. Men were observed to have a higher prevalence of a healthy state except for HOSP and COG. Reviewing the transitions in light of Equation 1 suggests that most of this sex difference is due to differences in becoming sick, P(HtoS), rather than differences in recovery of health, P(StoH). Table 4 shows that P(HtoS) is higher for men than for women only for HOSP and COG (and occasionally for SRH); Table 3 shows smaller and less consistent differences in P(StoH). Most of the gender difference is thus driven by difference in incidence of sickness rather than difference in recovery from it. Some of the gender difference is a function of the difference in death rates for men and women.

A different trend is seen for the age effects. In the first term of Equation 1, P(HtoH) – P(StoS) is in the numerator (this difference is not shown in the tables, but can be easily calculated). This quantity is usually positive, meaning that a healthy person is more likely to remain healthy than a sick person is to remain sick. The term is negative for BLK, meaning that a sick/sedentary person (walking less than 4 blocks per day is more likely to remain sick/sedentary that a healthy/active person (walking 4 or more blocks a day) is to remain healthy/active. This difference is more negative for the oldest old compared with younger age groups, meaning that, with increasing age, the probability of staying healthy becomes lower than the probability of staying sick, which decreases the prevalence of health.

Age and Health

The prevalence of a healthy state and five of the transition probabilities declined significantly in the expected direction with age. The one discrepant probability was P(StoS), the probability of remaining sick, which did not decline consistently, and was often highest in the middle age group. A similar pattern has been observed in other research on self-rated health, where P(StoS) increased from birth until about age 60, after which it declined.[23] This non-intuitive pattern arises because the most likely alternatives for a sick person are different at different ages. At younger ages, the most likely change is to recuperate, but as the probability of recovering health decreases with age, the probability of remaining sick increases. At the oldest ages, the most likely change from the sick state is death, and as the probability of dying from a state of sickness increases, the probability of remaining sick decreases. The sick state thus has a somewhat ambiguous meaning, since it represents a failure to recuperate (or being "stuck") for younger persons but a resistance to dying for older persons.

Gender and Health During Aging

Analyses comparing patterns among the 12 health variables disclosed significant trends by sex. Men had a higher prevalence of a healthy state for 10 of the variables, with women healthier only for cognitive status and hospitalizations. In spite of their higher prevalence of a healthy state at all age groups, men had a significantly higher death rate in all but one comparison. Men thus both died more often than women from a state of either sickness or health, remained more healthy than women while alive, and were more likely to recover from being sick.

The differences observed between men and women were thus not characterized by similar transitions offset by a period of years, as might happen if men's health trajectories were simply premature or accelerated versions of women's. Comparing the adjacent age categories for men and women (for instance, 65-74 year-old men compared to 75-84 year-old women) shows that younger men's transitions were more similar to older women's than younger women's to older men's for 58 (60%) of the 96 possible comparisons. This is seen graphically in Figure 2, where the transition probabilities for men are higher for health but lower for sickness, and there is no transformation of the women's transitions (as by moving the lines for women to the left, or by compressing the curves) that would make them match those for men). These results demonstrate qualitative differences in health transitions between men and women during aging, not just that men "age faster", as has been suggested.[10] If this had been the case, men would have developed sickness sooner than women, remained sick as much as women, and had equal likelihood of dying from a state of sickness as women. This trend was not seen, and in many cases opposite effects were observed.

That men in this sample died sooner than women is no surprise. It is unexpected that although men always had a higher death rate, more of them were healthy across all age ranges (except for hospitalization and cognitive status). The findings suggest that men may show more compression of mortality, or "squaring of the mortality curve" than women.[23] Put another way, the findings of

(1) a higher likelihood of death among men, whether they are sick or healthy, and by whatever definition of health, and (2) men's higher prevalence of health in most domains, argue strongly that sickness is not the key intermediary which makes men die more.

Similar observations about gender differences have been made by Leveille et al,[24] who defined health by the ability to climb two flights of stairs. They found that men were more likely to die, to remain healthy, and to recover, while women were more likely to become sick and to remain sick. Using life-table calculations, they concluded that the most important explanatory factor was that incidence of disability was higher for women. We extended that finding by using 12 different measures of health, and used Equation 1 to illustrate the roles of incidence and recovery in determining the prevalence of a healthy state. Likewise Hardy,[18] in a study of ADL disability, found that the higher prevalence of disability in women versus men is due to a combination of higher incidence and longer duration, resulting from lower rates of recovery and mortality among disabled women. Unlike these previous approaches, we determined that all of the non-death transition probabilities favored men somewhat, and not just incidence of sickness.

