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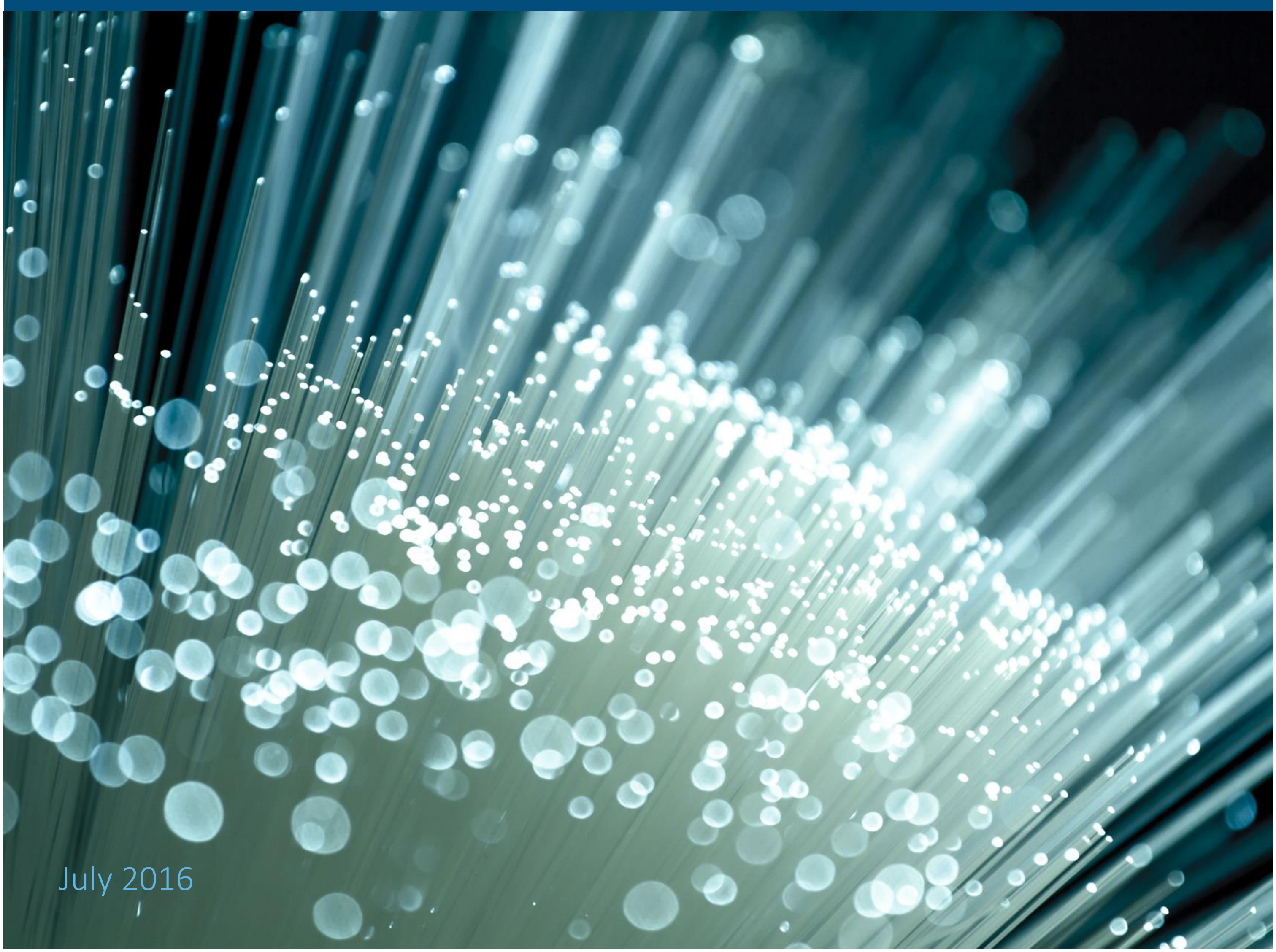
Long Term Care Morbidity Improvement Study

Estimates for the Non-Insured U.S. Elderly Population Based on the National Long Term Care Survey 1984-2004



July 2016

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Estimates for the Non-Insured U.S. Elderly Population Based on the National Long Term Care Survey 1984-2004

SPONSORS
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List of Abbreviations

ADL	Activity of Daily Living
AHEAD	Asset and Health Dynamics Among the Oldest Old Study
ALC	Assisted Living Community
ALF	Assisted Living Facility
ASDR	Age-Standardized Disability Rate
CDR	Crude Disability Rate
CI	Cognitive Impairment
CMS	Centers for Medicare and Medicaid Services
DLE	Disabled Life Expectancy
FFS	Fee for Service
FHS	Framingham Heart Study
HIPAA	Health Insurance Portability and Accountability Act of 1996
HAA	Honolulu Asia Aging Study
HHP	Honolulu Heart Program
HMO	Health Maintenance Organization
HRS	Health and Retirement Study
IADL	Instrumental Activity of Daily Living
ILTCI	Intercompany Long-Term Care Insurance Conference Association, Inc.
LE	Life Expectancy
LOS	Length of Stay
LTC	Long-Term Care
LTCI	Long-Term Care Insurance
MD	Morbidity Decrement
MLE	Maximum Likelihood Estimate
MMSE	Mini-Mental State Exam
NHANES	National Health and Nutrition Examination Survey
NHEFS	NHANES Epidemiologic Follow-up Study
NHIS	National Health Interview Survey
NLTCS	National Long Term Care Survey
NNHS	National Nursing Home Survey
SCI	Severe Cognitive Impairment
SD	Standard Deviation
SE	Standard Error
SI	Survival Increment
SOA	Society of Actuaries
SPMSQ	Short Portable Mental Status Questionnaire

ABSTRACT

Purpose: To estimate sex-specific trends in HIPAA ADL disability between 1984 and 2004 using the National Long Term Care Survey (NLTCS). To estimate age-standardized 20-year changes in ADL and cognitive impairment (CI) among the U.S. elderly using the HIPAA CI trigger. To estimate the joint distribution of cognitive impairment (CI) and ADL disability among aged Medicare enrollees using the HIPAA disability triggers.

Methods: ADL disability was defined as active personal assistance in two or more of six HIPAA ADLs. CI was defined as 3+ SPMSQ errors, caregiver report of Alzheimer's disease/dementia, or similar problems, with concurrent substantial supervision; CI-2 and CI-3 were defined similarly, with SPMSQ cut-points = 4+ and 5+ errors, respectively.

Results: Unisex ADL disability crude prevalence rates (CPRs) declined from 9.2% in 1984 to 8.2% in 2004 (a relative decline of 11.5%; −28.5% age-standardized [t = 9.85]). Sex differences in ADL prevalence rates were large and the rates of decline favored males. ADL CPRs declined for males from 7.3% to 5.8% (−19.8%; −34.8% age-standardized [t = 6.53]) and, for females, from 10.5% to 9.8% (−6.1%; −24.5% age-standardized [t = 7.04]).

