A Multistate Analysis of Active Life Expectancy

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Synopsis

With today's lower mortality rates, longer expectations of life, and new medical technologies, the nation's health policy focus has shifted from emphasis on individual survival to emphasis on personal health and independent living. Using longitudinal data sets and new methodological techniques, researchers have begun to assess active life expectancies, estimating not only how long a subpopulation can expect to live beyond each age, but what fractions of the expected remaining lifetime will be lived as independent, dependent, or institutionalized.

New ideas are addressed, applying recently developed multistate life table methods to Waves One and Two of the Massachusetts Health Care Panel Study. Expectations of active life are presented for those 65 and older who initially are in one of two functional states of well-being. Included are expectations of life, for those, for example, who were independent and remained so, or those who were dependent and became independent.

Although public health officials are concerned about the number of elderly who cease being independent, preliminary analysis shows that a significant number of the dependent elderly regain their independence, a situation which needs to be addressed in health care planning.

FERTILITY PATTERNS of the past and steadily increasing longevity today have made persons 65 years and older one of the fastest growing population subgroups in the country (*1, 2*).

Lower mortality rates, expectations of longer lives, and new medical technologies to prolong life have shifted the nation's public health policies from a focus on individual survival to promoting healthy living and prolonging active life. The shift demonstrates the need for more accurate assessment of the levels of independence and dependence of specific elderly age groups, information which will assist in measuring the quality of their health and in planning for their care.

Katz and coworkers (*3*) used a life table analytic method to demonstrate the concept of active life expectancy, a status that signifies a person's independence in the activities of daily living (ADL) in the community. They examined active life expectancy, defined as the "expected duration of functional wellbeing," to differentiate among those who were functionally independent, dependent, or institutionalized. Active life expectancies were calculated from data on those who were initially independent in their ADL score and living in the community. The concept of ADL involves limitations in one's ability to carry out functions such as eating, bathing, toileting, transferring from bed to chair, continence, and dressing (*4*).

The researchers found active life expectancies to decrease from 10.0 years for age group 65–69, to 8.1 years for those 70–74, 6.8 years for those 75–79, 4.7 years for those 80–84, and 2.9 years for those 85 and older. The percentage of the remaining years of life that could be lived in an independent state decrease from 61 percent for ages 65–69, to 57 percent for ages 70–74, 59 percent for ages 75–79, 53 percent for ages 80–84, and 40 percent for those 85 and older.

The analysis was inventive in combining decrements from death, dependency, and institutionalization so that active life expectancy could be

Expectations of remaining life, by functional state, Massachusetts, 1974, multistate method

Age	Independent at age shown					Dependent at age shown				
	Years remaining	Years remaining independent	Percent independent years	Years remaining dependent	Percent dependent years	Years remaining	Years remaining independent	Percent independent years	Years remaining dependent	Percent dependent years
65	16.5	14.7	89.5	1.7	10.5	15.5	11.1	71.9	4.4	28.1
66	15.8	14.1	89.3	1.7	10.7	14.6	10.0	68.3	4.6	31.7
67	15.1	13.3	88.8	1.7	11.2	14.2	10.4	73.2	3.8	26.8
68	14.4	12.7	88.2	1.7	11.8	13.4	9.3	69.2	4.1	30.8
69	13.7	12.0	87.5	1.7	12.5	12.7	8.5	67.4	4.1	32.6
70	13.1	11.4	87.0	1.7	13.0	12.1	8.2	67.5	3.9	32.5
71	12.4	10.7	86.2	1.7	13.8	11.6	7.9	68.1	3.7	31.9
72	11.8	10.1	85.5	1.7	14.5	10.8	6.8	63.1	4.0	36.9
73	11.2	9.5	84.7	1.7	15.3	10.2	6.3	61.9	3.9	38.1
74	10.7	9.0	84.1	1.7	15.9	10.0	6.8	68.4	3.2	31.6
75	10.1	8.5	83.4	1.7	16.6	9.5	6.6	69.0	3.0	31.0
76	9.6	7.8	81.6	1.8	18.4	8.4	4.4	52.4	4.0	47.6
77	9.0	7.3	80.2	1.8	19.8	8.2	4.9	59.1	3.4	40.9
78	8.5	6.7	78.1	1.9	21.9	8.1	5.4	66.7	2.7	33.3
79	8.4	6.2	76.7	1.9	23.3	7.5	4.5	60.2	3.0	39.8
80	7.6	5.6	74.4	1.9	25.6	6.5	2.5	39.1	3.9	60.9
81	7.1	5.1	71.8	2.0	28.2	6.3	2.9	45.7	3.4	54.3
82	7.0	4.7	70.6	2.0	29.4	5.9	2.3	40.0	3.5	60.0
83	6.4	4.5	70.3	1.9	29.7	5.7	2.7	47.6	3.0	52.4
84	6.0	4.1	68.4	1.9	31.6	5.3	2.2	42.0	3.1	58.0
85	5.6	3.8	67.0	1.9	33.0	4.6	0.9	20.4	3.7	79.6