The etiologies of these differences in incidence and prevalence of health between men and women remain somewhat nebulous. Historical analyses suggest that the environmental pressures of infectious disease and resource availability have caused women to live longer.[25] Other research suggests that lower mortality among women could be attributable to a low-risk, healthy lifestyle,[8,26] or to lack of male hormones such as testosterone.[27] Alternatively, women may assess their health differently, for instance with different anchoring points to define sick and healthy states.[28,29] Women may have a more accurate or nuanced perspective on their health than men do, or may be more willing to assume the sick role than men. This latter possibility is supported by the fact that hospitalization and cognitive status, the only variables where women were healthier than men, are relatively objective measures of health status. Nonetheless, timed walk, an objective measure of health, favored men. It might be useful to repeat these analyses using other variables, datasets, and age groups, with attention to differences in self-reported and performance measures, in order to understand the underlying factors behind these gender differences better.

4.7 Limitations.

About one-tenth of the data were missing, and imputed. The approach we used for imputation may have minimized changes by assuming that health status was mainly stable when not measured. The significance tests that are reported here should be considered as descriptive rather than definitive, due to the large number of comparisons that were made in this analysis. The category of "healthy" in the various outcome measures should not be interpreted literally, since the cutoffs for healthy and sick states were assigned by categorizing each variable individually, and not by cross-validating them with other metrics for subjective or objective health. Because the goal of this paper was to compare twelve different measures of health, the attention given to the prevalence of and transitions for each of the specific health measures was limited. In the interests of generating straightforward descriptive results, we did not adjust for other patient-level health or sociodemographic characteristics which could confound the associations between age, sex, and health. The one-year transition probabilities we computed are grounded on a Markov assumption that future states depend on current states, and there may be factors related to history or chronicity that influence future course that we did not evaluate.

5 Summary and Conclusion

Transition probabilities among various states of health during aging are rarely reported. We calculated transition probabilities for 12 health-related variables across different domains of health, and believe that these have utility for organizing future research and for characterizing the changes that happen during aging. In general, the 12 variables all behaved similarly, with a decline in health during aging. Men and women experienced different types of change in health over time, with men showing more health and less sickness, but greater likelihood of dying. Men did not simply age faster compared to women. They had a more "square" curve of health status over time, with drop-off at younger ages than women. There is no simple explanation for the differences observed between men and women; they may partly relate to women's health-related behaviors or perceptions of health. Future study can help to clarify how health is constructed and changes in different groups during aging.

Table 1: 12 Measures of Successful Aging

Category	Abbreviation	Question	Definition of Healthy
Not Hospitalized	HOSP	"Did you stay overnight in the hospital in the last 6 months"	No report of being hospitalized
No Bed Days	BED	"During the past two weeks, how many days have you stayed in bed all or most of the day because of illness or injury?"	No days in bed reported
Life Satisfaction	SPL	"How satisfied are you with the meaning and purpose of your life?, on a scale of 1 – 10, with 1 being extremely and 10 being not at all"	Score of 1 to 4
Life as a Whole	FLW	"How do you feel about life as a whole?" (1= delighted; 3 = mostly satisfied; 6 = terrible)	Score of 1-3
Not Depressed	DEP	10 questions of the Center for Epidemiologic Studies Short Depression Scale,[30] each ranked 0-3	Score < 10, out of a possible 30 points
No Limitations in Activities of Daily Living	ADL	"Do you have any difficulty performing this activity?" from a list of walking, transferring, eating, dressing, bathing, or toileting	No difficulties reported
No Limitations in Independent Activities of Daily Living	IADL	"Do you have any difficulty performing this activity?" from a list of heavy or light housework, shopping, meal preparation, money management, or telephoning	No difficulties reported
Intact Extremity Strength	EXSTR	"Do you have any difficulty with this activity" from a list of lifting, reaching, or gripping	No difficulty reported
Self-Rated Health	SRH	"How would you rate your health in general: excellent, very good, good, fair, or poor?"	Excellent, very good, or good self-reported health
Intact Cognition	COG	Modified Mini Mental State Examination,[31] scored from 0 to 100	Score above 89
Ability to Ambulate	TWLK	Timed 15 foot walk	Less than 10 seconds
Frequent Ambulation	BLK	"During the last week, how many city blocks did you walk?"	> 4 blocks per day, on average

Table 2: Prevalence of a healthy state among men and women, with health defined separately for each domain. Bolded entries represent significantly higher prevalence of health in women (left columns) or men (right columns). The differences between groups based on age are described in the text.

