Estimates of the Incidence, Prevalence, Duration, Intensity and Cost of Chronic Disability among the U.S. Elderly

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Abstract

Objectives: To estimate the burden of chronic disability on the U.S. elderly population, using unisex and sex-specific measures of long-term care (LTC) service use, intensity and costs.

Methods: Multistate life-table analysis of adjacent rounds of the National Long-Term Care Survey (NLTCS) from 1984, 1989 and 1994, using criteria introduced in the Health Insurance Portability and Accountability Act (HIPAA) of 1996 to stratify the disabled population according to level of disability based on ADL and cognitive impairment criteria. Rates of transition to/from nondisabled to disabled states and from all states to death were computed and analyzed for differences by age and sex. Rates of service use, intensity and costs were computed conditional on age and sex.

Results: Approximately 20 percent of the residual life expectancy at age 65 for males and 30 percent for females were spent in a state of chronic disability. For both sexes, the years of chronic disability above age 65 were split evenly between mild/moderate and severe disability. The expected costs of purchased LTC services were $59,000 (includes home/community care and institutional care, in constant 2000 dollars), with substantial sex differences—$29,000 for males versus $82,000 for females.

For both sexes, the overwhelming majority (92 percent) of the LTC costs were incurred during episodes of severe disability, with the remaining (8 percent) incurred during episodes of mild/moderate disability. Residual lifetime unpaid home/community care averaged 3,200 hours for males and 4,000 hours for females, with approximately one-third of those hours incurred during episodes of mild/moderate disability.

Conclusions: The criteria for identifying severely disabled persons introduced by HIPAA effectively targeted the high-cost disabled subpopulation. This group accounted for the overwhelming majority of purchased LTC services, and a large majority of unpaid LTC services, over age 65. Sex differences in expected per capita lifetime LTC costs were substantial, with females outspending males 2.8 to 1.

1. Introduction

Chronic disability among the elderly is commonly defined as the inability to independently perform one or more activities of daily living (ADLs) or instrumental activities of daily living (IADLs) for a period of 90 days or more; chronic disability also includes cognitive impairment (CI) associated with Alzheimer's disease and other dementias, with or without ADL/IADL limitations. The chronic nature of the disability induces a degree of permanence that distinguishes these health states from short-term medically unstable health states typically associated with acute health care. The chronic nature of the disability also tends to shift the focus away from the underlying chronic medical conditions responsible for disability and towards the long-term care (LTC) needs of the disabled individual. The stability of these chronic health states makes them suitable for analysis by a broad range of demographic methods.

This paper uses multistate life-table methods to analyze unisex and sex-specific incidence, prevalence and duration of chronic disability in the 1984, 1989 and 1994 rounds of the National Long-Term Care Survey (NLTCS). Six states were defined: nondisabled, mildly/moderately disabled, three levels of severely disabled and dead. The three levels of severe disability were defined using ADL and CI thresholds (singly, and in combination) consistent with the Health Insurance Portability and Accountability Act of 1996 (HIPAA—Public Law 104-191, Aug. 21, 1996) which governs the tax treatment of LTC services and insurance under private LTC insurance policies. Estimates of the prevalence and intensity of care were generated for all disability states. The nondisabled state contained the at-risk population for the disability transitions.

The remainder of the paper contains eight sections:

- "Background" provides basic definitions used to characterize and stratify the disabled population according to the severity of disability, using criteria introduced by HIPAA.
- "Data" describes the NLTCS.
- "Disability Classification" presents the methods used to classify NLTCS sample respondents according to severity of disability, using the HIPAA criteria.

- “Disability Prevalence” presents cross-sectional disability estimates from the 1984, 1989 and 1994 NLTCS.
- “Disability Incidence” presents unisex and sex-specific disability transition rates obtained from pooled longitudinal analyses of the 1984–1989 and 1989–1994 observation intervals in the NLTCS.
- “Disability Duration” presents the multistate life-table methods and results. The consistency of the results with external data on survival and with cross-sectional NLTCS data on disability prevalence is evaluated.
- “LTC Intensity and Cost” evaluates the implications of the multistate life-table for the care requirements and costs of care for the disabled elderly population. The costs and intensity of care are stratified by severity of disability to assess the impact of restrictions introduced by HIPAA.
- “Discussion” comments on the limitations of the analysis and possible extensions.

2. Background

Under HIPAA, LTC was defined to mean the necessary diagnostic, preventive, therapeutic, curing, treating, mitigating and rehabilitative services, and maintenance or personal care services required by a chronically ill severely disabled person. More generally, the Actuarial Standards Board (1999) defined LTC to include a wide range of health and social services such as adult day care, assisted living care, continuing care, custodial care, home health care, hospice care, respite care and skilled/intermediate nursing care. LTC is generally necessitated by the development of chronic disability, which may result from a variety of medical conditions such as cancer, heart disease, chronic lung disease, arthritis, osteoporosis, stroke, Parkinson’s disease, AIDS, Alzheimer’s disease and other diseases and medical conditions. LTC does not generally include short-stay hospital care.

In contrast, acute health care generally refers to skilled, medically necessary care provided by medical and nursing professionals for physiologically unstable conditions of relatively short duration, having a specific and foreseeable end, with the primary goal to restore the patient to a stable state. The limited duration and the relative instability of the associated medical conditions distinguish acute health care from LTC.

HIPAA was significant because it introduced for the first time in the United States precise legal definitions governing beneficiary eligibility for tax-favored treatment of LTC services provided under private LTC insurance contracts, and established rules governing tax-favored treatment of LTC insurance premiums and payments under qualified contracts. The net effect was that there came into existence a standard set of definitions of “chronically ill individuals” that had the force of law. This elevated HIPAA’s definitions of chronic disability to a level comparable to other demographic events such as births, deaths, marriages and divorces typically recorded in national/state vital statistics registration systems.

HIPAA focused primarily on severely disabled persons with activity of daily living (ADL; Katz and Akpom 1976) limitations, but it also introduced specific criteria for dealing with cognitive impairments (CIs) that are not associated with ADL limitations. Under HIPAA’s definitions for tax-qualified LTC insurance, a policyholder is eligible for LTC insurance benefits only if a licensed health care practitioner certifies that the individual satisfies one of three criteria (triggers):

1. ADL Trigger—the individual is unable to perform without “substantial assistance” from another individual at least two out of six ADLs (bathing, dressing, toileting, transferring, continence and eating) for at least 90 days due to a loss of functional capacity; or
2. Similar Level Trigger—the individual has a level of disability similar to the level in the ADL trigger; or
3. Cognitive Impairment (CI) Trigger—the individual requires “substantial supervision” to protect him/herself from threats to health and safety due to “severe cognitive impairment.”

HIPAA permitted but did not require an LTC insurer to use any subset of the three benefit triggers in determining a given policyholder’s eligibility for LTC benefits. Persons satisfying any one of the three triggers were defined as “chronically ill individuals” by HIPAA. Furthermore, HIPAA included references to the National Association of Insurance

Commissioners' Long-Term Care Insurance Model Act which defined "long-term care insurance" as any insurance policy or rider designed to provide coverage for at least 12 consecutive months for each covered person on an expense incurred, indemnity, prepaid or other basis. Chronicity was an integral part of the eligibility definition: HIPAA clearly excluded acute care needs from the benefit triggers of qualified LTC insurance policies.

HIPAA's ADL trigger did not count ADLs whose limitations can be appropriately resolved by the use of special equipment such as wheelchairs, walkers, canes, crutches, handrails, ramps, bed lifts, elevators, bed-pans, portable toilets, special underwear, catheters or similar devices.

HIPAA did not specifically mention instrumental activities of daily living (IADLs—i.e., housework, laundry, cooking, grocery shopping, outside mobility, travel, money management, taking medications and telephoning; Lawton and Brody, 1969) in defining LTC benefit triggers, but it is likely that persons who are so severely impaired that they satisfy the CI trigger would have difficulty with at least some IADLs. Certain combinations of ADLs and IADLs might also satisfy the Similar Level trigger, and the IRS requested comments on the types of disability that should be included under the Similar Level trigger (Internal Revenue Service 1997; Kassner and Jackson 1998; Spector and Fleishman 1998). To date, however, the Secretary of the Treasury has not issued regulations needed to operationalize the Similar Level trigger.

As a consequence, it is reasonable to consider chronically ill individuals who satisfy HIPAA's ADL and/or CI triggers to be severely disabled, and to consider individuals with ADL and/or IADL limitations and CI below HIPAA's thresholds to be mild/moderately disabled. This raises the issue of how effectively HIPAA targeted the severely disabled subpopulation in terms of the intensity and cost of LTC.

3. Data

The National Long-Term Care Survey (NLTCS) was a series of six related surveys conducted in 1982, 1984, 1989, 1994, 1999, and 2004. The NLTCS was designed to examine health problems, functional limitations, disability and use of LTC among the elderly (age 65+) at multiple points in time. The NLTCS collected information on IADL and ADL limitations, institutionalization and CI.

The NLTCS employed a nationally representative longitudinal design with cross-sectional replenishment at age 65–69. This design permitted both longitudinal and cross-sectional analyses. This paper used pooled cross-sectional analysis of the 1984, 1989 and 1994 NLTCS to develop estimates of the frequency and intensity of LTC service use among the U.S. elderly population and pooled longitudinal analysis of the 1984–1989 and 1989–1994 NLTCS survey pairs to evaluate health state transitions between adjacent rounds of the NLTCS, based on a Markov chain multistate life-table model.

Detailed descriptions of the 1984 and 1989 NLTCS data and the life table methods used in their analysis were provided in Stallard and Yee (2000). The data in that report were extended in the present paper to include the 1994 NLTCS, which had the effect of doubling the sample sizes for the transition rate estimates. In addition, the 1994 NLTCS provided additional information on costs of LTC services that was not collected in the earlier rounds but which was required for the cost analysis in the current paper. The rest of this section provides a brief summary of the NLTCS sampling methods and sample sizes.

The NLTCS began as a cross-sectional survey in 1982 with approximately 36,000 elderly Medicare enrollees aged 65 and over selected for initial assessment and future follow-up. Approximately 6,000 were disabled in the community and 2,000 were institutionalized. All participants were screened to assess their ability to perform nine IADLs and seven ADLs without help. Those disabled and living in the community were given detailed interviews to assess their functional state and the nature of care received. Those disabled and living in institutions (nursing homes or similar facilities with three or more beds that provided nursing care and personal care) were identified but not interviewed in 1982. Such persons were interviewed in all subsequent surveys.

The 1984 NLTCS was the first round to employ a longitudinal design with cross-sectional replenishment. The 1984 NLTCS was a longitudinal follow-up survey of the population sampled in 1982. However, because a pure longitudinal design would not sample persons who had turned age 65 in the interim, and, hence, would not provide a complete nationally representative cross-sectional sample of all U.S. elderly aged 65 years and older, the design was modified to include such persons in an additional sample component—the "cross-sectional replenishment." Approximately 5,000 people aged 63–64 in 1982 were added to the 1984 sample group. This group, together with a 45 percent subsample of the nondisabled sample in 1982, was screened to assess their ability to perform the nine IADLs and seven ADLs without help. Those found to be disabled or institutionalized in 1984 and those disabled or institutionalized in 1982 were given detailed interviews to assess their functional state and the nature of care received. The sampling and interviewing techniques used in 1984 were similarly employed in 1989 and 1994.

Table 1 displays the resulting sample sizes available for use in the current analysis by survey year, sex and attained age within the age range 65–99. Each round of the NLTCS included at least 2,525 persons aged 85–99 and 862 persons aged 90–99. The pooled analysis of the 1984 and 1989 rounds included 39,358 persons aged 65–99 and 5,053 persons aged 85–99. Information on 64 additional persons aged 100+ was suppressed from Table 1 due to cell size restrictions, but their data were used in the analysis. The 1994 NLTCS introduced a supplementary sample of about 500 persons aged 95+, enhancing its suitability for cross-sectional rate estimation at the oldest-old ages. Although these persons were not included in the pooled longitudinal analysis because they were not part of the 1984 or 1989 sample, they did contribute to the estimation of the cost and resource utilization parameters based on the 1994 NLTCS.

The NLTCS was linked to Medicare data records maintained by the Centers for Medicare and Medicaid Services (CMS) which permitted verification of the fact of death for NLTCS respondents who died during the study period 1984–1994.

4. Disability Classification

The NLTCS classified respondents according to whether the person was a resident in an institution or in a community setting. The latter were further classified according to the number of basic ADLs for which help was required, or, if none, according to the number of more complex IADLs for which help was required. At least one of these activity-limitations must have lasted or have been expected to last 90 days or longer in order for the person to be classified as chronically disabled in the NLTCS screening interview. Once a community resident was classified as chronically disabled in a screening interview, that person received the NLTCS detailed interview during that survey and all future surveys. Institutional residents received a modified version of the NLTCS detailed interview that assessed basic ADL limitations and CI. Once a person was classified as an institutional resident, that person was scheduled for a detailed interview (community or institutional form, as appropriate) during all future surveys.

Seven basic ADLs were assessed in the NLTCS: bathing, dressing, toileting, transferring, eating, continence and inside mobility, the first six of which were components of the HIPAA ADL trigger. Measured limitations in ADLs included the use of special equipment and the assistance of another person in performing designated activities.