Unisex CI CPRs were 9.2% and 6.7% in 1984 and 2004, respectively. Age-standardized relative declines were 42.6% for CI (t = 15.53), 41.6% for CI-2 (t = 13.45), and 40.7% for CI-3 (t = 12.15). Sex differences in CI prevalence rates were large (e.g., in 2004, 4.7% (M) vs. 8.1% (F)), but the relative declines were similar (e.g., 43.9% [M; t = 8.15] vs. 40.9% [F; t = 12.75]).

As of 2004, the unisex prevalence rates were 8.2% for ADL disability, 6.7% for CI, and 10.1% for ADL+CI combined. Sex differences in ADL+CI were large: 7.5% (males) vs. 12.0% (females).

The conditional probabilities of CI for community residents increased from 22% at 1 ADL to 65% at 6 ADLs; for institutional residents, from 50% at 1 ADL to 90% at 6 ADLs; and for both residence types, from 26% at 1 ADL to 78% at 6 ADLs.

Conclusions: ADL and CI disability prevalence rates differed substantially between the sexes in 1984 and 2004. The relative declines in ADLs were substantial for both sexes but larger for males. CI exhibited substantively important, highly statistically significant and similar relative declines for both sexes during the same period. CI and ADLs exhibited complex dependencies by residence type and sex. Actuarial analyses and forecasts that ignore these trends and dependencies may be severely biased.

EXECUTIVE SUMMARY

Actuaries have long recognized that improvements in LTC morbidity combined with declines in mortality rates can have profound consequences for lifetime disability and LTC/LTCI costs. The *LTC Morbidity Improvement Study* was undertaken to evaluate changes over time in morbidity/disability associated with activities of daily living (ADL) and cognitive impairment (CI), and their impact on lifetime morbidity/disability using data for aged Medicare enrollees from the 1984 and 2004 National Long Term Care Survey (NLTCS). The NLTCS has served as the main actuarial resource for information on LTC morbidity/disability and mortality rates among the non-insured general population aged 65 years and older.

The primary findings of the study were the large declines in ADL and CI disability during 1984–2004, both separately and combined, based on the HIPAA ADL and CI triggers; moreover the declines for the CI trigger were substantially larger than for the ADL trigger. These changes are displayed in Figures 1–3 which plot the age-specific prevalence rates for 1984 and 2004 for the ADL and CI triggers separately (Figs. 1 and 2) and combined (Fig. 3).

Figure 1: Percent of U.S. Elderly Population Meeting HIPAA ADL Trigger

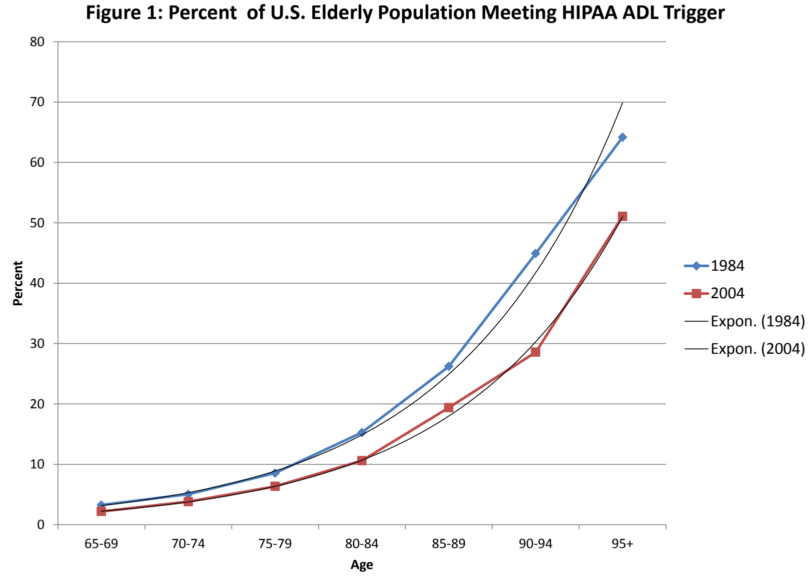
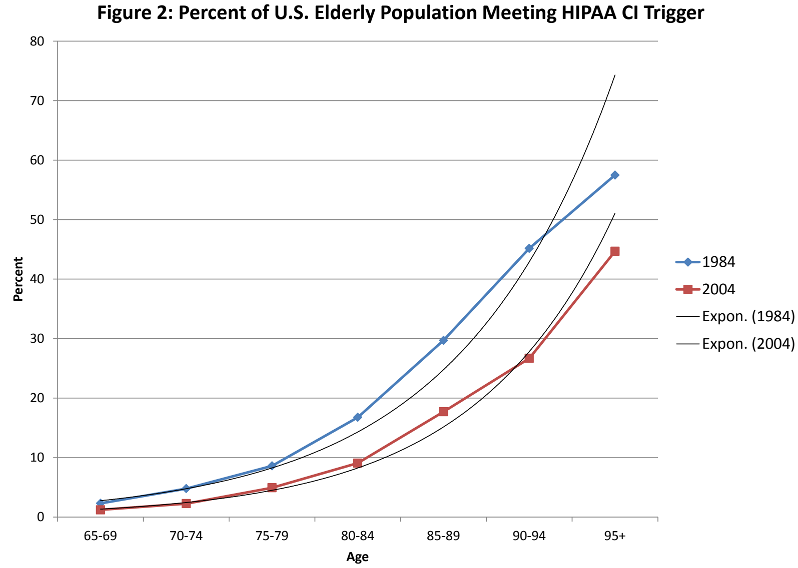
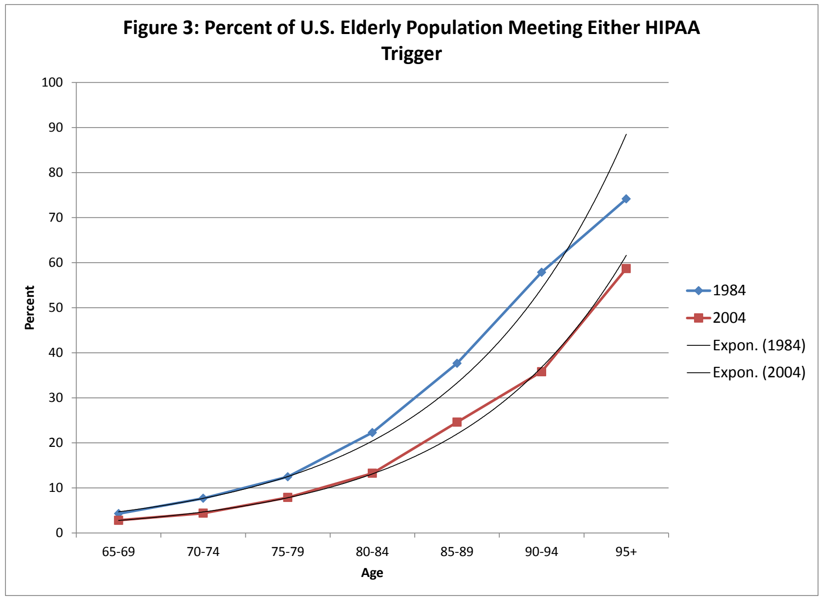


Figure 2: Percent of U.S. Elderly Population Meeting HIPAA CI Trigger



Also shown overlaying each plot is the best-fitting exponential function. These functions show that the age-specific prevalence rates were approximately exponential in form, especially the 2004 rates. The main deviations from the exponentials occurred at the highest age, 95+, where the relative rates of increase slowed down compared to the increases at younger ages.