	Female			Male		
	65-74	**75-84**	**85-94**	**65-74**	**75-84**	**85-94**
Number of observations	12261	12433	2183	7801	8867	1752
Mean Age	71.0	78.6	87.5	71.1	78.6	87.7
HOSP: No hospital days	**91.3**	**87.8**	**84.9**	88.0	85.6	81.7
BED: No bed days	94.3	92.3	89.3	**95.9**	**94.6**	**91.3**
SPL: Satisfied with Purpose of Life	75.7	69.8	59.6	**80.7**	**75.2**	**67.4**
DEP: Not depressed	80.2	73.8	64.3	**87.6**	**81.4**	**70.9**
ADL: No ADL difficulties	86.3	76.1	56.7	**90.2**	**82.7**	**67.6**
FLW: Feel life is worthwhile	94.4	91.0	83.6	**95.3**	91.7	85.6
EXSTR: Good extremity strength	67.6	57.6	42.1	**84.6**	**78.8**	**65.4**
SRH: High self-rated health	79.0	70.8	60.7	80.0	**73.6**	**64.7**
TWLK: Walk 10 feet < 10 seconds	64.3	44.5	16.9	**73.8**	**58.6**	**30.0**
IADL: No IADL difficulties	71.8	58.7	39.5	**80.9**	**70.5**	**50.7**
COG: 3MSE > 90	**70.9**	**54.6**	**27.6**	67.2	53.1	25.7
BLK: Walked 4+ blocks per day	33.3	20.9	8.5	**47.7**	**37.8**	**22.3**

Table 3: One-year transition probabilities for those starting in a healthy state for 12 different variables. Bolded entries indicate a significantly healthier transition (more likely remaining healthy, less likely remaining sick, less likely dying) among women compared to men (top half) or men compared to women (bottom half). The differences between groups based on age are described in the text.

	Age 65-74			Age 75-84			Age 85-94		
Female	P(HtoH)	P(HtoS)	P(HtoD)	P(HtoH)	P(HtoS)	P(HtoD)	P(HtoH)	P(HtoS)	P(HtoD)
HOSP	**0.92**	**0.08**	**0.01**	**0.88**	**0.10**	**0.02**	**0.80**	**0.13**	**0.07**
BED	0.95	0.05	**0.01**	0.92	0.06	**0.02**	0.86	0.08	**0.06**
SPL	0.85	0.15	**0.01**	0.80	0.18	**0.02**	0.70	0.27	**0.04**
DEP	0.88	0.11	**0.01**	0.84	0.14	**0.02**	0.77	0.19	**0.04**
ADL	0.90	0.09	**0.01**	0.85	0.14	**0.02**	0.72	0.24	**0.04**
FLW	**0.96**	0.04	**0.01**	0.92	0.06	**0.02**	**0.85**	0.11	**0.05**
EXSTR	0.83	0.17	**0.01**	0.77	0.21	**0.02**	0.66	0.30	**0.03**
SRH	**0.90**	**0.30**	**0.01**	0.85	0.37	**0.01**	0.73	**0.40**	**0.04**
TWLK	0.83	0.17	**0.00**	0.72	0.27	**0.01**	0.54	0.45	**0.01**
IADL	0.85	0.15	**0.01**	0.77	0.21	**0.02**	0.61	0.35	0.05
COG	**0.86**	**0.13**	**0.01**	**0.81**	**0.18**	**0.01**	0.67	0.30	0.04
BLK	0.65	0.01	**0.00**	0.55	**0.01**	**0.01**	0.49	0.03	0.03
Male									
HOSP	0.88	0.10	0.02	0.85	0.12	0.03	0.76	0.15	0.09
BED	0.95	**0.03**	0.02	0.92	**0.04**	0.04	0.84	0.07	0.10
SPL	**0.86**	**0.12**	0.02	**0.82**	**0.16**	0.03	0.71	**0.21**	0.08
DEP	**0.91**	**0.08**	0.02	**0.86**	**0.11**	0.03	0.76	**0.16**	0.07
ADL	**0.92**	**0.06**	0.02	**0.87**	**0.11**	0.03	0.75	**0.18**	0.07
FLW	0.95	**0.03**	0.02	0.92	0.05	0.03	0.82	0.10	0.08
EXSTR	**0.90**	**0.08**	0.02	**0.85**	**0.12**	0.03	0.74	**0.20**	0.06
SRH	0.89	0.35	0.01	0.84	**0.34**	0.03	0.75	0.45	0.06
TWLK	**0.85**	**0.13**	0.02	**0.76**	**0.22**	0.02	0.61	**0.34**	0.05
IADL	**0.88**	**0.11**	0.01	**0.81**	**0.17**	0.02	0.64	**0.30**	0.06
COG	0.83	0.15	0.02	0.78	0.20	0.03	0.62	0.33	0.05
BLK	**0.72**	0.02	0.01	**0.63**	0.02	0.02	0.54	0.04	0.03