NOTE: Small sample sizes preclude direct calculation of active life expectancies at the older ages.

estimated. Of equal or greater importance, however, is the method of determining dependent or institutionalized life expectancies. They based their analysis on a unistate life table technique developed by Reed and Merrell (*5*), published in 1939, which ignores return transitions from, for instance, a dependent to an independent status; they used an abridged life table with only five 5-year age groups; and they presumed that overall life expectancy for independent, noninstitutionalized persons is equal to the overall life expectancy of the total (independent, dependent, and institutionalized) population.

We adopted the more recent technique of multistate life table analysis (*6*) to incorporate both the decrements and increments of several interacting subpopulations. The multistate model is based on the simplest time (age)-inhomogeneous Markov chain. Fitting such a model to observed data usually requires positing constant intensities within each age interval, or performing a piecewise linear specification of the life table survival function (*7*).

Multistate life tables show persons leaving subpopulations, such as by migration between groups, marriage, or loss of job, and those entering, such as by migration, divorce, or reemployment. The tables are uniquely suited for analyses of the evolution of active life expectancy, a process in which about 24 percent of the dependent return to independent status, according to Katz and coworkers (*3*).

Multistate Analysis of Active Life

Methods of multistate analysis originally were developed to model the transitions of people from one state of existence to another, as for example, single to married, employed to unemployed, and rural to urban living. We show that methods of multistate analysis can help in modeling transitions from independent to dependent health status and back again.

A multistate analysis of active life expectancy can be used to describe, in terms of life-table measures, the health of the elderly within a region, and to estimate how many individuals move from one state to another and, more importantly, how many return to former states. Although many analysts are concerned about the number of elderly who move from the independent to dependent states, our preliminary analyses show that many of those in the dependent state return to an active state.

To estimate active life expectancies, we calculated multistate life tables using Katz and coworkers' data from Waves One and Two of the Massachusetts Health Care Panel Study (*8*). The data set was derived from an area probability sample of noninstitutionalized elderly, 65 years of age or older, in Massachusetts, identified in late 1974 and early 1975.

In Wave One, which began in late 1974, 1,625

Figure 1. Multistate life expectancies in years of the independent population, by age in years, Massachusetts elderly