The prevalence rates were defined as the fraction of each respective population who on any given day in 1984 or 2004 would be deemed to have met the HIPAA ADL and/or CI triggering criteria. Actuarial theory indicates that the prevalence rates are determined by the incidence and continuance rates in effect at the indicated time period but they are conceptually and numerically distinct from the incidence rates. Importantly for our study, the prevalence rates are substantially easier than the incidence rates to estimate from survey data such as the NLTCS and they can be estimated with much greater precision.



The major goal of the study was to conduct estimation of the changes over time in ADL and CI morbidity/disability rates as precisely as possible. The sample sizes were large with 21,399 participants in 1984 and 15,993 in 2004; individual survey participants were differentially weighted to account for differences in the individual probabilities of selection into the NLTCS sample. The sensitivities of the estimates to alternative weighting protocols were also assessed as part of the study.

The source data for Figs. 1–3 are in Tables 1.8, 2.16, and 2.21 (in Main Report), respectively, along with age-specific measures of change, summary measures of disability and change in disability, standard errors of the summary measures, and the associated t-statistics.

The primary measures of change were the reductions in the age-standardized disability rates (ASDRs) based on the 2004 NLTCS weighted unisex population. For the ADL trigger, Table 1.8 shows that the prevalence rate reduction was 3.26%, from 11.42% in 1984 to 8.16% in 2004, a relative decline of 28.5%, and an average annual rate of decline of 1.67% per year. The standard error of the change was 0.33% and the associated t-statistic was 9.85 (absolute value), which was highly statistically significant ($p << 0.001$); the t-statistic was in the range 8.23–16.45, indicating "high precision" of the associated estimate, but the t-statistic was not large enough to meet the more stringent cutpoint of $t > 32.90$ associated with the Longley-Cook standard for "full credibility." The separately estimated disability rates for 1984 and 2004 did meet the Longley-Cook standard.

The commonly used cutpoint of $t > 1.96$ for testing the statistical significance of an estimated change—achieved when the 95%-confidence interval excludes the 0-value—yields change estimates with very low precision when, as often occurs in published studies, the associated t-statistics are in the range 1.96–3.29, or equivalently $0.001 \le p < 0.050$. Moreover, assessing the precision of the estimates requires the t-statistics to be reported, which is often not done.

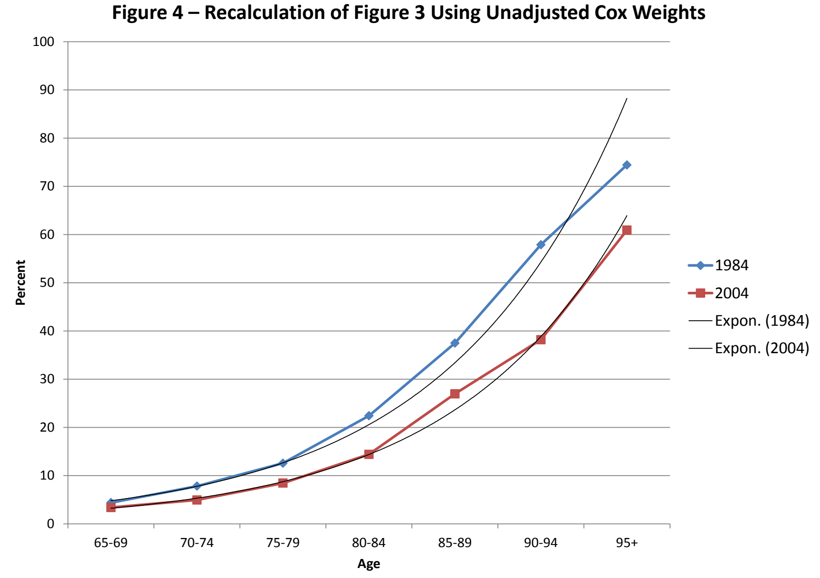
The relative change in the 2004 ASDR provides a reasonable summarization of the relative changes in the age-specific disability rates; an alternative summarization is provided by the relative change in the 1984 ASDR which is only slightly smaller: 28.3% vs. 28.5%. Thus, the ASDR changes are mildly dependent on the choice of the standard population. In contrast, the change in the overall totals without standardization avoids this mild dependency but provides a highly biased estimate of the relative change in the age-specific disability rates: 11.5% vs. 28.5%.

The corresponding calculations for the CI trigger (Table 2.16) showed that the prevalence rate reduction was 4.96% (2004 ASDR), from 11.65% in 1984 to 6.69% in 2004, a relative decline of 42.6%, and an average annual rate of decline of 2.74% per year. The standard error of the change was 0.32% and the associated *t*-statistic was 15.53, which was also highly statistically significant ($p << 0.001$); the *t*-statistic indicated that the associated estimate also had high precision.

The corresponding calculations for the combined ADL and CI triggers (Table 2.21) showed that the prevalence rate reduction was 5.94% (2004 ASDR), from 16.03% in 1984 to 10.09% in 2004, a relative decline of 37.1%, and an average annual rate of decline of 2.29% per year. The standard error of the change was 0.37% and the associated *t*-statistic was 16.27, which was also highly statistically significant ($p << 0.001$); the *t*-statistic indicated that the associated estimate also had high precision.

The sensitivities of the estimates to three alternative weighting protocols are shown in Figures 4–5. The first protocol (Duke/PNAS Weights) was the protocol used in generating Figures 1–3; this protocol was developed at Duke University by Kenneth Manton, the principal investigator of the NLTCS. The second (Unadjusted Cox Weights; Fig. 4) was generated using an alternative set of weights developed at Battelle, Inc., by Brenda Cox and colleagues. The third (Adjusted Cox Weights; Fig. 5) reflects our reconciliation of differences between the first and second protocols. The plots show that the use of the Cox weights primarily impacted the 2004 disability rates, modestly reducing the rate of morbidity improvement.

Figure 4 – Recalculation of Figure 3 Using Unadjusted Cox Weights



The differences between the three weighting protocols are shown Table 3.10. The annual rate of decline of 2.29% under the Duke/PNAS weights declined to 2.01% under the adjusted Cox weights and 1.88% under the unadjusted Cox weights. The associated *t*-statistic of 16.27 under the Duke/PNAS weights declined to 14.54 under the adjusted Cox weights and 13.71 under the unadjusted Cox weights. All three weighting protocols indicated that the rates of decline were highly statistically significant and the rate estimates had high statistical precision.

The t-statistics (in the rightmost two columns of Table 3.10) indicated that the adjusted Cox estimate was just outside the 95%-confidence interval for the Duke/PNAS (t = 1.97 vs. the 1.96 cutpoint) whereas the unadjusted Cox estimate was substantially further away (t = 2.88). Thus, the sensitivity analysis answered the question of whether the estimated large declines in ADL and CI disability during 1984–2004 were robust with respect to reasonable alternative survey weighting protocols: they were. The sensitivity analysis also showed that the adjusted Cox protocol produced estimates near to or within the 95%-confidence intervals for the corresponding Duke/PNAS estimates, indicating that our reconciliation of the differences between the Duke/PNAS and the Cox protocols was successful.