Nine IADLs were assessed in the NLTCS: light housework, laundry, cooking, grocery shopping, outside mobility, travel, money management, taking medications and telephoning. Measured limitations in IADLs generally included only the assistance of another person in performing designated activities (exceptions: outside mobility and telephoning, which included the use of special equipment). In all cases, IADL limitations must have been due to “a disability or health problem” in order to be recognized by the NLTCS. The ADL questions in the NLTCS screening interview probed limitations in both inside and outside mobility, but the questions in the NLTCS detailed community interview treated outside mobility as an IADL, not as a basic ADL.

There were several differences between the NLTCS procedures for classifying and counting ADL limitations and the procedures used in HIPAA. The standard protocol for tabulations from the NLTCS deleted continence from the list of ADLs because continence was queried only as part of the toileting items (e.g., Manton, Corder and Stallard 1997). HIPAA retained continence, but deleted inside mobility, in defining its ADL list. The NLTCS protocol counted ADLs whose limitations could be resolved by the use of special equipment without the use of personal assistance; HIPAA excluded such cases. The NLTCS protocol was based on self-reported limitations in ADLs whereas the HIPAA ADL trigger required certification by a licensed health care practitioner. Moreover, the HIPAA ADL trigger included contemporaneous certification that the limitation would last at least 90 days whereas the NLTCS protocol for ADLs explicitly evaluated this expectation only once for each respondent at the time of the screener interview in which he or she originally met the screener disability criteria.

This paper used the implementation of the HIPAA criteria for ADL limitations described in Stallard and Yee (2000). For each ADL, the possible sets of limitations were ordered according to the following hierarchy:

0. Performs the ADL independently
1. Needs help, but does not get help, with the ADL
2. Performs the ADL with special equipment
3. Gets standby help, uses no special equipment
4 Gets standby help, also uses special equipment
5. Gets active help, uses no special equipment
6. Gets active help, also uses special equipment
7. Unable to perform the ADL.

This hierarchy was applied to each of the six HIPAA ADLs and inside mobility, generating a classification of ADL limitations ranging from no deficiency to complete inability to perform the ADL. Levels 3 and higher most closely match the criteria in the HIPAA ADL trigger. Levels 2 and higher match the criteria in the standard NLTCS ADL protocol. Levels 1 and 2 identify ADL limitations below the HIPAA threshold.

HIPAA did not specify how the assessment of CI was to be conducted. Subsequent regulations indicated that the assessment should be based on “clinical evidence and standardized tests” (Internal Revenue Service 1997; p. 6). Following the implementation in Stallard and Yee (2000), the definition of CI in this paper was based on the error-score on the Short Portable Mental Status Questionnaire (SPMSQ; Pfeiffer 1975). For those who took the 10-item test, scores of three or four errors were classified as “mild/moderate CI,” and five or more errors as “severe CI,” with only the latter assumed to meet the HIPAA CI trigger.

In addition, if the interviewer was unable to talk directly to the sampled person because the person had Alzheimer’s disease or any other form of dementia, then that person was classified as having severe CI (equivalent to the classification of persons with 5–10 errors on the SPMSQ). For certain institutionalized persons who did not receive the SPMSQ, the classification of severe CI was based on classifications established in prior NLTCS interviews and in searches of the linked Medicare records for Alzheimer’s disease and other dementias. Such non-SPMSQ data accounted for approximately 30 percent of persons classified as having any level of CI in this sample; and approximately 45 percent of persons classified as having severe CI.

The classification procedure for persons who did not receive the SPMSQ closely followed the “inclusion criteria” of the algorithm for identifying suspected Alzheimer’s disease described in Kinosian et al. (2000, Table 1). Some modification was necessary to broaden the scope to identify all types of severe CI, not just Alzheimer’s disease. The “exclusion criteria” of Kinosian et al.’s (2000) algorithm were modified to retain non-Alzheimer’s dementias. Specifically, three conditions (arteriosclerotic dementia, alcoholic dementia and dementia in conditions classified elsewhere) were moved from the exclusion criteria to the inclusion criteria, and the exclusions for Parkinson’s disease, stroke and arteriosclerosis/atherosclerosis were deleted; the exclusion for mental retardation was retained.

Each NLTCS respondent was uniquely assigned to one of five groups, which were indexed by Roman numerals I–V:

I. Nondisabled
II. Disabled, satisfies neither HIPAA’s ADL nor CI trigger
III. Disabled, satisfies HIPAA’s ADL trigger, but not HIPAA’s CI trigger
IV. Disabled, satisfies HIPAA’s CI trigger, but not HIPAA’s ADL trigger
V. Disabled, satisfies both HIPAA’s ADL and CI triggers.

Groups II–V collectively formed the disabled subpopulation. Initial assignment to Group II was based on the respondent's satisfying any of the following criteria:

1. Institutionalization in an LTC facility
2. Any ADL limitation classified in the range 1–7 on the ADL hierarchy (i.e., needs help, uses special equipment, gets help from another person or unable to perform the activity), applied to the six HIPAA ADLs and inside mobility
3. Any IADL limitation satisfying the NLTCS IADL criteria
4. Any CI (scored as three or more errors on the SPMSQ or other evidence of impairment or dementia used to impute an SPMSQ score of 5–10 errors).

Persons who were not classified as disabled were assigned to Group I (i.e., nondisabled).

Following initial assignment to Group II, an assessment was made of the number of HIPAA ADLs with limitations classified in the range 3–7 (i.e., gets help from another person, or unable to perform the activity) on the ADL hierarchy. Disabled persons with two or more such ADLs were "promoted" from Group II to III. Following this, an assessment was made of the number of errors on the SPMSQ, and disabled persons with five or more actual or imputed errors were "promoted" from Group II to IV or from Group III to V.

5. Disability Prevalence

Table 2 contains the relative frequency distributions by year and age for the five disability groups estimated for the U.S. elderly population using sample-weighted tabulations of the NLTCS. The age standardized frequency for Group I increased from 75.3 percent in 1984 to 78.5 percent in 1994, with standard errors approximately equal to 0.3 percent each based on the sample sizes in Table 1. Alternatively, the aggregate age standardized frequency for Groups II–V decreased from 24.7 percent in 1984 to 21.5 percent in 1994. This corresponds to an overall average rate of disability decline of almost 1.4 percent per year, consistent with results reported in Manton, Corder and Stallard (1997) and Stallard (2000).

Figure 1 displays the relative frequencies by year and select ages for Groups II–V. The figure shows that the overall disability decline for 1984–1994 had different temporal patterns for different ages. Furthermore, an increase in CI (Groups IV and V combined) appeared from 1984 to 1989, followed by a decrease from 1989 to 1994. This suggests that the CI imputation procedures for nursing-home non-respondents to the SPMSQ in 1984 may have underestimated the proportions in Group V due to the lack of information from prior rounds of the NLTCS, or Medicare diagnostic codes, for these cases. If so, there would be a corresponding overestimation of the proportion in Group III. Alternatively, given the substantial decline from 1989 to 1994 it is possible that the imputations for the 1989 NLTCS overestimated the prevalence of CI with 1984 and 1994 providing more consistent estimates. The pooling of the three data years in the cross-sectional analysis and the two inter-survey intervals in the longitudinal analysis was designed, in part, to minimize bias relating to potential errors in CI assessment/imputation in the 1984 or 1989 NLTCS.

6. Disability Incidence

Table 3 displays the unisex and sex-specific five-year disability transition matrices aggregated over all ages estimated for the U.S. elderly population using sample-weighted tabulations of the NLTCS; the last column shows the sample sizes for each disability status. Corresponding age-specific transition matrices were computed for five-year age groups ranging from 65–69 to 100–104. Two additional matrices were computed for ages 65 and 105–109 and were used to initialize the life tables at age 65 and to close them out at age 112. To capture mortality in the transition matrices, the five disability groups were extended to include a sixth group (VI. Dead) that formed the only absorbing state in the multistate life-table model.

Several general patterns were identified. The persistency rates (diagonal terms) for the nondisabled Group I were substantially higher than for any of the disabled groups, and within the disabled groups the persistency rates were highest for Groups II and V (the extremes), and lowest for Group III and IV (the single trigger groups). The death rates generally increased over the five groups, an exception being Group IV whose death rates generally were between those of Groups II and III. For all five groups, the persistency rates declined and the death rates increased with increasing age. The low persistency rates of Group IV were in part due to the relatively high transition rates to Group V, consistent with a relatively lengthy progressive decline in cognitive abilities that ultimately leads to a loss of independence in ADLs. If the Group IV persistency and Group IV–V transition rates were combined, then the resulting CI persistency rates would be comparable to the Group II persistency rates. Transitions from Groups III–V to Group I were relatively infrequent except for Group IV below age 75. When an improvement did occur, it was much more likely to be from Groups III–IV to Group II. Transitions from Group V to lower levels of disability were very rare.

Examination of the sex-specific transition rates showed that females generally had higher persistency and lower death rates. Males in Group IV had higher transition rates below age 75 to Group I than females. However, below age 75, females in Group IV had equal or higher transition rates to Group II than males. These differences lead one to expect females to have greater total life expectancy and greater disabled life expectancy above age 65.

7. Disability Duration

7.1 Multistate Life-Table Methods

Estimates of the average lifetime duration of disability above age 65, 75, 85 and 95 were computed using multistate life-table procedures (see Willekens et al. 1982, for discussion and detailed mathematical development). Briefly, the standard form of the multistate life-table model is a time-non-homogeneous finite-state continuous-time Markov process. For observations made at discrete regularly spaced time intervals (such as in the NLTCS), this simplifies to a Markov chain model.

The Markov chain model employs a conditional (or local) independence assumption for the transition probabilities from each initial disability state (i.e., the “states” of the Markov chain) to the disability states observed at the follow-up assessment. For many observation plans, this may be unrealistic. Therefore, it is important to define the disability states so that the local independence assumption is reasonably plausible.

As shown in Table 3, six disability states were defined for the model in this paper:

I. Nondisabled
II. Mild/moderate disability
III. HIPAA ADL only
IV. HIPAA CI only

V. HIPAA ADL and CI jointly

VI. Dead.

The first five states corresponded to the five groups defined in Section 4. These six states approximated a hierarchy from the lowest level of disability (i.e., active or nondisabled) up to the highest levels of disability (i.e., ADL and CI jointly, followed by death). The Markov assumptions imply that the transitions from any one state to the next are independent both of prior states and of the duration in the current state. These assumptions can be made more realistic by increasing the number of states in the model. The trade-off is that it becomes more difficult to reliably estimate the transition rates as the number of states is increased. The six states in the current model represented a reasonable compromise.

The general process governing the six-state Markov chain model is defined by

$$\mathbf{l}_{t+1} = \mathbf{l}_t \cdot {}_1\mathbf{P}_t , \tag{1}$$

where $\mathbf{l}_t$ is a six-element row vector of initial state counts at the start of the unit time (one-year) interval indexed by t and ${}_1\mathbf{P}_t$ is the 6×6 transition probability matrix governing transitions over the interval (t, t + 1). Equation (1) can be parameterized to represent a survival process by setting row 6 of the transition probability matrix ${}_1\mathbf{P}_t$ to 0. In this case, l_{t6} records the deaths in the interval (t − 1, t). This process can be re-specified for five-year time intervals as

$$\mathbf{l}_{t+5} = \mathbf{l}_t \cdot {}_5\mathbf{P}_t , \tag{2}$$

where ${}_5\mathbf{P}_t$ is the transition probability matrix governing transitions over the five-year interval (t, t + 5)—see Table 3.

The group specific residual life expectancy at age t for group g is defined as

$$e_{tg} = \int_t^{\infty} l_{sg}\, ds \Big/ \sum_{g=1}^{5} l_{tg} \ , \tag{3}$$

which is additive over the five surviving groups.

Linear interpolation procedures were employed between adjacent values of $\mathbf{l}_t$ and $\mathbf{l}_{t+5}$ to obtain values of $\mathbf{l}_s$ for $t < s < t + 5$. This facilitated the integration calculations required for computing nondisabled and disabled life expectancy without having to make explicit assumptions about the nature of the underlying continuous time process.

An alternative approach involves solving for the transition hazard-rate matrices underlying equation (2) assuming an underlying continuous-time Markov process (Singer and Spilerman 1976; Stallard and Yee 2000; Bladt and Sørensen 2005; Pritchard 2006).

Stallard and Yee (2000) investigated the use of this latter approach for analysis of disability transitions in the NLTCS and concluded that the use of a continuous-time Markov process model to estimate incidence and continuance rates for *institutional* episodes produced highly biased results, whereas the estimated institutional prevalence rates were reasonably accurate, as were the estimated noninstitutional incidence, continuance, and prevalence rates. Pritchard (2006) also analyzed disability transitions in the NLTCS, introducing a penalized maximum likelihood method for estimating continuous-time Markov process models that better addressed the statistical issues of identification and embeddability. Despite the bias in the resulting institutional incidence and continuance rates, both applications treated institutionalization as a single discrete state.

The current application differs from the prior two in that: (1) institutionalization was treated as an LTC service, not a discrete disability state; and (2), with the linearity assumption described above, the calculations did not use the transition intensities.