Table 4: One-year transition probabilities for those starting in a sick state for 12 different variables. Bolded entries indicate a significantly healthier transition (more likely becoming healthy, less likely remaining sick, less likely dying) among women compared to men (top half) or men compared to women (bottom half). The differences between groups based on age are described in the text.

	Age 65-74			Age 75-84			Age 85-94		
Female	P(StoH)	P(StoS)	P(StoD)	P(StoH)	P(StoS)	P(StoD)	P(StoH)	P(StoS)	P(StoD)
HOSP	0.68	0.26	0.06	**0.61**	0.29	**0.11**	0.54	0.27	**0.20**
BED	0.55	0.37	**0.08**	**0.44**	0.41	**0.15**	0.34	0.37	**0.30**
SPL	0.37	0.60	**0.03**	0.30	0.64	**0.06**	0.24	0.61	**0.16**
DEP	0.35	0.62	**0.03**	0.29	0.64	**0.07**	0.20	0.63	**0.17**
ADL	**0.36**	0.59	**0.05**	0.25	0.67	**0.08**	0.15	0.70	**0.15**
FLW	**0.37**	0.54	**0.09**	**0.29**	0.56	**0.15**	0.18	0.53	**0.29**
EXSTR	0.31	0.66	**0.03**	0.23	0.72	**0.05**	0.14	0.74	**0.12**
SRH	0.31	0.64	**0.04**	0.25	0.67	**0.07**	**0.24**	0.61	**0.15**
TWLK	0.29	0.68	**0.03**	0.16	0.80	**0.05**	0.06	0.84	**0.10**
IADL	0.30	0.67	**0.03**	0.22	0.73	**0.05**	0.16	0.73	**0.11**
COG	0.27	0.70	**0.03**	0.17	0.78	**0.05**	0.07	0.83	**0.11**
BLK	0.14	0.84	**0.02**	0.08	0.88	**0.04**	0.03	0.88	**0.09**
Male									
HOSP	0.63	0.29	0.08	0.56	0.28	0.16	0.49	0.23	0.28
BED	0.49	0.35	0.15	0.33	0.36	0.32	0.26	0.33	0.41
SPL	**0.41**	**0.53**	0.06	0.32	**0.56**	0.12	0.24	**0.54**	0.22
DEP	0.37	**0.54**	0.08	0.27	**0.57**	0.16	0.18	0.58	0.25
ADL	0.31	0.59	0.10	0.23	**0.60**	0.17	0.13	**0.63**	0.24
FLW	0.29	0.55	0.16	0.20	0.52	0.28	0.15	0.46	0.39
EXSTR	**0.37**	**0.57**	0.07	**0.31**	**0.56**	0.14	**0.20**	**0.56**	0.24
SRH	0.32	**0.60**	0.08	0.25	**0.62**	0.13	0.18	0.59	0.24
TWLK	**0.34**	**0.61**	0.05	**0.21**	**0.70**	0.09	**0.08**	**0.76**	0.16
IADL	**0.34**	**0.59**	0.08	**0.24**	**0.64**	0.12	0.17	**0.64**	0.19
COG	0.27	0.69	0.04	0.18	**0.74**	0.08	0.07	**0.78**	0.15
BLK	**0.21**	**0.76**	0.04	**0.14**	**0.79**	0.07	**0.08**	**0.77**	0.15

Figure 1: Transition probability model, showing the probability of remaining in a state or moving to another state during specific time intervals (such as one year).