Figure 5 – Recalculation of Figure 3 Using Adjusted Cox Weights

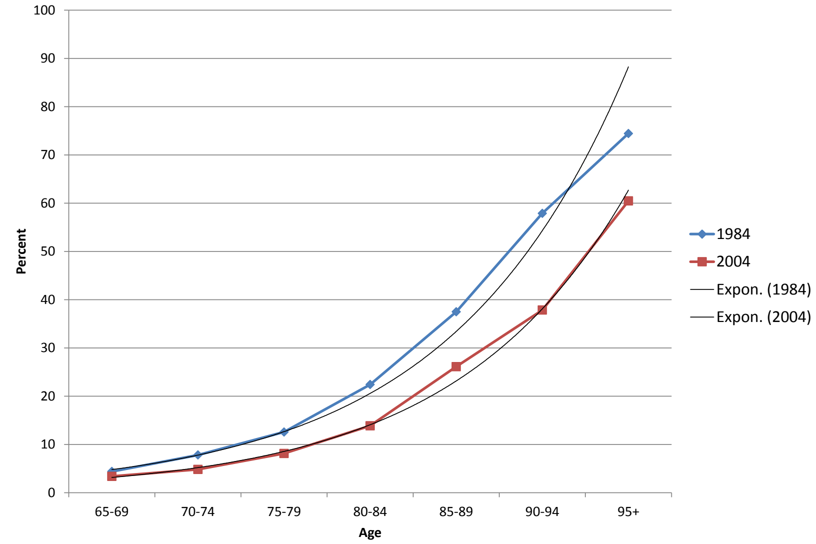


Table 1 displays the expected lifetime years of disability, their changes, and the component survival increments and morbidity decrements, for the combined HIPAA ADL and CI triggers under the three alternative weighting protocols shown in Figs. 3–5.

Table 1
Alternative Estimates of Change in Unisex HIPAA ADL/CI Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
Weighting Protocol	1984	2004	Survival Increment	Morbidity Decrement	Net Change
Duke/PNAS Weight	2.50	1.81	**0.35**	**1.05**	**-0.70**
Unadjusted Cox Weight	2.52	1.97	**0.36**	**0.90**	**-0.55**
Adjusted Cox Weight	2.52	1.92	**0.36**	**0.95**	**-0.59**
Life Expectancy	16.64	18.11	1.48	–	1.48

Source: Authors' calculations based on the 1984 and 2004 NLTCS; see Tables 2.27, 3.11, and 3.12 in Main Report.

We use the term *survival increment* to represent the increased lifetime disability that would occur due solely to reductions in mortality under the assumption that age-specific morbidity rates remained constant. Similarly, we use the term *morbidity decrement* to represent the reduction in lifetime disability that would occur due solely to reductions in morbidity under the assumption that the age-specific mortality rates remained constant. In each case the morbidity decrements far exceeded the corresponding survival increments. The *t*-statistics for the morbidity decrements were 16.25, 13.67, and 14.48, respectively, indicating that the estimated morbidity decrements were statistically highly significant and had high precision. The *t*-statistics for the net changes were 11.53, 8.83, and 9.68, respectively, also indicating that the estimated net changes were statistically highly significant and had high precision.

The evidence supporting the morbidity compression hypothesis was very strong, using the HIPAA ADL and CI triggering criteria to define morbidity. Moreover, the effect sizes were large and the alternative estimates had high statistical precision—the relative reduction in expected lifetime years of disability was in the range 22–28%, and 24–28% with the unadjusted Cox estimate eliminated.

The relative declines in ADLs were substantial for both sexes but larger for males. CI exhibited substantively important, highly statistically significant and similar relative declines for both sexes. CI and ADLs exhibited complex dependencies by residence type and sex. Actuarial analyses and forecasts that ignore these trends and dependencies may be severely biased.

Among the outstanding questions that are raised by our results are the following:

- What are the implications of the finding that the CI relative declines were faster than the ADL relative declines? Given that CI may precede ADL disability some part of the ADL decline must be attributable to the CI decline. Given that CI can generate long disability episodes, how can their interactions best be understood?
- What are the implications of the finding that the ADL improvement rates for females were slower than for males? Does this indicate that the common practice of unisex pricing for LTC insurance must be abandoned?
- What are the implications of the fact that the proportion of the elderly with LTC insurance coverage is close to 10% of the total population? Do the policyholders form a special subgroup whose disability dynamics differ substantially from the general population results in our study? If so how do their dynamics differ?

The last question motivated our final task of assessing the feasibility of simulating the impact of alternative underwriting protocols using the data and insights gained from the analyses described above. Our assessment concluded that such simulations could not be done successfully using the NLTCS data alone—primarily due to design limitations in the early waves of the survey. However, the simulations could be done using other publicly available data, possibly in conjunction with the NLTCS, and we describe how this could be done. An important limitation in such applications will be the relatively small sample sizes that result once a given set of underwriting protocols is imposed on the sample. We describe how proportional hazards and logistic regression procedures can be used to mitigate the effects of this limitation.

INTRODUCTION

Improvement in LTC morbidity in combination with declining mortality rates can have profound consequences for lifetime disability and LTC/LTCI costs. The LTC Morbidity Improvement Study was designed to evaluate changes over time in activities of daily living (ADL) and cognitive impairment (CI) morbidity rates, and their impact on lifetime disability. This report describes the study and presents the results.

Specific Aims

1. Precise estimation of changes over time in ADL morbidity rates (using a simulated HIPAA ADL trigger) and the impact of those changes on lifetime disability.
2. Replicate Aim 1 for changes over time in CI morbidity rates (using a simulated HIPAA CI trigger).
3. Assess the sensitivity to alternative sets of survey weights.
4. Assess the feasibility of simulating the impact of alternative underwriting protocols.

Aim 1

The primary focus was on the changes over time in the ADL morbidity rates and the impact of those changes on lifetime disability. The HIPAA ADL trigger was modeled using a threshold of two of six ADL impairments. The HIPAA ADL morbidity rates and lifetime disability values were calculated for the combined community and institutional populations aged 65 years and older for 1984 and 2004, with the changes in the morbidity rates and lifetime disability values based on the differences between their values in 1984 and 2004. Supplemental calculations were generated for 1982, 1984, 1989, 1994, 1999, and 2004 using the traditional NLTCS ADL triggers, which include ADL impairments that could have been resolved through the use of special equipment (Manton et al., 2006).

Aim 2

The secondary focus was on the changes over time in the CI morbidity rates and the impact of those changes on lifetime disability. Results from the 2004 NLTCS indicated that the HIPAA CI trigger accounted for an additional 23.6% morbidity beyond that attributable to the HIPAA ADL trigger. This task required comparable tables for the 1984 NLTCS which were estimated using logistic regression models to impute missing CI status for severely disabled institutional residents. The logistic regression models were developed from the 2004 NLTCS using comparable data where CI status was observed.