7.2 Multistate Life-Table Results

Table 4 displays the age-specific residual life expectancy estimates by disability group and sex calculated under the assumption that the initial state vectors, $\mathbf{l}_{65.5}$, were equal to the corresponding NLTCS sample-weighted disability distributions for persons who were 65 years of age at their last birthday. The corresponding survival functions were linearly extrapolated backwards to exact age 65 for use in the life expectancy calculations. The unisex results show that nearly three-quarters (74.2 percent) of the 17.6-year life expectancy at age 65 was spent nondisabled. The nondisabled share of residual life expectancy declined to almost 60 percent at age 75 and below 40 percent at age 85.

Sex differences were large. Less than 20 percent of the residual life expectancy at age 65 for males was spent chronically disabled, with less than 10 percent spent severely disabled in Groups III–V. Almost 30 percent of the residual life expectancy at age 65 for females was spent chronically disabled, with nearly 15 percent spent severely disabled in Groups III–V. For both sexes, about half of the disability time was spent severely disabled. Females had about a 1.3-year advantage in nondisabled life expectancy at age 65 that was mostly dissipated by age 75 and actually reversed by age 85. Females had about a 4.1-year advantage in total residual life expectancy at age 65, but 2.8 of these years (68.3 percent) were spent disabled. These results were consistent with the sex differences in persistency and death rates observed in Table 3.

Because the NLTCS sample was designed to be representative of the entire U.S. elderly population, it was reasonable to expect the total residual life expectancies calculated from the Markov chain model to closely match similar estimates for the total population. The last three columns of Table 4 showed that the model most closely matched the estimates for the 1925 birth cohort (which reached age 65 in 1990) produced by the Social Security Administration (Bell, Wade and Goss 1992). Indeed, the differences between the estimates from the model and the 1925 birth cohort were generally smaller than the differences between the life expectancies based on the period life tables for 1989–1991 and 1999–2001. These comparisons served to validate the overall behavior of the model and provided confidence in the accuracy of the results.

Figure 2 compares the unisex survival curves from the Markov chain model with the corresponding curves from the 1925 cohort and 1989–1991 period life-tables. The three survival curves were very close until the mid-80s at which point the 1989–1991 curve dropped more rapidly than the other two curves. The largest absolute discrepancy occurred at about age 95. The model curve and the 1925 cohort curve were almost indistinguishable. Where differences were detectable, the model was midway between the 1925 cohort and the 1989–1991 period curves. Given that it takes 20 years for the model-based cohort to reach age 85, and 30 years to reach age

95, the patterns in Figure 2 were reasonably consistent with a projected gradual improvement in mortality over the decades of the 1990s, 2000s and 2010s.

The detailed behavior of the model was more difficult to validate because of the absence of comparable published estimates. One way to deal with this was to examine how well the model matched the cross-sectional disability prevalence rates exhibited in Table 2. Figures 3–7 compare the unisex model-based results for Groups I–V with corresponding prevalence rates for 1994 and pooled prevalence rates for 1984, 1989 and 1994.

Given the overall behavior of the model evaluated via comparisons of life expectancies and survival probabilities, the expectation was that the model-based detailed prevalence rates would initially (at younger ages) be close to the cross-sectional rates with small gradual divergences toward reduced disability at older ages. This pattern was observed in Figure 3 where the model-based prevalence rates for Group I initially matched those of the pooled data. By age 85–89, the model-based prevalence rates diverged upwards from the pooled data.

Also included in Figure 3 were the Group I prevalence rates based on the 1994 data. These are complementary to the Group II–V rates in Figure 1. As expected from Figure 1, the 1994 Group I rates were higher than the pooled rates. However, Figure 3 showed that they were also higher than the model-based rates, providing evidence that the model captured the pooled experience from the three rounds of the NLTCS, but not the secular declines in disability rates across the three rounds.

Figures 4–7 showed that the model captured the major features of the level and age-trends of the prevalence rates for the four disability groups. In general, the model-based rates were close to or between the pooled rates and the 1994 rates, the main exceptions being at ages 70–79 in Figure 4 and ages 90–99 in Figure 7.

8. LTC Intensity and Cost

This section provides estimates of the overall cost burden of disability on the elderly population and assesses how effectively HIPAA targets the severely disabled subpopulation.

Table 4 shows that the disabled life expectancy at age 65 was evenly divided between the mildly/moderately disabled Group II and the HIPAA-defined severely disabled Groups III–V, implying that approximately half of the disabled population was ineligible for benefits under tax-qualified LTC insurance policies and could not claim medical expense deductions on their federal income tax returns for their out-of-pocket LTC costs. In practice, this means that LTC services for these individuals generally would not be covered by insurance and, when paid out-of-pocket, the costs would be paid with after-tax dollars.

The NLTCS collected extensive information on LTC intensity and cost. Table 5 displays the LTC intensity parameters by disability group and sex obtained from the pooled 1984, 1989 and 1994 NLTCS, aggregated over all ages. Corresponding costs were derived from the 1994 NLTCS and were expressed in constant 2000 dollars in Table 5. All parameters were expressed on a per capita basis and were grouped according to whether the services were provided in a nursing home or in the community (which included the respondent's home and other noninstitutional settings). Expressing the parameters on a per capita basis means that the parameters applied to the general population of persons in each disability group, independent of location of residence. The per capita costs were expressed on an annual basis (i.e., they were computed by multiplying the corresponding daily cost rates by 365.25) and they represented a mixture of zero dollar costs for those who did not use the indicated services and non-zero dollar costs for the those who did use the indicated services. For example, the $980 annual nursing-home cost for unisex Group II (second line) reflects non-zero costs for the 3.8 percent of that group in a nursing home (on any given day) and zero costs for the remaining 96.2 percent. Similarly, the $29,904 cost for unisex Group V reflects non-zero costs for the 64.0 percent of that group in a nursing home (on any given day) and zero costs for the remaining 36.0 percent. The highest nursing-home cost and utilization rates were experienced by Group V, with Group III a distant second. In contrast, Group III had the highest annual cost and utilization rates for paid care among community residents ($3,803), with Group V a close second on cost ($3,338) but a distant fourth on utilization rates (15.2 percent vs. 26.1 percent). The lower utilization rate for Group V reflected the fact that only 36.0 percent of this group resided in the community compared with 60.7 percent for Group III.

Given the observation in Table 3 that the overall five-year transition rate from Group IV to V was more than double the Group IV persistence rate, it is informative to contrast the intensity and cost parameters for these two groups in Table 5. The nursing-home proportion increased from 13.4 percent to 64.0 percent, with corresponding annual cost increases from \$3,200 to \$29,904. The annual cost of paid care in the community increased from \$873 to \$3,338, implying that the total annual cost increased from \$4,073 to \$33,242—a factor of 8.2.

The multistate life-table model facilitates calculation of a variety of summary measures of the cost burden of disability. The general expression for the summarized costs is given by

$$C_{tg} = \int_t^{\infty} c_{sg} v^s l_{sg} ds \Big/ \sum_{g=1}^{5} l_{tg} \,, \tag{4}$$

where c_{sg} is the age-specific cost component and l_{sg} is the life-table survival function at age s for group g; and v is an appropriate discount factor.

To implement equation (4), the intensity and cost components in Table 5 were tabulated by five-year age groups (65–69, 70–74, ..., 90+), linearly interpolated to single years within the age range 67–90, and held constant below age 67 and above age 90. The use of age-specific intensity and cost components provided a first-order approximation to changes in family structure, living arrangements and informal/formal care due to the loss of a spouse and the aging of the children of very old disabled persons. The discount factor v was set to 1.0 for all cost calculations involving cumulative time of care.

For cost summarization, the discount factor is typically set equal to the ratio of a cost inflation factor and an investment accumulation factor. During the period 2001–2007 the inflation rate for the nursing home and adult daycare component of the CPI was 4.5 percent per year, a value that matched the LTC insurance valuation interest rate for policies issued during 1995–2005. It can be argued that the LTC insurance valuation interest rate is an appropriately conservative rate for discounting future LTC costs faced by the elderly given that only a small fraction of these costs will be prefunded through insurance or other mechanisms that could yield higher rates of investment income on the accumulated funds. Both rates were assumed to be equal in the future, which allowed the factor v to be set to 1.0 in equation (4).

Unisex and sex-specific results are presented separately in Tables 6–8 for person-years of nursing home (NH) care and home and community-based (HCB) care, hours of HCB care, and costs of NH and HCB care, calculated for ages 65+, 75+, 85+, and 95+.

The top panels of Tables 6–8 display the distribution of person-years of LTC by disability group and type of care. For each combination of disability and age, the sum of person-years NH and HCB has as its upper limit the residual life expectancy in Table 4, with differences occurring because not all disabled persons received personal care. Of the 2.24 years spent in HIPAA Groups III–V at ages 65+ in the unisex life-table (Table 4), 1.53 years (68.3 percent; Table 6) were spent with paid HCB/NH LTC. This contrasts with the 2.31 years spent in Group II, where 0.66 years (28.6 percent) were spent with paid HCB/NH LTC. For females, 72.1 percent of the years in HIPAA Groups III–V were spent with paid HCB/NH LTC, compared with 59.3 percent for males.

The middle panels of Tables 6–8 display the distribution of HCB hours of LTC by disability group and payment status. Total hours of care were the most direct measures of intensity in the NLTCS. The unisex total at ages 65+ was 4,686 hours, with males requiring 3,771 hours and females 5,451 hours. For males, 14.7 percent were paid hours; for females, 26.0 percent were paid hours. On average, males consumed 3,216 and females 4,034 hours of unpaid care. This care was generally provided by the disabled person's spouse or children and the volume of care indicated that this was a major component of LTC in the United States. Because no actual payments were made, it is difficult to determine the economic value of this care. One can approximate the value by using the overall average hourly cost for paid care in Table 6 ($9.12 per hour, unisex age 65+). This is similar to the approach used by Arno, Levine and Memmott (1999) and implies a value of $29,330 for males and $36,790 for females.

The bottom panels of Tables 6–8 display the distribution of LTC costs by disability group and type of care. The overall unisex cost of HCB/NH LTC at age 65+ was $58,855; $29,150 for males and $81,826 for females. Overall, 92.2 percent (males 91.4 percent; females 92.6 percent) of HCB/NH costs were incurred during disability episodes included in HIPAA Groups III–V.

This contrasts with unpaid hours of care where, overall, 65.5 percent (males 65.0 percent; females 66.0 percent) of such hours were incurred during HIPAA disability episodes. The fact that the vast majority of HCB/NH costs were incurred during HIPAA disability episodes indicated that HIPAA successfully targeted the elderly subpopulation most seriously impacted financially by severe disability. Only about 8 percent of LTC costs occurred outside of HIPAA disability episodes.

The cost estimates in Tables 6 were compared with nursing home and home health care costs reported for ages 65+ by Spillman and Lubitz (2000, Table 1), by (1) inflating their estimates from 1996 to 2000 dollars (+19.0% CPI-NH), (2) restoring to their estimates the 10 percent of nursing home care and 42 percent of home health care costs covered by Medicare (Spillman and Lubitz 2000, p. 1410); and (3) removing 54 percent of the home health care costs to reflect the use of these services among non-severely disabled persons (Stallard 2000, Table 3). With these adjustments, the Spillman and Lubitz (2000) analysis yielded a total cost of $56,010, with $45,225 for nursing home care and $10,785 for home health care. Their adjusted total estimate was 4.8 percent lower than the $58,855 estimate in the current analysis; their adjusted nursing home estimate was 8.6 percent lower than the current $49,497 estimate; and their adjusted home health care estimate was 15.2 percent higher than the current $9,358 estimate. These comparisons provided evidence that the estimates in Tables 6–8 were reasonable, although they were not sufficient to confirm the specific dollar values.

The multistate life-table model allows a variety of supplementary calculations to be conducted. For example, the state vector $\mathbf{l}_t$ can be reset at any age t to obtain estimates for any of the five disability states represented in the model. Using this method, the group-specific average costs of HCB/NH LTC at ages 65+ were calculated as: I, $56,827; II, $73,002; III, $99,922; IV, $82,630; and V, $130,611. The $56,827 estimate for Group I was the average net cost of future HCB/NH LTC expenditures for a group that approximated an insurable subpopulation (Stallard and Yee 2000). For comparison, the American Academy of Actuaries Committee on Long-Term Care (1997) estimated that the single-premium cost at age 65 for a typical LTC insurance policy at the end of 1996 with 5 percent compounded inflation protection, lifetime benefits, a 90-day elimination period (deductible) at the start of each benefit period and benefit caps of $100 per

NH day and $50 per HCB day, would be in the range $57,000–67,000. Adjusting this range for NH inflation through mid-2000 (+17.0% CPI-NH) yielded a revised range of $66,700–78,400. Assuming that the 0.25-year benefit elimination period reduced Group I's 2.07 person-years of paid HCB/NH LTC to 1.82 person-years, and that the same relative reduction (12.1 percent) applied to the $56,827 Group I cost estimate, a net cost of $49,962 was obtained before application of the daily benefit caps. This net cost represented 64–75 percent of the LTC insurance single-premium cost, close to the 60–70 percent loss ratios used by LTC insurers. Again, these comparisons provided evidence that the current estimates were reasonable.