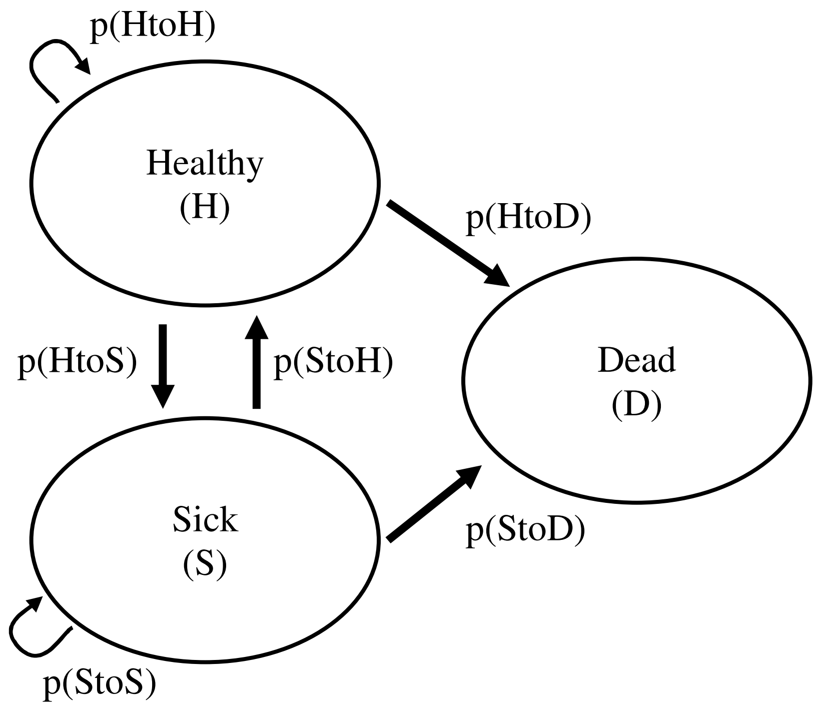
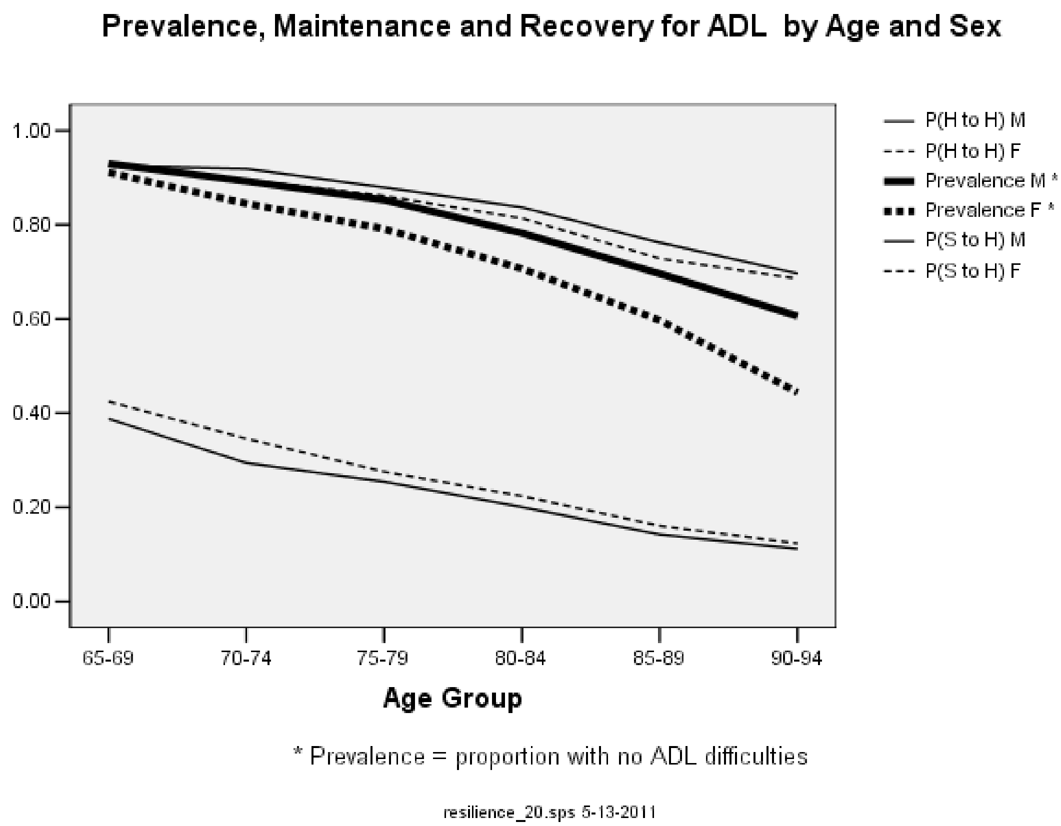


Figure 2: Prevalence of ADL impairment, and probability of transitions between states of ADL difficulties, by age and sex. "Sick" is any ADL difficulty, and "Healthy" is no ADL difficulty. P(HtoH) is the probability of remaining healthy, and P(StoH) is the probability of returning to health. The other probabilities (becoming sick and remaining healthy) are not shown).



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