Aim 3

The tertiary focus was on the impact of different sets of survey weights. Sensitivities to these weights were evaluated as part of this aim. The differences between the PNAS weights (Manton et al., 2006) and the alternative Cox weights (Cox and Wolters, 2008) were known to be substantial. The analysis assessed the impact of the Cox weights, and related alternatives, on the results of Aims 1 and 2. Differences between the PNAS and Cox weighting protocols were attributable to differences in their treatments of respondents who were nondisabled at the time of the NLTCS screener interviews in 1984 vs. 2004. A proposed adjustment to the Cox weighting protocol resolved most of the differences, supporting the results of Aims 1 and 2 and providing a reasonable alternative to the PNAS weighting protocol. The unadjusted Cox weighting protocol yielded biased estimates; use of the Cox weights without the adjustment was not recommended.

Aim 4

The fourth aim was to assess the feasibility of simulating the impact of alternative underwriting protocols using the data and insights gained from the analyses conducted in the first three aims. The availability of just a limited set of variables on which to stratify the general population meant that the results of such analyses could only be indicative of, but not definitive for, the insured population due to the additional selection criteria used to define that subpopulation. Our assessment concluded that such simulations could not be done successfully using the NLTCS data alone—primarily due to design limitations in the early waves of the survey. However, the simulations could be done using other publicly available data, possibly in conjunction with the NLTCS, and we describe how this could be done.

Overview

This section has ten parts. *First*, we motivate our use of the NLTCS and provide a summary description of this survey. *Second*, we describe the HIPAA ADL and CI triggers. *Third*, we show how the NLTCS can be used to simulate the two HIPAA triggers. *Fourth*, we note the linkage of the NLTCS to the Medicare data files. *Fifth*, we present statistics and formulas for the NLTCS survey weights. *Sixth*, we present formulas for age-standardized disability rates. *Seventh*, we present formulas for life expectancy. *Eighth*, we present formulas for disabled life expectancy. *Ninth*, we present the logistic regression model. *Tenth*, we discuss use of *t*-tests and confidence intervals in evaluating the precision of our estimates of morbidity improvement.

1. NATIONAL LONG TERM CARE SURVEY (NLTCS)

The National Long Term Care Survey (NLTCS) was selected as the primary data source for this project due to its high quality, extensive temporal range, relevance to the aims, and ready availability.

Quality: The NLTCS is the best source of data for national disability trends among persons aged 65 years and older (Freedman et al., 2002). The National Health Interview Survey (NHIS), in combination with the National Nursing Home Survey (NNHS), was the only other data source rated close in quality.

Temporal Range: The NLTCS was fielded in 1982, 1984, 1989, 1994, 1999, and 2004, using comparable instrumentation in all years. Comparable instrumentation was a key requirement for assessing morbidity improvement. Limitations of the 1982 sampling design with respect to institutionalized respondents, however, necessitated that our analysis of the changes in the morbidity rates and lifetime disability values should begin with the 1984 NLTCS.

Relevance: The NLTCS facilitates simulation of HIPAA ADL and CI triggers in a peer-reviewed form accepted for use by LTCI actuaries; e.g., see Stallard and Yee's (2000) report on the SOA LTCI Section website.[1]

Data Availability: A public use version of the NLTCS is available free of charge to users who certify that they will comply with the terms of the NLTCS Data Use Agreement.[2] Users who comply with a somewhat more stringent set of terms can obtain copies of linked Medicare data from the Centers for Medicare and Medicaid Services (CMS).[3]

NLTCS Summary Description

The NLTCS was designed to measure disability and use of LTC among the non-insured U.S. elderly (age 65+) population[4] at multiple points in time from 1982 to 2004. The cumulative sample size (*n*) over all six survey years (waves) was 49,258 distinct persons.

The six survey years were 1982, 1984, 1989, 1994, 1999, and 2004. Each wave consisted of a telephone screener interview followed by an in-person detailed interview for those respondents who met various disability screening criteria (designated as "screen-ins"). In-person screening visits were also conducted for those respondents who could not be contacted by telephone, followed by detailed interviews for those who screened-in. The number of persons who completed the screener interviews defined the cross-sectional sample size for each survey year.

Each survey year, the cross-sectional sample size was in the range 16,000–21,000, with approximately 6,000–7,500 detailed in-person interviews for persons who met various disability screening criteria. Detailed interviews were conducted for both community and institutional residents at all survey years except for 1982, when the fact of institutionalization was noted without further information being collected. The institutional detailed interview was a shortened, modified form of the community detailed interview with sample sizes in the range 970–1,770 for the period 1984–2004.

Disability included basic and instrumental ADL (abbreviated as ADL and IADL, respectively) impairments whose duration had lasted or was expected to last 3+ months, cognitive impairment (CI), and institutionalization in a nursing home or similar LTC facility. During the later waves of the NLTCS, the options for residing in an assisted living community (ALC) expanded substantially. Approximately half of the ALC residents in 2004 were classified as institutionalized in a nursing home or similar health-care facility using the standard temporally-consistent NLTCS protocol for making this determination.

2. Health Insurance Portability and Accountability Act (HIPAA)

[1] http://www.soa.org/research/experience-study/ltc/ltc-home-community.aspx
[2] http://www.icpsr.umich.edu/icpsrweb/NACDA/studies/9681?classification=CD-ROM.I.*&archive=NACDA
[3] http://www.nltcs.aas.duke.edu/availabledata.htm
[4] We use the term "non-insured" to refer to the general population without regard to their insurance status; when insurance status is at issue, we will use the terms "insured" and "uninsured".

The Health Insurance Portability and Accountability Act of 1996 (Public Law 104–191) (HIPAA) established requirements for qualified LTC insurance contracts and issuers of those contracts; and for qualified LTC services and the chronically disabled recipients of those services (Internal Revenue Service, 1997).

HIPAA ADL Trigger

The HIPAA ADL trigger required that a "chronically ill individual"[5] be unable to perform without "substantial assistance" (hands-on or standby) from another individual at least two out of six ADLs:

bathing,	continence,
dressing,	eating,
toileting,	transferring,

for at least 90 days due to a loss of functional capacity.

HIPAA CI Trigger

The HIPAA CI trigger required that a chronically ill individual needs "substantial supervision" (i.e., continual oversight) to protect him/herself from threats to health and safety due to "severe cognitive impairment," defined as:[6]

> A loss or deterioration in intellectual capacity that is (a) comparable to (and includes) Alzheimer's disease and similar forms of irreversible dementia, and (b) measured by clinical evidence and standardized tests that reliably measure impairment in the individual's
> (i) short-term or long-term memory,
> (ii) orientation as to people, places, or time, and
> (iii) deductive or abstract reasoning.

3. Using the NLTCS to Simulate the HIPAA ADL and CI Triggers

NLTCS ADL Assessment

The NLTCS assessed the performance status for each non-institutionalized individual during the screener interview and for all individuals regardless of institutional status during the detailed interview for seven ADLs:

bathing,	continence,

[5] HIPAA uses the term "chronically ill individual" rather than "chronically disabled individual." See <http://www.law.cornell.edu/uscode/search/display.html?terms=7702B&url=/uscode/html/uscode26/usc_sec_26_00007702---B000-.html>. We use the terms interchangeably throughout this report.