9. Discussion

The multistate life-table is a powerful tool for the analysis of disability transitions in the elderly population. Demographic applications of this model to the joint analysis of mortality and morbidity data have evolved from Sullivan's (1971) static component or prevalence rate method for single-decrement life tables to Katz et al.'s (1983) double-decrement life-table method, to the more general increment-decrement or multistate life-table method employed in this paper (Rogers, Rogers and Branch 1989). Branch et al. (1991) argued for the superiority of the multistate life-table method in computing active (nondisabled) life expectancy. Land, Guralnik and Blazer (1994) introduced Markov panel-data regression procedures to the active life expectancy model and Laditka and Wolf (1998) extended their approach to allow unequal follow-up intervals with three or more states, using an embedded Markov chain with monthly changes to approximate an embedded continuous-time Markov process.

Markov chain transition rates based on the NLTCS were first estimated by Manton (1988), updated by Manton, Corder and Stallard (1993), and updated further by Pritchard (2006). These three applications used a seven-state model with institutionalization treated as a single nonabsorbing discrete state. Stallard and Yee (2000) used the NLTCS to estimate a five-state Markov chain model, also with institutionalization treated as a single nonabsorbing discrete state, as an initial step in estimating incidence and continuance tables for home and community-based (HCB) LTC using the HIPAA disability criteria.

Stallard and Yee (2000) conducted detailed analyses of the assumption that the continuance functions governing the persistence (survival) of episodes in each disability state following transition into that state were exponential in form. The exponential form of the survival function was a consequence of the constant hazard assumption typically used in the Markov chain model when converting from discrete to continuous time. This assumption was implicit in the embedded monthly Markov chain method proposed by Laditka and Wolf (1998).

Stallard and Yee (2000) found the constant hazard assumption to be satisfactory for HCB LTC episodes but seriously in error for NH LTC episodes. Instead, NH LTC episodes were appropriately modeled using continuance functions that were stochastic mixtures of pairs of exponential survival functions, with each NH admission cohort split roughly 50-50 between short-stay and long-stay residents.

Figure 8 illustrates this phenomenon using data from the Society of Actuaries 1984–1991 LTC Intercompany Study (SOA 1996). The horizontal axis represents length of stay (LOS) in months following the start of an insured HCB/NH LTC disability episode. The vertical axis represents the density of claims at the indicated LOS-values (note the unequal LOS class-intervals). Model 1 was the best fitting exponential distribution; Model 2 was the best fitting mixture of two exponential distributions. Compared with Model 1, Model 2 provided a significant improvement in fit to the observed data. The implied incidence under Model 2 was 1.7–1.8 times higher than that implied under Model 1. This signaled that one should be cautious when attempting to use the Markov chain model to estimate incidence and continuance parameters on a monthly basis.

Wolf and Gill (2009) adapted the embedded monthly Markov chain method proposed by Laditka and Wolf (1998) to study the impact of the length of the interval between disability assessments, using data with monthly assessments to estimate models for 1-month, 12-month, and 24-month intervals, with the models for 1-month intervals designated as the "true models." They commented (2009, p. 382–383): "If transition probabilities are derived from survey data with a two-year observation interval, for example, our results suggest that onset and recovery probabilities may be as little as 5% of their true values." Conversely, the implied incidence rates under the true 1-month model were up to 20 times higher than those implied by the 24-month model. They indicated that these discrepancies (biases) were large enough to undermine the assumption that the underlying continuous-time process was Markovian, which also invalidated the assumption that the 1-month model was the true model.

Stallard and Yee (2000) showed that the multistate life-table model accurately predicted the NH prevalence rates, even though the underlying process was not Markovian, implying that the model produced compensating errors in the incidence and continuance rates: the incidence rates were underestimated while the average durations were overestimated. Wolf and Gill (2009) similarly showed that the large discrepancies in their onset and recovery probabilities were offsetting, allowing reasonably accurate estimates of nondisabled and disabled life expectancies to be generated from the associated multistate life-table models.

Wolf and Gill (2009) did not consider the impact of the number of states on the assumption that the process was Markovian. They used a three-state model (nondisabled, disabled, and dead) with disability based on one or more of four ADLs; institutionalized persons were retained in the analysis but not as a distinct state (as in the current analysis). In contrast, Stallard and Yee (2000) used a five-state model, with two disability states for community residents and a third disability state for institutionalized persons. Their validation tests suggested that decomposing institutionalization into two states, thereby increasing the number of states from five to six, would be sufficient to satisfy the Markov assumptions.

If the six-state model were in fact Markovian, it would follow that a three-state model based on collapsing four of the six disability states into a single disability state would not be Markovian. Such a mechanism could account for the very large biases (e.g., 20 to 1) in Wolf and Gill's (2009) analysis. A similar mechanism (with two of the six disability states collapsed into a single institutionalization state) could account for the much smaller biases (e.g., 1.8 to 1) in Stallard and Yee's (2000) analysis.

The current analysis followed Stallard and Yee's (2000) recommendation to decompose the institutionalized population into subpopulations with similar disability characteristics, but altered the treatment so that institutionalized persons were combined with noninstitutionalized persons with similar disability characteristics, based on the HIPAA disability triggers. This required that the number of HIPAA disability states be increased from one to three (forming Groups III–V).

The nursing home utilization rates at ages 65+ for the HIPAA disability groups ranged from 13% for Group IV to 66% for Group V, with Group III at 42% (unisex rates derived using the top rows of Tables 4 and 6). The corresponding rate for the mildly/moderately-disabled Group II was only 4%, consistent with the expectation that nursing homes were primarily used by severely disabled persons. However, these results also confirmed that the institutionalized component of the severely disabled population was heterogeneous, being differentially weighted towards Group V and away from Group IV.

Given the complexity of the model and the large number of parameters that were estimated in the current application, it was essential to validate the outputs of the model against available external and internal data. The marginal survival function compared favorably with the Social Security Administration's cohort life-table survival function for the 1925 birth cohort, a cohort that reached age 65 in 1990, just one year from the midpoint of the NLTCS observation interval 1984–1994 for the data used to calibrate the multistate life-table model (Figure 2). Further tests showed that the implied age-specific disability prevalence rates from the multistate life-table model deviated only slightly from the cross-sectional NLTCS prevalence rates and that the patterns of deviation were consistent with gradually improving secular trends in disability (Figures 3–7). These comparisons supported the conclusion that the reported results from the multistate life-table model were reasonably accurate.

Joint analyses of the 1982, 1984, 1989 and 1994 NLTCS provided strong evidence of secular declines in age-specific disability prevalence rates (Manton, Corder and Stallard 1997). Secular declines in functional limitations during this period were confirmed by Freedman and Martin (1998) using data from the 1984 and 1993 Survey of Income and Program Participation; secular declines in severe cognitive impairment during at least the latter part of this period were confirmed by Freedman, Aykan and Martin (2001) using data from the 1993 Asset and Health Dynamics of the Oldest Old Study and the 1998 Health and Retirement Survey.

The estimates of nondisabled and disabled life expectancies in the current analysis were based on pooled analyses of the 1984–1989 and 1989–1994 observation intervals of the NLTCS. Pooling increased the stability of the estimated parameters and centered the analysis on the cross-sectional experience during 1984–1994. Secular declines in disability were not explicitly represented in the multistate life-table calculations. They were implicitly represented to the extent that the five-year transition probability matrices were chain-multiplied in equation (2), and to the extent that these matrices were impacted by secular changes during 1984–1994. Further research will be needed to assess the need for additional adjustments and to develop optimal strategies for reflecting secular changes in disability and mortality in the multistate life-table model. Examples of how these analyses might be conducted were provided by Boult et al. (1991), Crimmins, Hayward and Saito (1994) and Cai and Lubitz (2007).

The primary aim of this paper was to estimate the burden of chronic disability on the U.S. elderly population, using unisex and sex-specific measures of LTC service use, intensity and costs. The results showed that the burden was substantial, whether measured in person-years or lifetime hours of care, or in terms of the associated costs. For example, the expected unisex lifetime cost in constant 2000 dollars beyond age 65 of purchased LTC services was $59,000, with substantial sex differences: $29,000 for males vs. $82,000 for females. Adjusting these estimates for NH inflation through mid-2010 (+51.4% CPI-NH) yielded expected lifetime costs in constant 2010 dollars of $89,000, $44,000, and $124,000, respectively.

A second aim was to assess how well the HIPAA ADL and CI triggers targeted the high-cost disabled subpopulation. The results showed that the overwhelming majority (92%) of the lifetime costs were incurred during episodes of severe disability during which the HIPAA triggers would almost surely be satisfied. This implied that almost all of the financial risks related to LTC were insurable.

The methods used to achieve these aims have implications for actuarial modeling in this area. The standard approach to multistate modeling with panel data involves use of a Markov chain model assuming an embedded continuous-time Markov process. The current results were developed without specific assumptions about the characteristics of the embedded process. This approach was motivated by Stallard and Yee (2000) who demonstrated that the institutional transition rates did not come close to satisfying the Markov assumptions. Pritchard (2006, p. 73), using the same data, noted that this problem was restricted to only one of six nonabsorbing states (in his model; four in Stallard and Yee 2000), implying that violations of the Markov assumptions for institutionalization might not be serious. To the contrary, the results in Table 6 imply that 84% of the lifetime costs of LTC beyond age 65 were institutional (nursing home) costs, suggesting that the violations might be quite serious for LTC insurance applications, particularly those involving elimination periods and benefit caps; these latter applications require accurate estimates of both incidence and continuance rates. Figure 8 illustrates the type of biases that might occur.

The treatment of institutionalization in this paper as a type of LTC service for the four disabled groups (II–V) responded directly to Stallard and Yee's (2000) recommendation that institutionalization not be modeled as a single state. While one might anticipate that this treatment would come closer to meeting the Markov assumptions, the available data do not permit confirmation. This may change in the near future as results become available from a joint project of the Society of Actuaries and the American Academy of Actuaries under which HCB, NH, and combined HCB/NH LTC incidence and continuance rates will be generated directly from newly emerging insured experience data without reliance on Markov chain models (Yee 2010).

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Table 1 -- Distribution of 1984-1994 NLTCS Sample by Attained Age and Sex

Atained Age	Survey Year 1984	1989	1994	Total	1984 & 1989
		Unisex			
65-69	7,943	4,875	3,734	16,552	12,818
70-74	5,048	3,529	3,303	11,880	8,577
75-79	3,900	3,541	5,656	13,097	7,441
80-84	2,695	2,774	2,834	8,303	5,469
85-89	1,663	1,549	1,622	4,834	3,212
90-94	681	772	684	2,137	1,453
95-99	181	207	573	961	388
Total	22,111	17,247	18,406	57,764	39,358
		Males			
65-69	3,532	2,133	1,659	7,324	5,665
70-74	2,099	1,496	1,389	4,984	3,595
75-79	1,459	1,390	2,288	5,137	2,849
80-84	873	947	999	2,819	1,820
85-89	434	421	460	1,315	855
90-94	148	176	156	480	324
95-99	32	27	120	179	59
Total	8,577	6,590	7,071	22,238	15,167
		Females			
65-69	4,411	2,742	2,075	9,228	7,153
70-74	2,949	2,033	1,914	6,896	4,982
75-79	2,441	2,151	3,368	7,960	4,592
80-84	1,822	1,827	1,835	5,484	3,649
85-89	1,229	1,128	1,162	3,519	2,357
90-94	533	596	528	1,657	1,129
95-99	149	180	453	782	329
Total	13,534	10,657	11,335	35,526	24,191

Source: Author's calculations based on the 1984-1994 NLTCS.

Table 2 -- Unisex Population Distribution (%) by Year, Age, and Disability Group

Attained Age	Disability Group: I. Non-disabled	II. Mild/ Moderate Disability	III. HIPAA ADL only	IV. HIPAA CI only	V. HIPAA ADL + CI	Total
All Years						
All Ages	76.9	12.2	5.6	1.6	3.7	100.0
65-69	90.0	6.3	2.6	0.5	0.6	100.0
70-74	84.6	9.9	3.3	0.8	1.4	100.0
75-79	75.9	13.9	5.5	1.7	2.9	100.0
80-84	63.1	19.0	8.5	2.8	6.6	100.0
85-89	44.1	23.9	14.0	5.0	12.9	100.0
90-94	25.5	24.5	22.3	5.4	22.2	100.0
95-99	12.5	22.3	30.4	4.4	30.4	100.0
Age-Standardized	76.9	12.2	5.6	1.6	3.7	100.0
1984						
All Ages	76.0	12.9	6.3	1.7	3.2	100.0
65-69	89.3	7.0	2.7	0.4	0.7	100.0
70-74	83.3	10.6	4.0	0.9	1.2	100.0
75-79	74.7	14.8	6.1	1.7	2.8	100.0
80-84	60.2	20.9	9.8	3.0	6.0	100.0
85-89	41.6	24.6	16.2	6.1	11.5	100.0
90-94	20.6	25.8	26.9	6.7	20.1	100.0
95-99	---	25.8	41.7	---	24.8	100.0
Age-Standardized	75.3	13.1	6.5	1.7	3.4	100.0
1989						
All Ages	76.5	11.9	5.5	1.8	4.3	100.0
65-69	90.7	5.6	2.3	0.6	0.8	100.0
70-74	84.2	9.9	3.2	1.0	1.7	100.0
75-79	74.4	14.4	5.6	1.9	3.7	100.0
80-84	61.5	18.6	8.6	3.3	8.0	100.0
85-89	41.7	24.5	15.2	5.3	13.4	100.0
90-94	25.4	25.6	19.5	5.6	24.0	100.0
95-99	13.9	21.8	28.6	---	34.5	100.0
Age-Standardized	76.3	12.0	5.6	1.8	4.3	100.0
1994						
All Ages	77.9	11.8	5.2	1.4	3.6	100.0
65-69	90.0	6.3	2.7	0.6	0.4	100.0
70-74	86.0	9.4	2.7	0.6	1.3	100.0
75-79	78.3	12.8	5.1	1.4	2.4	100.0
80-84	66.6	18.0	7.4	2.3	5.7	100.0
85-89	48.0	23.0	11.5	3.9	13.7	100.0
90-94	29.2	22.7	21.8	4.4	21.9	100.0
95-99	15.9	20.8	25.5	7.3	30.6	100.0
Age-Standardized	78.5	11.6	5.1	1.4	3.4	100.0

Note 1: Results for age 65+ were age-standardized to the pooled unisex population estimates for all years combined.
Note 2: "---" denotes suppressed cell with fewer than 11 sample persons. Suppression was applied only to the printed tables; the actual values were used in subsequent analyses.
Source: Author's calculations based on the 1984-1994 NLTCS.