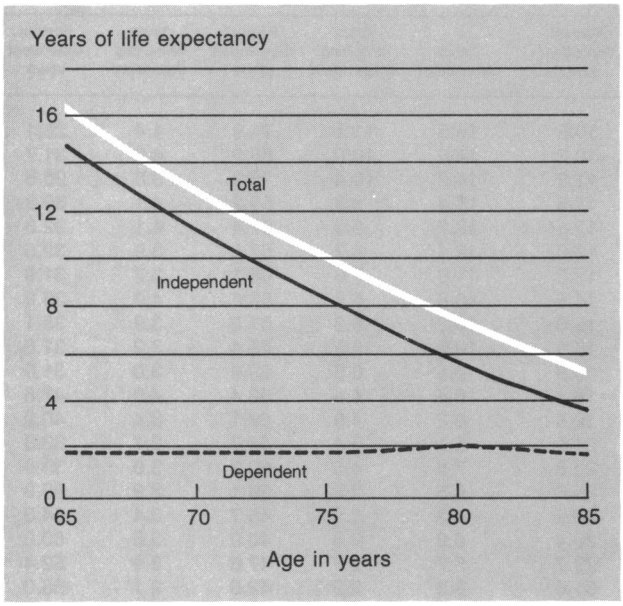
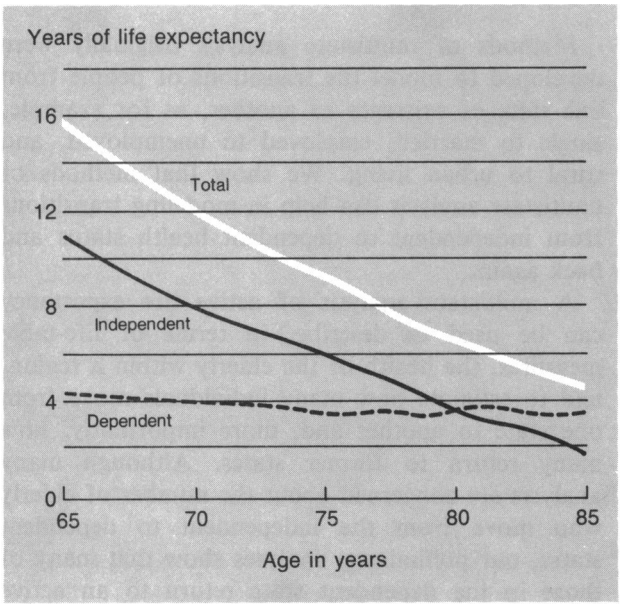


Figure 2. Multistate life expectancies in years of the dependent population, by age in years, Massachusetts elderly



people were interviewed in person for about 60 minutes by trained interviewers, who used a structured questionnaire, achieving a 79 percent response rate. In Wave Two, which began in early 1976, interviewers obtained information for 1,446 individuals, 89 percent of the original respondents. The second wave included 1,317 community respondents, 27 nursing home respondents, and 102 decedents. Comparisons with the general Massachusetts elderly population substantiated the generalizability of the results to the State (*9*).

Respondents were classified as dependent or independent on the basis of their ADL responses. To maintain consistency between our analysis and the analysis of Katz and coworkers, we used four variables of ADL. The variables are the ability to bathe oneself (considered independent if respondents bathed themselves completely or had help washing one part of their body), to dress (considered independent if respondents dressed themselves completely or had help only in tying shoes), to transfer (considered independent if respondents did not require help in moving from bed to chair), and to eat (considered independent if respondents fed themselves and only required help in cutting meat or buttering bread). If respondents were dependent in any one of the four variables, or were institutionalized (in Wave 2), they were defined as being in the dependent state. Information about toileting and continence, the other two areas of the original Katz scale, was not obtained in this panel study.

Preliminary Findings

The preliminary estimates of active life expectancy were slightly higher than those of Katz and coworkers, partly because we used complete rather than abridged age groups; divided the life expectancy transitions by the total life expectancy in each functional state, rather than by the overall aggregate Massachusetts life expectancies; and did not deflate our estimates by 20 percent to adjust for the 15-month interval between interviews. Because we dealt with multiple functional states simultaneously, we could not deflate our estimates by 20 percent unless we made the untenable assumption that transitions between states are equal (for example, a transition from independence to death having the same effect as the transition from independence to dependence).

However, to smooth some of the life expectancy curves, we applied mortality estimates from the National Health Interview Survey, Longitudinal Study of Aging data (*10*) to the Massachusetts data. Because we used functional status-specific mortality estimates, the functional form of the curves should be accurate, but may overestimate actual life expectancies. Nevertheless, the transitions between states, our central focus, should have remained relatively unaffected.

Table 1 shows life expectancies for the baseline independent and dependent functional states for all respondents interviewed in the 1974 Massachusetts

sample. The columns for the independent categories show that those who were independent at age 65 could expect to live 16.5 years, of which 14.7 would be in an independent state, and 1.7 years in a dependent state. By age 80 respondents could expect to live 7.6 years, of which 5.6 would be independent and 1.9 dependent. The table provides more information, and in greater detail, than the one in the Katz study.

The complete life table includes 21 single years of age, rather than 5 age groups. The columns under the independent category provide more information, since we can determine the total life expectancy as well as the life expectancy in each state for the independent population.