[6] http://www.unclefed.com/Tax-Bulls/1997/Not97-31.pdf

dressing,
eating,
toileting,
transferring,
inside mobility,

of which only the latter (inside mobility) was not included in the HIPAA ADL trigger.

The NLTCS assessment on the detailed interview allowed each screened-in individual to be rated on each ADL according to the following *impairment hierarchy*:

0. Performs ADL
1. Needs, but does not receive, help with ADL
2. Performs ADL with special equipment
3. Standby help with/without special equipment
4. Active help with/without special equipment
5. Unable to perform ADL.

Following Stallard and Yee (2000), we assumed that two or more ADLs at levels 3–5 were required to meet the simulated HIPAA ADL trigger. This was substantially stricter than the traditional NLTCS triggers which counted the ADLs at levels 2–5 as disabled, thereby including ADL impairments that could have been resolved through the use of special equipment.

NLTCS Cognitive Assessment

Cognitive impairment can be assessed in the NLTCS using either the Short Portable Mental Status Questionnaire (SPMSQ; Pfeiffer, 1975), with the cut-points for the HIPAA Severe Cognitive Impairment Criterion based on a choice of 3+, 4+, or 5+ errors out of 10 questions; or a caregiver report of Alzheimer's disease, dementia, or other cognition problems sufficient to prevent completion of the SPMSQ with a passing score of 0–2, 0–3, or 0–4 errors.

The 1999 NLTCS replaced the SPMSQ with the Mini-Mental State Exam (MMSE; Folstein et al., 1975), for which roughly comparable cut-points were <23, <20, or <17 correct out of 30 questions, equivalent to a passing score of 0–7, 0–10, and 0–13 errors, respectively (Lee et al., 1998).

The SPMSQ cut-points span the range of generally accepted values; the mapping to the MMSE was specifically designed for use in comparing Alzheimer's disease patients having one or the other but not both tests.

The MMSE was validated against the DSM-III-R clinical diagnosis of dementia by Baldereschi et al. (1993) who found that the cut-point at MMSE <24 correct had a sensitivity of 95% and a specificity of 90%.[7] All of our cut-points fall in a range just below Baldereschi's recommended cut-point, indicating that our classifications of respondents as cognitively impaired will be similar to or more conservative than (i.e., trading lower sensitivity for increased specificity) Baldereschi's classification, depending on the specific cut-points used.

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[7] The *sensitivity* of a diagnostic test is the conditional probability of a positive test result given that the person actually has the condition; the *specificity* of a diagnostic test is the conditional probability of a negative test result given that the person actually does not have the condition. The higher these values, the better the test.

It is informative to relate our cut-points to data on dementia staging.

Petersen et al. (1999, unnumbered Table) reported that the average MMSE correct score for patients diagnosed with *mild* Alzheimer's disease was 21.4 ± 0.4 SD (standard deviation), compared to averages of 22.6 ± 0.5 SD for *very mild* Alzheimer's disease and 26.0 ± 0.3 SD for *mild* cognitive impairment (MCI).

With respect to *very mild* Alzheimer's disease, Morris et al. (2001, Table 1) reported an average MMSE correct score of 23.7 ± 2.7 SD, 1.1 points higher than Petersen et al. (1999). Both studies support the MMSE cut-point of <23 cited above as the largest of our 3 selected values, implying that *very mild* Alzheimer's disease and *mild* cognitive impairment would generally be excluded by our cut-points, whereas *mild* Alzheimer's disease may or may not be excluded depending on the selected cut-point.

Hughes et al. (1982, Table II) reported average SPMSQ error scores of 1.8 ± 1.7 SD and 5.7 ± 2.2 SD, respectively, for *very mild* vs. *mild* Alzheimer's disease, supporting the SPMSQ cut-point range of 3–5 errors and the mapping of these cut-points to 8–14 MMSE errors.

Farlow (2005a,b) reported that Alzheimer's disease patients at moderate to severe stages of progression have MMSE scores in the range 5–17 correct. Gill et al. (1995) reported that patients at mild to moderate stages of progression have MMSE scores in the range 16–23 correct. Feldman and Woodward (2005) cited a broader range of 10–26 correct MMSE scores for mild to moderate Alzheimer's disease, with the boundary between moderate and mild between 16 and 17 correct. These results imply that patients with mild Alzheimer's disease could have MMSE scores in the range 17–26 or 18–23 correct. In both cases, our cut-points at <23 and <20 progressively exclude mild Alzheimer's disease; the <17 cut-point extends those exclusions to all mild, and possibly some moderate, cases of Alzheimer's disease.

Hence:

- Patients with *mild* Alzheimer's disease could meet the simulated HIPAA criteria for *severe* cognitive impairment, which specifically mentions Alzheimer's disease without excluding mild cases, when using our cut-points.
- Patients with *mild* cognitive impairment and *very mild* Alzheimer's disease are unlikely to meet the simulated HIPAA criteria when using our cut-points.

Two additional comments appear relevant: (1) It is almost tautological to assert that *mild* cognitive impairment is not the same as *severe* cognitive impairment. (2) *Very mild* Alzheimer's disease is a stage that was classified as *questionable* dementia by Hughes et al. (1982) in their original paper on the topic, allowing for all other stages of dementia to be treated as severe cognitive impairment.

Cases of mild Alzheimer's disease or other forms of mild dementia that did not meet the HIPAA substantial supervision criterion could be excluded from our simulated CI triggers, depending on how one interpreted that criterion.

NLTCS IADLs

We used the NLTCS IADLs to assess the functioning of screened-in individuals who exhibited lower levels of disability and to supplement the cognitive information in our simulated HIPAA CI triggers. The temporal trends in IADLs correlated well with the temporal trends in ADLs and CI, consistent with reports that IADL impairments tend to occur earlier in the disablement process (Manton et al., 1998; LaPlante, 2010).

The NLTCS assessed the performance status for each non-institutionalized individual during the screener interview and again during the detailed interview for nine IADLs:

1. Doing laundry
2. Doing light housework
3. Getting around outdoors
4. Going places outside of walking distances
5. Making telephone calls
6. Managing money
7. Preparing meals
8. Shopping for groceries
9. Taking medications.

Barberger-Gateau et al. (1992) found that four of the nine IADLs (i.e., #4, 5, 6, and 9 above) could be used as a CI/dementia screening tool for elderly community residents, possibly replacing rather than just supplementing the CI information. These authors reported diagnostic sensitivities of 0.62, 0.67, 0.88, and 0.94, respectively, for mild, moderate, and severe CI (defined as MMSE <24, <22, and <18 correct) and dementia (based on NINCDS-ADRDA criteria for clinical diagnosis); with corresponding specificities of 0.80, 0.76, 0.73, and 0.71. Subsequent papers by the same authors (Barberger-Gateau et al., 1993 and 1999) reported that IADL impairments were predictive of subsequent diagnoses of dementia for 1–3 years, but not 5 years, after assessment; e.g., the relative risks of incident dementia one year after assessment increased from 11:1 for one IADL impairment to 318:1 for four IADL impairments. The findings of strong IADL-dementia relationships were independently replicated by De Lepeleire et al. (2004) who reported a diagnostic sensitivity of 0.81 with specificity of 0.48 compared with the MMSE (but without reporting the associated cut-point).