Table 3 -- Unisex and Sex-Specific Disability Transition Rates (%)

Initial Disability Status	Disability Status 5 Years Later						Sample Size
	I. Non-disabled	II. Mild/ Moderate Disability	III. HIPAA ADL only	IV. HIPAA CI only	V. HIPAA ADL + CI	VI. Dead	
Unisex							
I. Nondisabled	**66.3**	9.5	3.6	1.3	2.5	16.7	18,683
II. Mild/moderate disability	7.0	**34.0**	10.9	3.5	8.4	36.2	5,551
III. HIPAA ADL only	1.1	7.7	**18.2**	0.8	8.5	63.8	2,931
IV. HIPAA CI only	3.4	10.2	5.8	**10.6**	24.9	45.1	783
V. HIPAA ADL + CI	---	1.2	3.6	1.0	**22.8**	71.1	1,953
Males							
I. Nondisabled	**65.2**	7.1	3.0	1.3	1.7	21.8	8,096
II. Mild/moderate disability	8.6	**27.0**	8.9	3.2	7.4	44.9	1,658
III. HIPAA ADL only	---	7.0	**14.0**	---	9.4	67.1	938
IV. HIPAA CI only	---	9.3	5.0	**6.4**	18.6	53.4	237
V. HIPAA ADL + CI	---	---	---	---	**16.1**	79.3	529
Females							
I. Nondisabled	**67.3**	11.3	4.1	1.3	3.1	12.9	10,587
II. Mild/moderate disability	6.3	**37.0**	11.7	3.6	8.9	32.5	3,893
III. HIPAA ADL only	0.9	8.0	**20.4**	0.6	7.9	62.2	1,993
IV. HIPAA CI only	---	10.7	6.2	**12.7**	27.9	41.0	546
V. HIPAA ADL + CI	---	1.2	4.3	1.1	**25.4**	67.9	1,424

Note: "---" denotes suppressed cell with fewer than 11 sample persons. Suppression was applied only to the printed tables; the actual values were used in subsequent analyses.
Source: Author's calculations based on 1984-1994 NLTCS.

Table 4 -- Age-Specific Residual Life Expectancy by Age, Disability Group, and Sex

Age	Disability Group: I. Non-disabled	II. Mild/ moderate disability	III. HIPAA ADL only	IV. HIPAA CI only	V. HIPAA ADL + CI	III-V	Total	U.S. Total: 1925 Cohort	CY 1989-1991	CY 1999-2001
Unisex										
65	13.06	2.31	1.03	0.30	0.90	2.24	17.60	17.63	17.28	17.77
75	6.91	2.07	1.05	0.32	1.05	2.42	11.40	11.49	11.00	11.12
85	2.61	1.51	1.06	0.29	1.25	2.61	6.73	6.75	6.23	6.22
95	0.60	0.76	0.97	0.15	1.21	2.34	3.69	3.68	3.29	3.19
65	74.2%	13.1%	5.9%	1.7%	5.1%	12.7%	100.0%			
75	60.6%	18.2%	9.2%	2.8%	9.2%	21.2%	100.0%			
85	38.8%	22.5%	15.7%	4.4%	18.6%	38.8%	100.0%			
95	16.2%	20.5%	26.3%	4.1%	32.9%	63.3%	100.0%			
Males										
65	12.34	1.50	0.72	0.24	0.54	1.50	15.33	15.27	15.12	16.11
75	6.77	1.37	0.74	0.25	0.62	1.61	9.76	9.60	9.39	9.89
85	2.89	1.04	0.81	0.23	0.71	1.75	5.68	5.59	5.31	5.47
95	0.81	0.61	1.24	0.15	0.52	1.91	3.34	3.24	2.92	2.82
65	80.5%	9.8%	4.7%	1.5%	3.5%	9.8%	100.0%			
75	69.4%	14.0%	7.6%	2.6%	6.4%	16.5%	100.0%			
85	50.8%	18.3%	14.3%	4.1%	12.5%	30.9%	100.0%			
95	24.3%	18.4%	37.1%	4.5%	15.7%	57.3%	100.0%			
Females										
65	13.65	2.97	1.30	0.35	1.18	2.83	19.44	19.61	19.02	19.12
75	6.99	2.55	1.27	0.36	1.33	2.96	12.50	12.85	12.08	11.99
85	2.47	1.74	1.21	0.32	1.50	3.03	7.24	7.33	6.66	6.62
95	0.52	0.78	0.99	0.15	1.40	2.54	3.84	3.81	3.40	3.29
65	70.2%	15.3%	6.7%	1.8%	6.1%	14.5%	100.0%			
75	55.9%	20.4%	10.2%	2.9%	10.6%	23.7%	100.0%			
85	34.1%	24.0%	16.7%	4.5%	20.7%	41.9%	100.0%			
95	13.6%	20.3%	25.8%	3.9%	36.4%	66.1%	100.0%			

Source: Author's calculations based on 1984-1989 and 1989-1994 NLTCS. Last two columns are from NCHS (1997) and Arias et al. (2008).
The 1925 birth cohort values are from Bell et al. (1992, p.61), using sex-specific l_xs as weights to obtain unisex results.

Table 5 -- LTC Intensity and Cost Parameters for Disabled Persons, by Disability Group and Sex

Item	Disability Group: II. Mild/ Moderate Disability	III. HIPAA ADL only	IV. HIPAA CI only	V. HIPAA ADL + CI
Unisex				
For Services Provided in a Nursing Home				
Percent Residing in Nursing Home	3.8%	39.3%	13.4%	64.0%
Annual Cost of Nursing Home Services Per Capita	$980	$15,961	$3,200	$29,904
For Services Provided in the Community				
Percent Residing in Community	96.2%	60.7%	86.6%	36.0%
Percent with One or More Community Helpers	78.9%	60.5%	74.7%	36.0%
Average Annual Hours of Community Care Per Capita	639	1703	805	1427
Percent with Paid Community Helpers	23.1%	26.1%	20.3%	15.2%
Average Annual Hours of Paid Community Care Per Capita	95	418	96	359
Average Annual Cost of Paid Community Care Per Capita	$873	$3,803	$873	$3,338
Percent with Out-Of-Pocket (OOP) Payments for Community Care	15.5%	13.7%	11.6%	8.2%
Average Annual Cost of OOP Payments for Commuity Care Per Capita	$266	$1,086	$396	$899
Average Annual Hours of Unpaid Community Care Per Capita	544	1286	709	1068
Males				
For Services Provided in a Nursing Home				
Percent Residing in Nursing Home	4.1%	30.4%	11.9%	55.9%
Annual Cost of Nursing Home Services Per Capita	$989	$12,392	$3,017	$22,488
For Services Provided in the Community				
Percent Residing in Community	95.9%	69.6%	88.1%	44.1%
Percent with One or More Community Helpers	80.8%	69.1%	73.3%	44.1%
Average Annual Hours of Community Care Per Capita	828	2001	912	1689
Percent with Paid Community Helpers	15.3%	25.0%	18.8%	14.8%
Average Annual Hours of Paid Community Care Per Capita	69	349	89	267
Average Annual Cost of Paid Community Care Per Capita	$695	$3,269	$836	$2,561
Percent with Out-Of-Pocket (OOP) Payments for Community Care	10.1%	12.4%	11.0%	8.5%
Average Annual Cost of OOP Payments for Commuity Care Per Capita	$155	$510	$268	$829
Average Annual Hours of Unpaid Community Care Per Capita	759	1652	823	1422
Females				
For Services Provided in a Nursing Home				
Percent Residing in Nursing Home	3.7%	43.5%	14.2%	67.0%
Annual Cost of Nursing Home Services Per Capita	$970	$17,667	$3,338	$32,585
For Services Provided in the Community				
Percent Residing in Community	96.3%	56.5%	85.8%	33.0%
Percent with One or More Community Helpers	78.2%	56.4%	75.4%	33.0%
Average Annual Hours of Community Care Per Capita	558	1562	743	1329
Percent with Paid Community Helpers	26.5%	26.6%	21.0%	15.3%
Average Annual Hours of Paid Community Care Per Capita	107	451	99	393
Average Annual Cost of Paid Community Care Per Capita	$952	$4,057	$890	$3,627
Percent with Out-Of-Pocket (OOP) Payments for Community Care	17.8%	14.3%	11.9%	8.1%
Average Annual Cost of OOP Payments for Commuity Care Per Capita	$314	$1,368	$461	$927
Average Annual Hours of Unpaid Community Care Per Capita	452	1111	643	937

Note: All costs were converted from nominal 1994 dollars to constant 2000 dollars using an inflation factor of 1.290 based on the CPI-U *Hospital and Related Services* Index (inflation factor = 1.103 for Sept. 1994 to Dec. 1996) and the CPI-U *Nursing Homes and Adult Daycare* Index (inflation factor = 1.170 for Dec. 1996 to CY 2000).
Source: Author's calculations based on 1984-1994 NLTCS.

Table 6 -- Intensity and Cost of LTC Beyond Ages 65, 75, 85, and 95, by Disability Group and Location of Care: Unisex

Age	II. Mild/ Moderate Disability	III. HIPAA ADL only	IV. HIPAA CI only	V. HIPAA ADL + CI	III-V	Total
Duration of LTC by Disability Group and Location of Care						
Person-Years of Nursing Home LTC						
65+	0.10	0.43	0.04	0.59	1.07	1.16
75+	0.11	0.50	0.04	0.71	1.25	1.36
85+	0.11	0.58	0.04	0.90	1.52	1.63
95+	0.08	0.55	0.02	0.89	1.47	1.55
Person-Years of HCB LTC						
65+	1.84	0.59	0.23	0.31	1.13	2.97
75+	1.69	0.55	0.25	0.34	1.14	2.82
85+	1.28	0.48	0.23	0.36	1.07	2.34
95+	0.64	0.42	0.12	0.32	0.86	1.50
Person-Years of Paid HCB LTC						
65+	0.56	0.27	0.06	0.13	0.46	1.02
75+	0.57	0.26	0.07	0.16	0.49	1.07
85+	0.48	0.25	0.08	0.18	0.51	0.99
95+	0.25	0.22	0.04	0.17	0.44	0.68
Person-Years of Paid HCB/NH LTC						
65+	0.66	0.70	0.10	0.73	1.53	2.19
75+	0.68	0.76	0.12	0.87	1.74	2.42
85+	0.59	0.83	0.12	1.08	2.02	2.62
95+	0.33	0.77	0.06	1.07	1.91	2.23
Hours of HCB LTC by Disability Group and Payment Status						
Average Total Hours of HCB LTC						
65+	1,494	1,709	243	1,241	3,192	4,686
75+	1,355	1,617	266	1,420	3,303	4,658
85+	1,042	1,614	253	1,563	3,430	4,472
95+	590	1,354	129	1,478	2,961	3,552
Average Total Hours of Paid HCB LTC						
65+	232	440	30	324	794	1,026
75+	234	447	35	389	871	1,104
85+	207	525	38	489	1,052	1,259
95+	111	514	18	506	1,037	1,148
Average Total Hours of Unpaid HCB LTC						
65+	1,262	1,268	213	917	2,398	3,660
75+	1,121	1,170	232	1,031	2,433	3,554
85+	836	1,089	215	1,073	2,377	3,213
95+	479	840	111	973	1,924	2,403
Cost of LTC by Disability Group and Location of Care						
Average Total Cost of Nursing Home LTC						
65+	$2,449	$17,963	$992	$28,094	$47,048	$49,497
75+	$2,478	$21,109	$1,207	$34,146	$56,462	$58,940
85+	$2,842	$25,357	$1,160	$45,094	$71,610	$74,452
95+	$1,731	$26,424	$737	$48,761	$75,922	$77,653
Average Total Cost of Purchased HCB LTC						
65+	$2,115	$3,978	$270	$2,995	$7,243	$9,358
75+	$2,104	$3,972	$315	$3,590	$7,878	$9,982
85+	$1,862	$4,601	$343	$4,395	$9,340	$11,201
95+	$992	$4,527	$164	$4,542	$9,233	$10,224
Average Total Cost of Purchased HCB/NH LTC						
65+	$4,564	$21,940	$1,262	$31,089	$54,291	$58,855
75+	$4,582	$25,081	$1,523	$37,736	$64,340	$68,922
85+	$4,703	$29,958	$1,503	$49,489	$80,950	$85,653
95+	$2,723	$30,951	$900	$53,303	$85,154	$87,877

Note: All costs are in constant 2000 dollars (see footnote to Table 5).
Source: Author's calculations based on 1984-1994 NLTCS.