Katz and coworkers, in their study of active life expectancy, provided an optimistic view of the elderly. For example, they estimated that at age 65 years, 61 percent of the remaining life expectancy would be active. From a public policy standpoint, however, we are more interested in how many years are likely to be spent as dependent. We found that those who are independent at age 65 may expect to spend 90 percent of their remaining years independent, and 10 percent dependent, as shown in the independent columns of the table. Those who are independent at age 80 may expect to spend 74 percent of their remaining lifetime independent, and 26 percent dependent, as shown in the dependent columns of the same table and in figure 1. Note that independent persons at each age can continue to expect to spend the majority of their remaining life independent.

Multistate analyses produce average expectations of life for those respondents who are dependent at each age. For instance, the total life expectancy for those who are dependent at age 65 is 15.5 years, as shown in the dependent columns of the table. Moreover, such individuals can expect to live 72 percent of their remaining years in active life, as for example, by a "recovery." However, they can expect to spend 28 percent of their remaining life time dependent. As the population ages, the percentage of time independent decreases and the percentage of time dependent increases.

By age 80, 39 percent of the remaining time for a person then dependent can be expected to be spent independent, and dependent for 61 percent of the remaining 6.5 years, on the average. Figure 2 shows that the dependent population at each age can expect to spend the majority of years independent until age 80. Dependent persons aged 80 years and older are less likely to transfer from dependent to independent than they are to remain dependent.

Although we directly extended the analysis of active life expectancy, the results are preliminary. Moreover, if longitudinal data on the baseline institutional population were available, we could provide details on transitions from institutionalization to independence and dependence. Nevertheless, despite its preliminary nature, the approach adopted in this work demonstrates the utility of using the multistate method to provide estimates on transitions, return transitions, and active life expectancies.

Conclusions

While many people are concerned about growing old and dying, more are concerned with becoming ill, disabled, dependent, or institutionalized (*11*). The growing size of the retired population will generate profound challenges to the nation's social, economic, and political systems, which in turn will require more accurate public health data on the quality of life of older citizens, and whether it is improving, staying the same, or decreasing.

Our findings may be used to begin to address such issues, which cannot be illuminated by conventional single-decrement life tables. Multistate life tables take into account several states simultaneously, allow return transitions, and permit each subpopulation under examination to show both increments and decrements. The tables are able to reveal, for example, that even those who are dependent at age 65 can expect, on the average, to live more than 70 percent of their subsequent years independent.

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The Centers for Disease Control Program to Prevent Primary and Secondary Disabilities in the United States

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Synopsis

The Disabilities Prevention Program builds on traditional Centers for Disease Control (CDC) strengths in public health surveillance, epidemiology, and technology transfer to State and local governments in translating the findings of research into prevention programs.

The objectives of the CDC program are to provide a national focus for the prevention of primary and secondary disabilities, build capacity at the State and community levels to maintain programs to prevent disabilities, and increase the knowledge base necessary for developing and evaluating effective preventive interventions.

During 1989, CDC, in consultation with the National Council on Disabilities and members of the disability community, has elected to focus its effort in three areas: developmental disabilities, injuries to the head and spinal cord, and secondary complications among persons with physical disabilities.

RESULTS OF A 1986 HARRIS POLL showed that 15 percent of the U.S. population over the age of 16 years—27 million persons—reported a disability. A disability in this study was defined as the existence of a limiting health condition that interfered with normal activities or limited the ability to work (*1*). Survey results also showed that citizens with disabilities are often poor (50 percent of those with disabilities versus 25 percent of persons without disabilities reported household resources of less than $15,000), that two-thirds of disabled Americans between the ages of 16 and 64 are not working (although two-thirds of those not working want to work), and that 25 percent have encountered job discrimination because of their disability. The most significant measure of the impact of a disability is that a large majority of persons with disabilities report that their disability has prevented them from reaching their full potential.

Examining these data further, one finds that disabilities affect persons of all ages, but the impact and the nature of the causes of disabilities vary in different segments of the population (see table). For children and young adults, developmental disabilities and unintentional injuries from motor vehicle crashes and recreational activities are of foremost importance. In older age groups, injuries from falls and chronic diseases become increasingly important, as do intentional injuries from assault, especially among the elderly in urban areas.

Background

The National Council on Disabilities (NCD, formerly the National Council on the Handicapped), an independent Federal agency whose members are appointed by the President of the United States, is charged with reviewing all laws,