These findings were important for our purpose because the NLTCS screening protocols tested for IADL impairment but not for cognitive impairment. To the extent that cognitively impaired community residents were identifiable through their IADL impairments, the NLTCS screening criteria would have correctly designated these persons to receive the detailed interview, at which point they would have received the cognitive assessment protocols described below.

Barberger-Gateau's and De Lepeleire's *sensitivity* values indicated that the loss to the sample of severely cognitively impaired (at a level comparable to Alzheimer's disease) individuals would have been small. Thus, the risk of erroneous exclusion (i.e., screen-out) would have been limited to severely cognitively impaired persons who had no impairments on the four IADLs identified by Barberger-Gateau, and no impairments on the remaining five of nine IADLs and seven ADLs queried on the NLTCS screener. Such persons were highly unlikely to be in need of substantial supervision to protect themselves from threats to health and safety due to severe cognitive impairment, as required by HIPAA.

Barberger-Gateau's and De Lepeleire's *specificity* values were lower, but these were not relevant because the consequence of erroneous inclusion (i.e., screen-in), compared to the counterfactual that we were actually screening for cognitive impairment, not IADL impairment, would be that some number of additional non-cognitively impaired individuals would screen-in for the detailed interview. Once these individuals received the cognitive assessment on the detailed interview, our "error" would be recognized and could then be corrected.

Although neither HIPAA trigger directly mentions IADLs, they can be used to simulate the substantial supervision component of the CI trigger, a use which is important to us because substantial supervision was not queried in the NLTCS cognitive assessments. Moreover, as described below, we used the IADLs only to *supplement*, not to replace, the CI information on the detailed interview, implying that the loss to the sample of individuals meeting the substantial supervision component of the HIPAA CI trigger also would have been small, given the close relationship between IADL impairment and cognitive impairment. Some risk of erroneous classification could remain if the IADL help were not sufficiently "substantial" to meet the HIPAA criteria.

Following Stallard (2011a), we assumed that the HIPAA substantial supervision criterion was met by NLTCS respondents with severe cognitive impairment who simultaneously met:

1. The NLTCS criteria for any ADL or IADL disability at the screener interview (which then qualified them for the detailed interview); or
2. The NLTCS criteria for IADL disability or inside mobility impairment at the detailed interview; or
3. The simulated HIPAA criteria for at least one ADL disability at the detailed interview.

Thus, our simulated HIPAA CI trigger was restricted to respondents who met:

1. The NLTCS criteria for severe cognitive impairment; and
2. The NLTCS criteria for substantial supervision.

The design of the NLTCS presented two other analytic challenges in implementing the simulated HIPAA CI trigger across the multiple waves:

1. The NLTCS screener component of the substantial supervision criteria was fully known for the 1982 and 2004 surveys but was missing information for the other years.
2. The NLTCS institutional component of the caregiver report for non-completion of the SPMSQ or MMSE was fully known for the 1999 and 2004 surveys but was missing information for the other years.

We developed solutions to these challenges under Aim 2 of the project; the logistic regression model used for this purpose is described below in Subsection 9.

4. NLTCS Linked Medicare Data

Linkage to Medicare enrollment, billing/diagnosis, and vital statistics data was accomplished for all 49,258 sampled persons in the NLTCS. Such data can be used to provide precise dates-of-onset of new medical conditions, to facilitate studies of changes in medical expenditures before and after the onset of major medical conditions, and to determine the precise dates of death for persons with specified characteristics.

5. NLTCS Survey Weights

Survey weights were employed for tabulation of responses as described in Manton et al. (2006). Standard errors (SEs) of weighted estimators of binomial proportions were based on rescaled survey weights using procedures developed by Potthoff et al. (1992) which yielded a single rescaling factor, c_s (described below), for each of the 1984 and 2004 NLTCS as follows: $c_{s,1984} = (1486.0754)^{-1}$ and $c_{s,2004} = (2690.6239)^{-1}$.

The estimated overall survey design effects (also described below) were 1.13 in the 1984 NLTCS and 1.19 in the 2004 NLTCS, implying, after inverting the design effects, losses in effective sample sizes of 11.5% and 16.0%, respectively, compared to a simple random sampling design with the same sample sizes, but with equal weights (Kish, 1965, p. 259).

The following material provides a self-contained summary of the mathematics associated with survey weights.

Basic Definitions

Let

r_i = probability that person i is one of n persons selected for a survey in a population (P) of size N;

$W_i = 1/r_i$, the inverse of the probability that person i is one of n persons selected for the survey.

Hence W_i is the "survey weight" for person i and r_i is the probability of selection. For example, the 1984 and 2004 NLTCS averages of r_i were:

$$E_{1984}(r_i) = 21{,}399 / 28{,}034{,}914 = 0.000763298$$

$$E_{2004}(r_i) = 15{,}993 / 36{,}245{,}325 = 0.000441243.$$

Supplementary Definitions

Let

p_i = probability that a randomly selected person in the population is, in fact, person i

= $1/N$,

by convention, under the assumption of equally likely selection probabilities, which obviously satisfies the condition

$$\sum_{i \in P} p_i = 1.$$

Let

$s \in S$ denote one of many possible distinct samples;

p_s = probability that a randomly chosen sample is, in fact, s.

The probabilities do not have to be equal but they must satisfy the condition

$$\sum_{s \in S} p_s = 1.$$

Basic Relationships

By connecting the above definitions, one can establish that the *a priori* probability, that person i is a member of s, is the sum of p_s over all samples containing person i. Hence,

$$r_i = \sum_{s':\, i \in s'} p_{s'}$$

and

$$W_i = 1 / \sum_{s':\, i \in s'} p_{s'}.$$

By solving for the sum of the survey weights in s, one obtains the following sequence of results:

$$\begin{aligned}
\sum_{i \in s} W_i &= \sum_{i \in s} 1 / \sum_{s':\, i \in s'} p_{s'} \\
&= \sum_{i \in s} \left(1 / \sum_{s':\, i \in s'} p_{s'} \right) \times \left(p_s / p_s \right) && \text{(multiplying by 1)} \\
&= \sum_{i \in s} p_{s|i} / p_s, && \text{(where } p_{s|i} = \text{ cond. prob. of } s \text{ given } i\text{)} \\
&= \sum_{i \in s} p_{i|s} / p_i && \text{(where } p_{i|s} = \text{ cond. prob. of } i \text{ given } s\text{)} \\
&= 1/(1/N) && \text{(since } p_i = 1/N\text{)} \\
&= N,
\end{aligned}$$

where N is the size of the surveyed population, P. Hence, the sum of the survey weights is exactly equal to the size of the surveyed population.