Table 7 -- Intensity and Cost of LTC Beyond Ages 65, 75, 85, and 95, by Disability Group and Location of Care: Males

Age	II. Mild/ Moderate Disability	III. HIPAA ADL only	IV. HIPAA CI only	V. HIPAA ADL + CI	III-V	Total
Duration of LTC by Disability Group and Location of Care						
Person-Years of Nursing Home LTC						
65+	0.07	0.24	0.03	0.31	0.57	0.64
75+	0.08	0.28	0.03	0.37	0.67	0.75
85+	0.10	0.33	0.03	0.46	0.82	0.92
95+	0.09	0.54	0.03	0.38	0.94	1.03
Person-Years of HCB LTC						
65+	1.21	0.48	0.17	0.23	0.89	2.09
75+	1.10	0.46	0.19	0.26	0.91	2.01
85+	0.82	0.48	0.18	0.25	0.91	1.73
95+	0.48	0.70	0.11	0.15	0.96	1.44
Person-Years of Paid HCB LTC						
65+	0.24	0.19	0.05	0.08	0.31	0.56
75+	0.26	0.20	0.05	0.09	0.34	0.61
85+	0.24	0.24	0.07	0.10	0.41	0.65
95+	0.16	0.40	0.06	0.07	0.53	0.68
Person-Years of Paid HCB/NH LTC						
65+	0.31	0.42	0.08	0.39	0.89	1.20
75+	0.34	0.47	0.09	0.46	1.02	1.36
85+	0.34	0.58	0.10	0.57	1.24	1.58
95+	0.25	0.94	0.08	0.45	1.46	1.71
Hours of HCB LTC by Disability Group and Payment Status						
Average Total Hours of HCB LTC						
65+	1,235	1,443	215	878	2,535	3,771
75+	1,128	1,421	238	1,021	2,680	3,808
85+	785	1,671	221	994	2,886	3,671
95+	415	2,405	96	587	3,088	3,503
Average Total Hours of Paid HCB LTC						
65+	110	276	22	147	445	555
75+	123	286	27	184	497	620
85+	111	449	39	236	725	835
95+	73	817	25	174	1,016	1,089
Average Total Hours of Unpaid HCB LTC						
65+	1,126	1,167	192	731	2,090	3,216
75+	1,005	1,135	211	837	2,183	3,188
85+	675	1,222	181	758	2,161	2,836
95+	342	1,588	71	413	2,073	2,414
Cost of LTC by Disability Group and Location of Care						
Average Total Cost of Nursing Home LTC						
65+	$1,438	$9,922	$382	$12,228	$22,532	$23,971
75+	$1,632	$12,019	$536	$14,367	$26,922	$28,554
85+	$2,596	$14,830	$369	$18,057	$33,255	$35,851
95+	$2,016	$24,492	$0	$14,834	$39,327	$41,343
Average Total Cost of Purchased HCB LTC						
65+	$1,078	$2,480	$207	$1,414	$4,101	$5,179
75+	$1,107	$2,400	$247	$1,784	$4,431	$5,538
85+	$988	$3,698	$362	$2,059	$6,119	$7,106
95+	$647	$6,579	$228	$1,444	$8,252	$8,899
Average Total Cost of Purchased HCB/NH LTC						
65+	$2,516	$12,402	$589	$13,643	$26,634	$29,150
75+	$2,739	$14,419	$783	$16,151	$31,353	$34,092
85+	$3,583	$18,528	$730	$20,116	$39,374	$42,957
95+	$2,663	$31,072	$228	$16,278	$47,579	$50,242

Note: All costs are in constant 2000 dollars (see footnote to Table 5).
Source: Author's calculations based on 1984-1994 NLTCS.

Table 8 -- Intensity and Cost of LTC Beyond Ages 65, 75, 85, and 95, by Disability Group and Location of Care: Females

Age	II. Mild/ Moderate Disability	III. HIPAA ADL only	IV. HIPAA CI only	V. HIPAA ADL + CI	III-V	Total
Duration of LTC by Disability Group and Location of Care						
Person-Years of Nursing Home LTC						
65+	0.12	0.60	0.05	0.81	1.45	1.57
75+	0.12	0.65	0.05	0.93	1.63	1.75
85+	0.12	0.70	0.04	1.10	1.84	1.96
95+	0.07	0.59	0.02	1.03	1.65	1.72
Person-Years of HCB LTC						
65+	2.36	0.70	0.26	0.37	1.33	3.68
75+	2.09	0.62	0.28	0.40	1.30	3.39
85+	1.50	0.50	0.25	0.40	1.16	2.66
95+	0.68	0.39	0.12	0.36	0.88	1.56
Person-Years of Paid HCB LTC						
65+	0.82	0.34	0.08	0.18	0.59	1.41
75+	0.79	0.32	0.08	0.20	0.60	1.39
85+	0.60	0.27	0.08	0.21	0.56	1.16
95+	0.27	0.20	0.04	0.20	0.44	0.72
Person-Years of Paid HCB/NH LTC						
65+	0.94	0.93	0.12	0.98	2.04	2.98
75+	0.91	0.97	0.14	1.13	2.23	3.14
85+	0.72	0.97	0.12	1.31	2.41	3.13
95+	0.34	0.79	0.06	1.24	2.09	2.43
Hours of HCB LTC by Disability Group and Payment Status						
Average Total Hours of HCB LTC						
65+	1,705	1,971	261	1,515	3,746	5,451
75+	1,514	1,805	281	1,680	3,766	5,279
85+	1,171	1,658	267	1,829	3,753	4,924
95+	635	1,255	138	1,737	3,131	3,766
Average Total Hours of Paid HCB LTC						
65+	332	590	35	460	1,085	1,417
75+	309	572	39	522	1,133	1,442
85+	255	582	36	606	1,225	1,480
95+	122	491	16	604	1,111	1,233
Average Total Hours of Unpaid HCB LTC						
65+	1,373	1,380	226	1,054	2,661	4,034
75+	1,205	1,233	242	1,158	2,633	3,837
85+	916	1,076	230	1,222	2,528	3,444
95+	513	764	123	1,133	2,020	2,533
Cost of LTC by Disability Group and Location of Care						
Average Total Cost of Nursing Home LTC						
65+	$3,116	$24,530	$1,228	$40,143	$65,900	$69,016
75+	$3,027	$27,363	$1,409	$46,641	$75,412	$78,440
85+	$2,960	$30,730	$1,285	$57,352	$89,367	$92,327
95+	$1,527	$28,556	$700	$58,812	$88,068	$89,595
Average Total Cost of Purchased HCB LTC						
65+	$2,957	$5,317	$312	$4,224	$9,853	$12,810
75+	$2,787	$5,159	$350	$4,780	$10,289	$13,076
85+	$2,299	$5,181	$326	$5,479	$10,987	$13,286
95+	$1,087	$4,426	$144	$5,484	$10,054	$11,141
Average Total Cost of Purchased HCB/NH LTC						
65+	$6,073	$29,846	$1,540	$44,367	$75,753	$81,826
75+	$5,814	$32,522	$1,758	$51,421	$85,701	$91,515
85+	$5,260	$35,911	$1,612	$62,831	$100,353	$105,613
95+	$2,613	$32,983	$843	$64,296	$98,122	$100,735

Note: All costs are in constant 2000 dollars (see footnote to Table 5).
Source: Author's calculations based on 1984-1994 NLTCS.

Figure 1 -- Age-Standardized and Select Age-Specific Distributions (%), Disability Groups II-V,

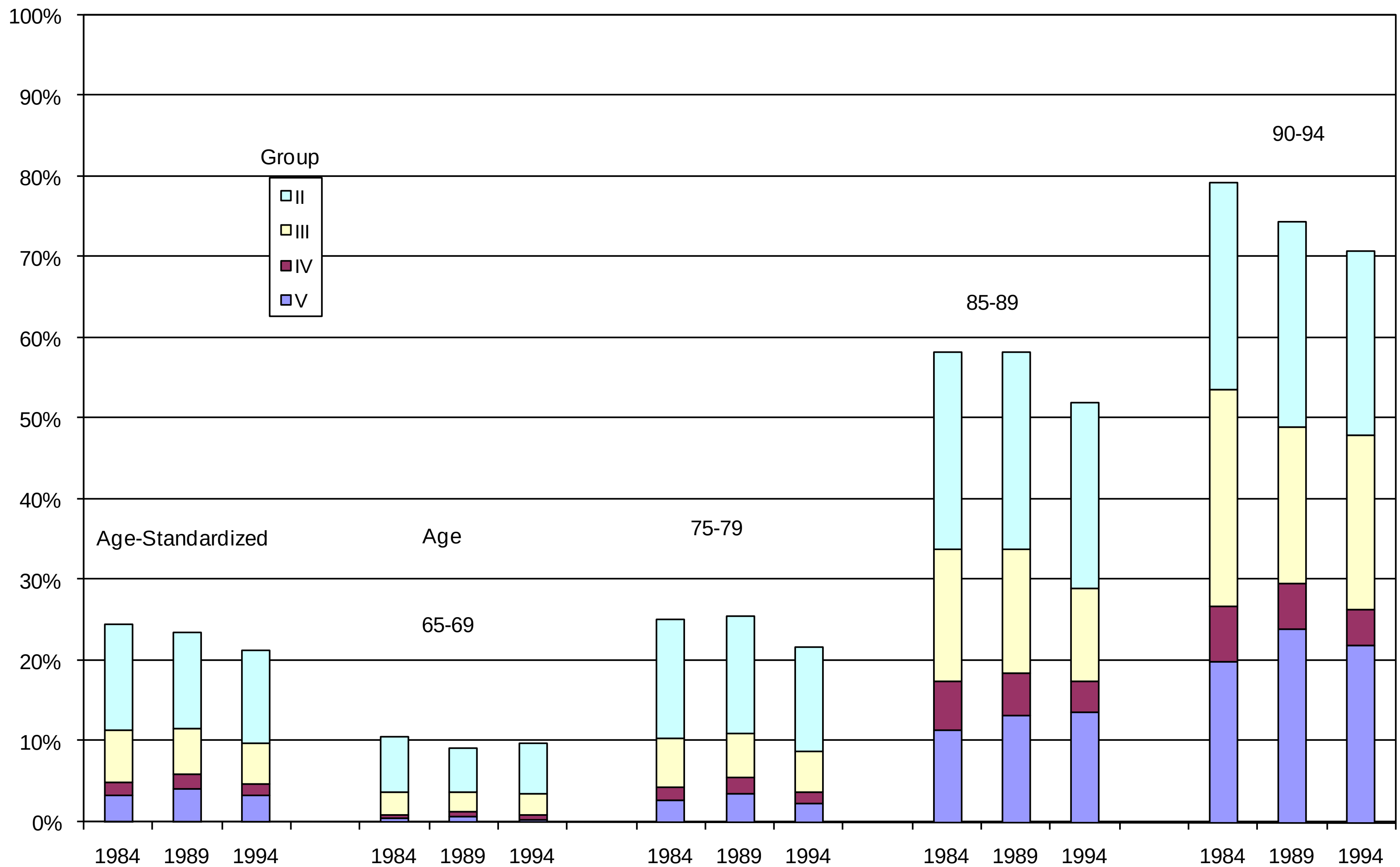


Figure 2 -- Observed and Predicted Relative Survival Probabilities, NLTCS Model vs. 1925 Cohort and 1989-1991 Period Life Tables

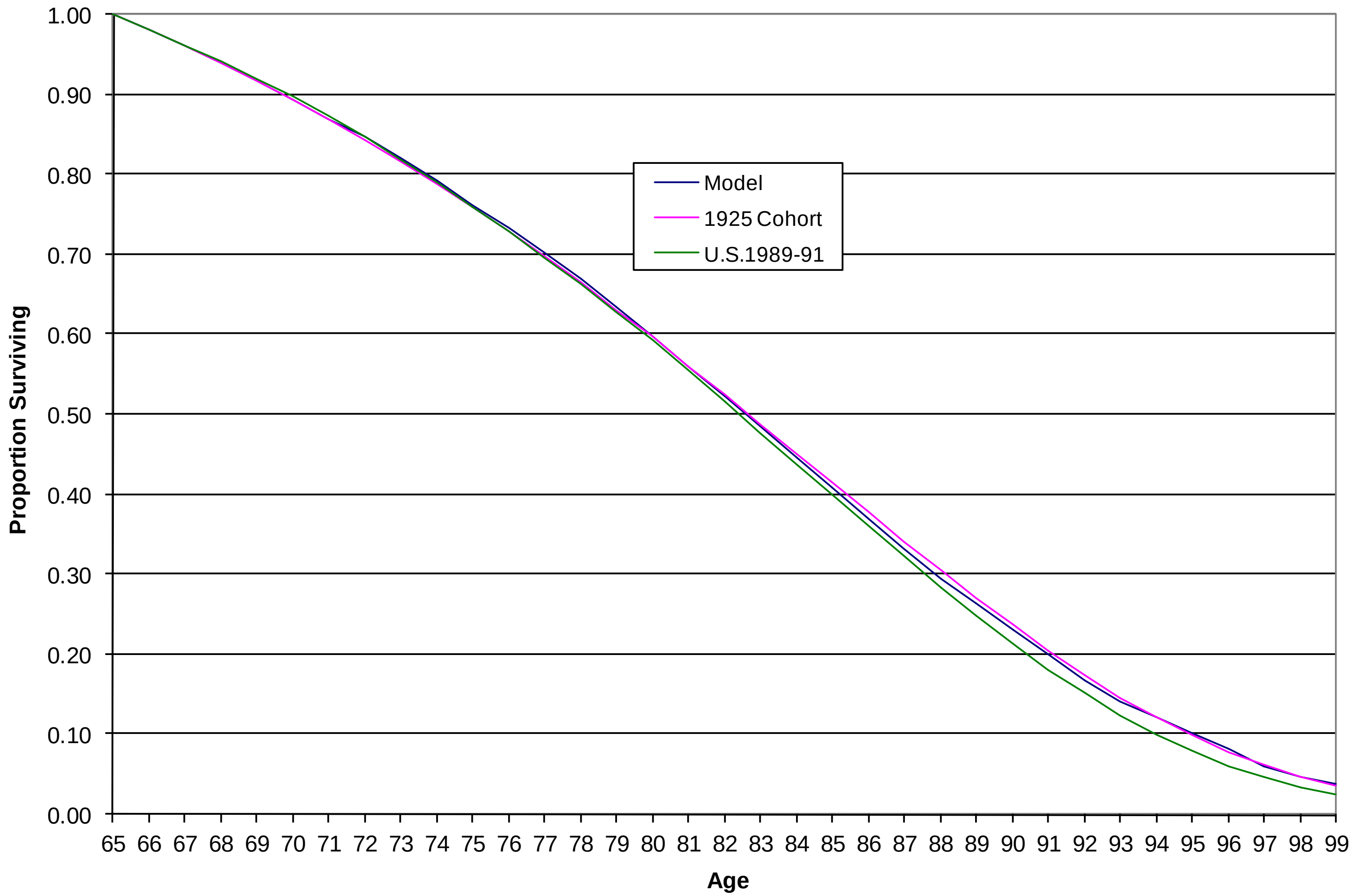


Figure 3 -- Observed and Predicted Prevalence (%): Group I (Nondisabled)

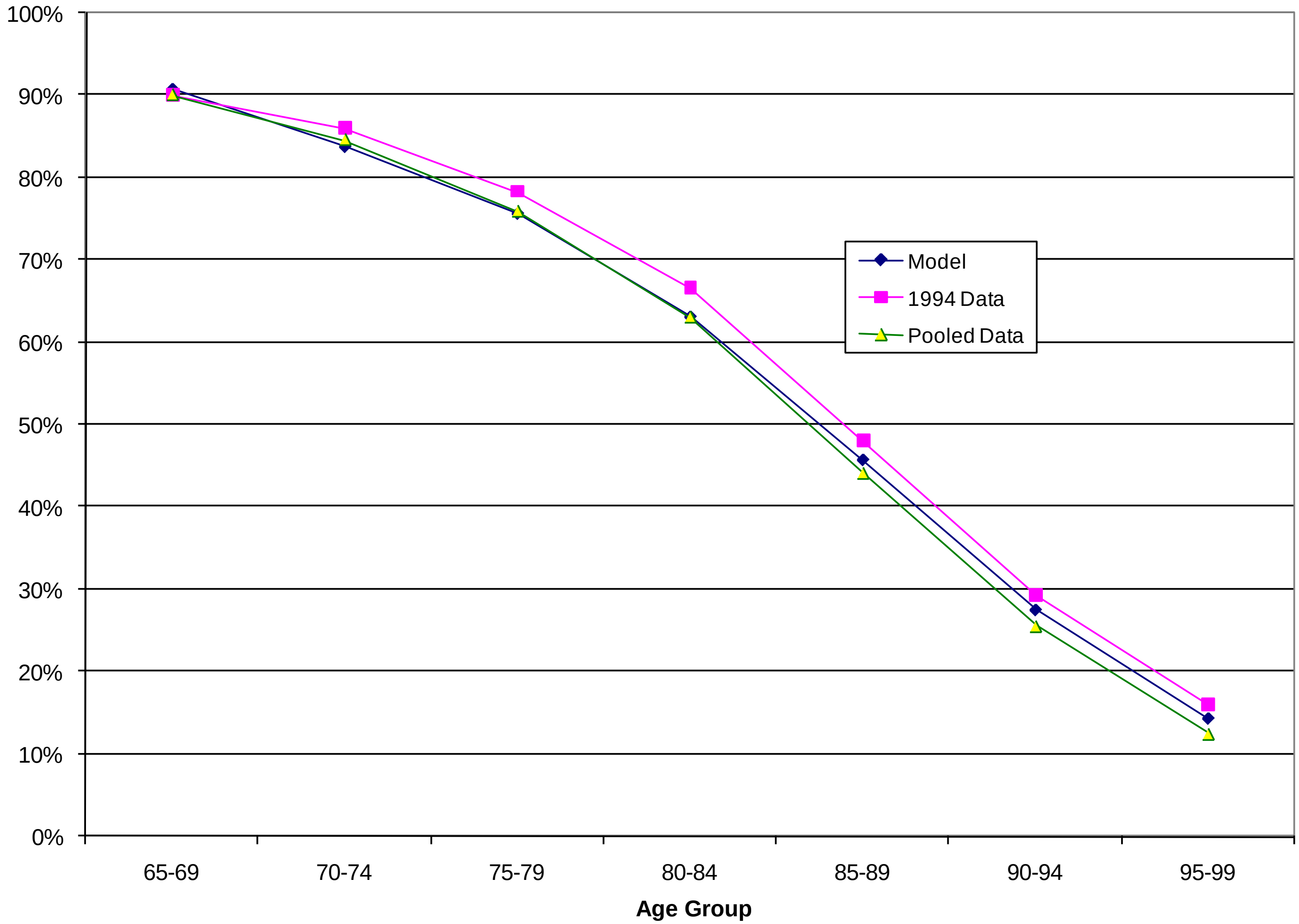


Figure 4 -- Observed and Predicted Prevalence (%): Group II (Mild/Moderate Disability)

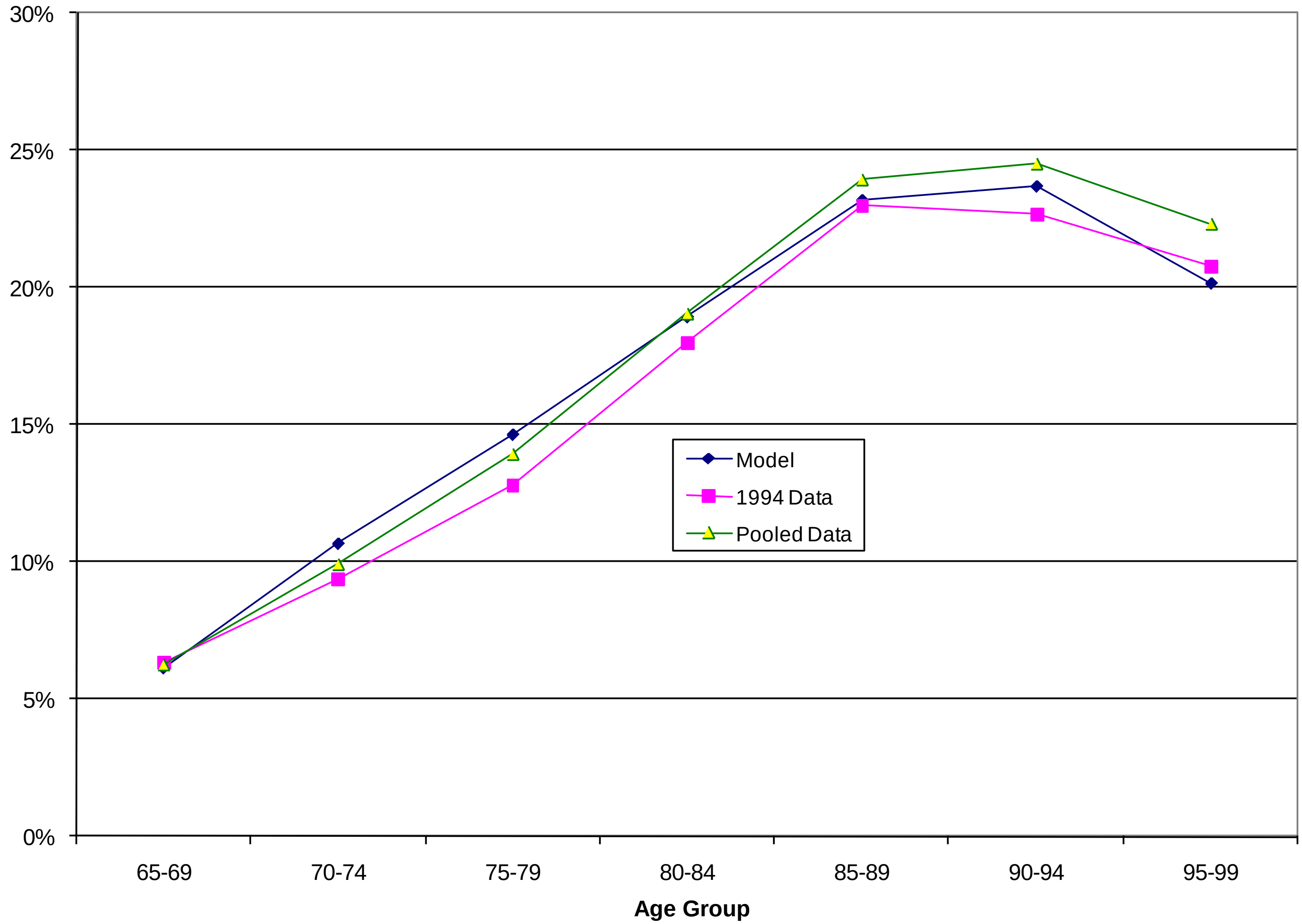


Figure 5 -- Observed and Predicted Prevalence (%): Group III (HIPAA ADL Only)

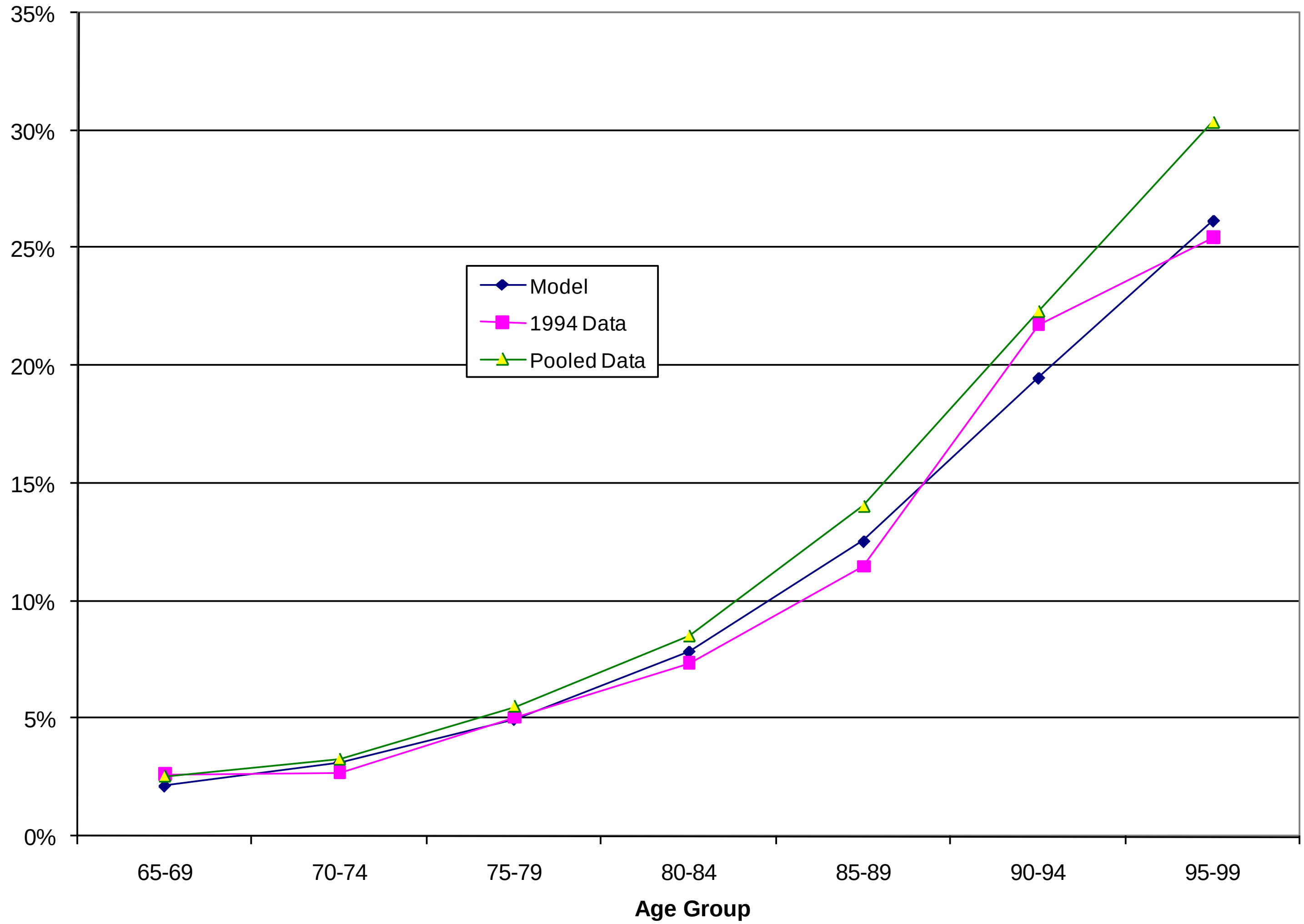


Figure 6 -- Observed and Predicted Prevalence (%): Group IV (HIPAA CI Only)

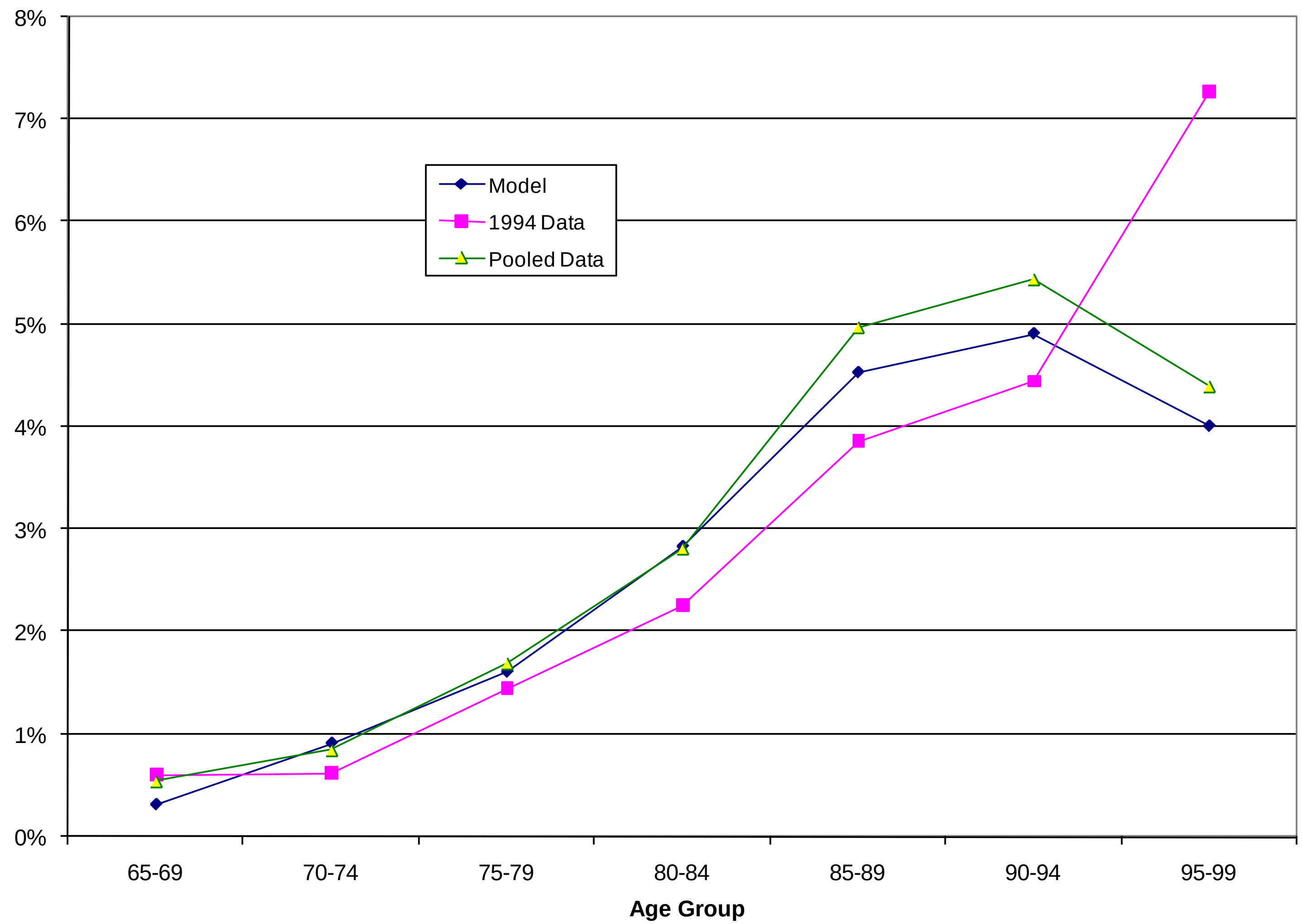


Figure 7 -- Observed and Predicted Prevalence (%): Group V (HIPAA ADL + CI)

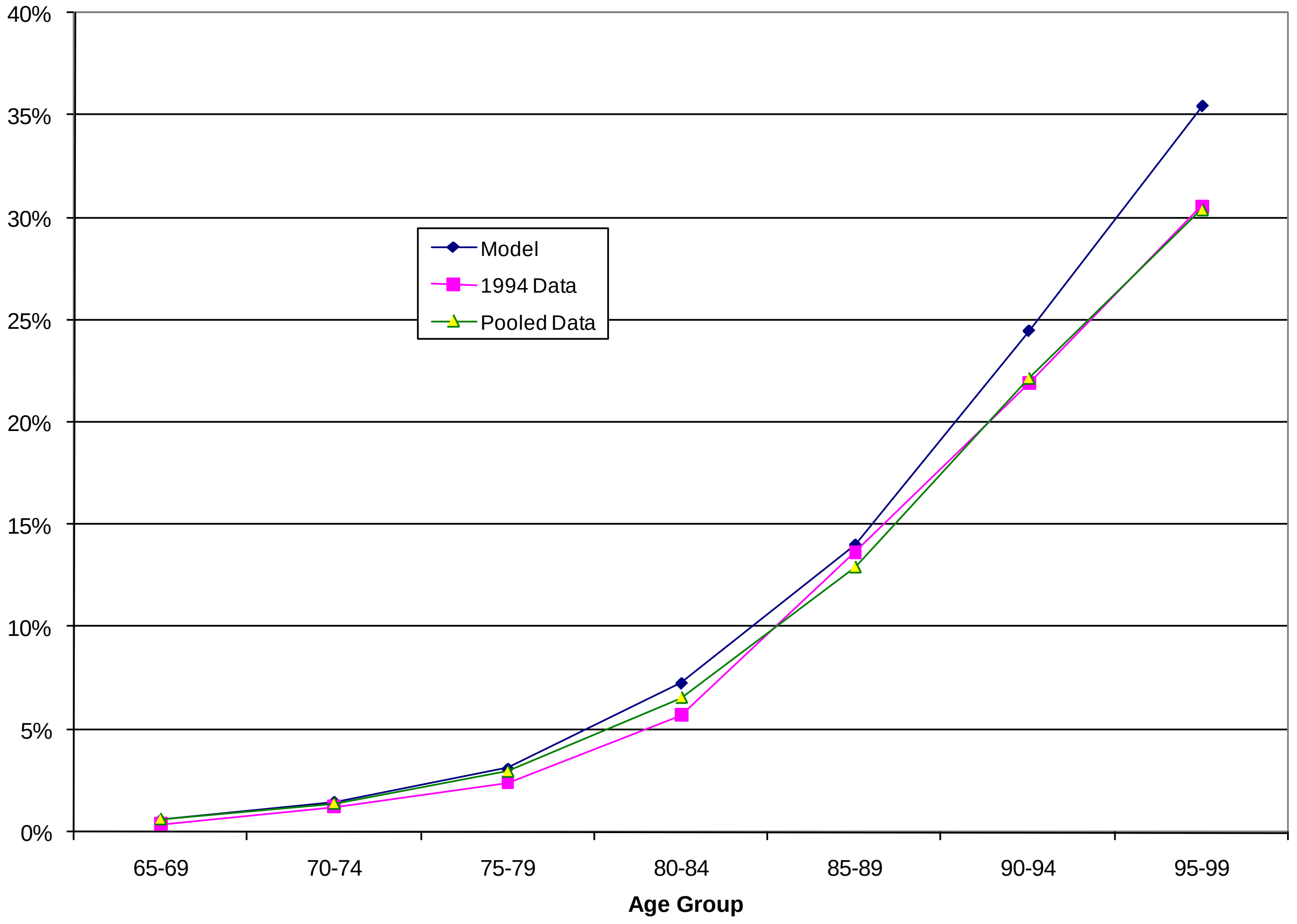
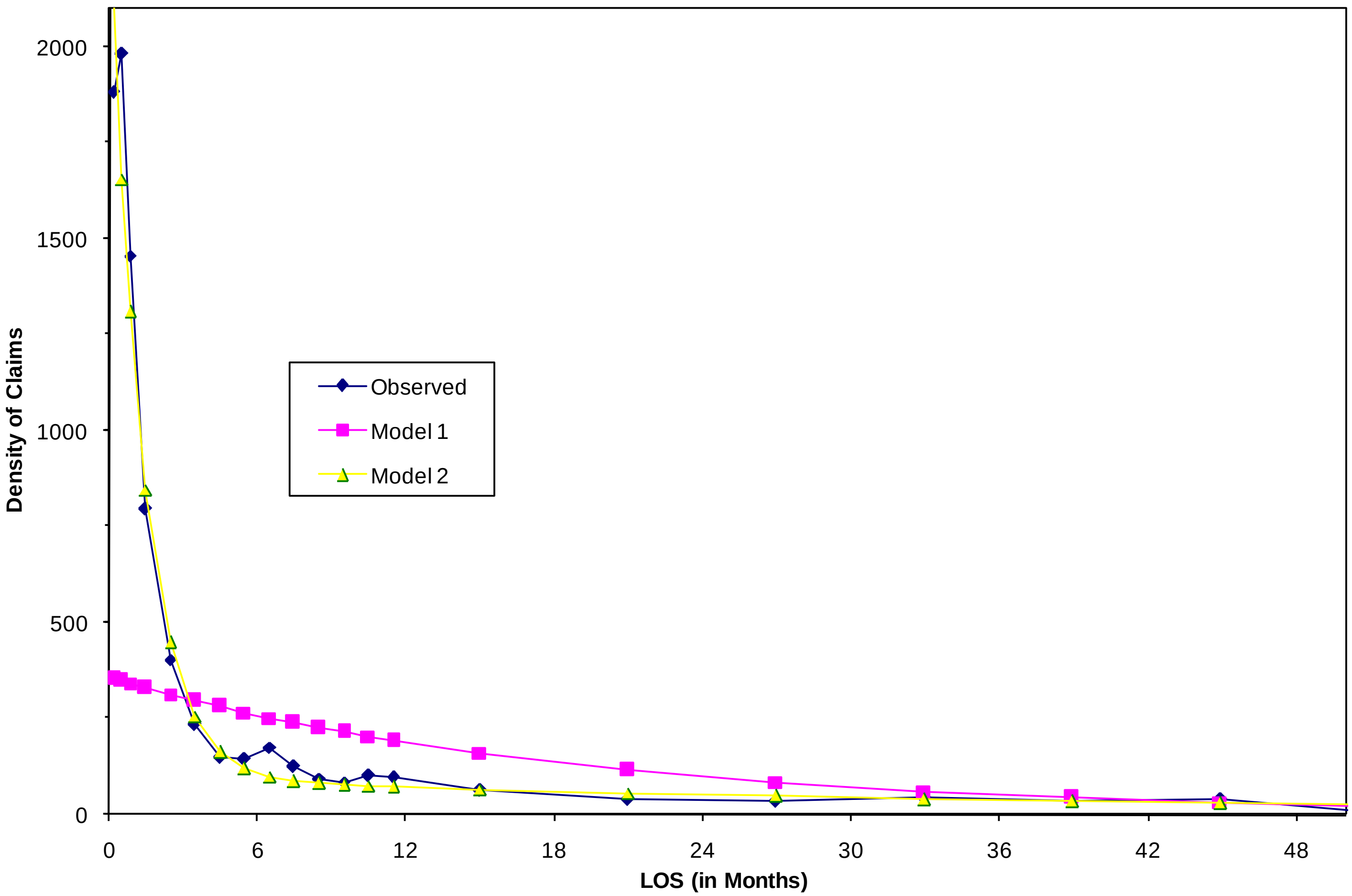


Figure 8 -- Models 1 and 2 for Insured LTC Claims with 0-Day Elimination Period -- Benefit Period Concept for Insurable Stays, Both Sexes 1984-1991 LTC Intercompany Study, All Ages at Incidence



Source: Stallard and Yee (2000)