Survey-Weighted Estimates of Mean Values

Consider the unweighted average $\bar{X}$ of the variate X_i associated with person i in the population P, defined as:

$$\bar{X} = \sum_{i \in P} X_i \,/\, N.$$

Define the survey-weighted average $\bar{X}_s$ of the variate X_i associated with person i in sample s, as:

$$\begin{aligned} \bar{X}_s &= \sum_{i \in s} W_i \times X_i / \sum_{i \in s} W_i \\ &= \sum_{i \in s} p_{i|s} \times X_i. \end{aligned}$$

The expected value of $\bar{X}_s$ is $\bar{X}$, as seen in the following sequence of results:

$$\begin{aligned} \mathrm{E}(\bar{X}_s) &= \sum_{s \in S} p_s \times \sum_{i \in s} p_{i|s} \times X_i \\ &= \sum_{i \in P} p_i \times \sum_{s:\, i \in s} p_{s|i} \times X_i \\ &= \sum_{i \in P} p_i \times X_i \\ &= \sum_{i \in P} X_i \,/\, N \\ &= \bar{X}, \end{aligned}$$

which proves that $\bar{X}_s$ is an unbiased estimator of $\bar{X}$.

Rescaling of Survey Weights

Multiplication of the survey weights by an arbitrary constant, c_s, leaves $\bar{X}_s$ unaltered:

$$
\begin{aligned}
\bar{X}_s &= \sum_{i \in s} W_i \times X_i / \sum_{i \in s} W_i \\
&= \sum_{i \in s} c_s \times W_i \times X_i / \sum_{i \in s} c_s \times W_i \\
&= \sum_{i \in s} w_{is} \times X_i / \sum_{i \in s} w_{is}.
\end{aligned}
$$

Two common assumptions are:

1. $c_s = 1$, for which: $\sum_{i \in s} w_{is} = N$

and

2. $c_s = n / N$, for which: $\sum_{i \in s} w_{is} = n.$

Potthoff et al. (1992) provided a superior alternative assumption:

$$
\begin{aligned}
c_s &= \sum_{i \in s} W_i \; / \sum_{i \in s} W_i^2 \\
&= N / \sum_{i \in s} W_i^2.
\end{aligned}
$$

Potthoff's alternative assumption implies the following re-weighting formula:

$$
\begin{aligned}
w_{is} &= W_i \times c_s \\
&= W_i \times \sum_{i' \in s} W_{i'} / \sum_{i' \in s} W_{i'}^2.
\end{aligned}
$$

Effective Sample Size

Define the "equivalent" or "effective" sample size $\hat{n}_s$ as the sum of the rescaled survey weights. For the Potthoff rescaling, we obtain:

$$\begin{aligned}
\hat{n}_s &= \sum_{i\in s} w_{is} = \sum_{i\in s} w_{is}^2 && (\text{since } w_{is} = W_i \times c_s) \\
&= n \times \bar{w}_s && (\text{using } \bar{w}_s = \sum_{i\in s} w_{is} / n) \\
&= n \times \bar{w}_s^2 + \sum_{i\in s} (w_{is} - \bar{w}_s)^2 \\
&= n \times \left(1 - \sum_{i\in s} (w_{is} - \bar{w}_s)^2 / \sum_{i\in s} w_{is}^2 \right) \\
&\le n,
\end{aligned}$$

with equality only when the survey weights, W_i *or* w_{is}, are equal for all i in sample s.

Potthoff et al. (1992) demonstrated the superiority of $\hat{n}_s$ over n as the "sample size" parameter for a statistically homogeneous population with independent observations. Assuming that the dichotomous variate X_i is coded 0 or 1, an unbiased survey-weighted estimator of the associated Bernoulli probability parameter, q_s, is given by:

$$\hat{q}_s = \sum_{i\in s} w_{is} \times X_i / \hat{n}_s \ ;$$

with an unbiased estimator of the variance of the estimator given by:

$$\text{var}(\hat{q}_s) = \hat{q}_s \times (1 - \hat{q}_s) / (\hat{n}_s - 1).$$

Design Effect

The ratio $n / \hat{n}_s$ is called the "design effect." It approximates the relative increase in the variance attributable to differentials in the sampling probabilities, r_i.

The use of n in variance formulas for survey-weighted estimators yields downwardly biased standard errors. The use of N in such formulas has no justification.

6. Age-Standardized Disability Rate

We define the age-standardized disability rate (ASDR) in year y as a function of the age-specific disability prevalence rates applied to some arbitrary standard vector of age-specific population counts, for ages 65 years and above, as follows:

$$\text{ASDR}_y(\{N_x\}) = \sum_{x=65}^{\omega} N_x \cdot \pi_{x,y} \Big/ \sum_{x=65}^{\omega} N_x$$

where

$N_x =$ Standard (mid-year) population at age x

and

$\pi_{x,y} =$ Disability prevalence rate at age x in year y.

Age standardization is used by demographers to make cross-temporal comparisons; temporal differences in the population age structure are controlled by using a constant age structure in all comparisons. Under the assumption that the standard population is known, the variance of the age-standardized disability rate is

$$\text{var}\left(\text{ASDR}_y(\{N_x\})\right) = \sum_{x=65}^{\omega} (N_x)^2 \cdot \text{var}(\pi_{x,y}) \Big/ \left(\sum_{x=65}^{\omega} N_x \right)^2,$$

where $\text{var}(\pi_{x,y})$ can be estimated using Potthoff's formula shown above.

Given our interest in comparing ASDRs between 1984 and 2004, we presented most results using two alternative standard populations: one ($\{N_{x,1984}\}$) corresponds to the population associated with the 1984 age-specific rates; the other ($\{N_{x,2004}\}$) corresponds to the population associated with the 2004 age-specific rates.

For simplicity, we refer to the first set, $\text{ASDR}_y(\{N_{x,1984}\})$, $y = 1984, 2004$, as the 1984 ASDRs; and to the second set, $\text{ASDR}_y(\{N_{x,2004}\})$, $y = 1984, 2004$, as the 2004 ASDRs.

$\text{ASDR}_{1984}(\{N_{x,1984}\})$ was defined to exactly match the 1984 unstandardized total (termed *crude*) disability rate (CDR_{1984}). Likewise, $\text{ASDR}_{2004}(\{N_{x,2004}\})$ was defined to exactly match CDR_{2004}. These conditions are illustrated in Table 1.8 under the heading "1984" where the 1984 ASDR exactly matched the 1984 Total and under the heading "2004" where the 2004 ASDR exactly matched the 2004 Total.

With these conventions, the relative changes in the 1984 and 2004 ASDRs were generally very close and exhibited little sensitivity to the choice of standard population.

7. Life Expectancy

We define the life expectancy (LE) at age x in year y as follows:

$$e_{x,y} = \int_0^\infty {}_t p_{x,y} \; dt$$

where

$${}_t p_{x,y} = l_{x+t,y} / l_{x,y}$$

and

$l_{x+t,y} =$ probability of survival from birth to age $x+t$ in year y.

The life expectancy value provides a summarization of the age-specific mortality probabilities in a given population at a given time which does not require the selection of a standard population.

8. Disabled Life Expectancy

We define the disabled life expectancy (DLE) at age x in year y as follows (Sullivan, 1971):

$$e_{D\,x,y} = \int_0^\infty {}_t p_{x,y} \; \pi_{x+t,y} \; dt$$

where

$${}_t p_{x,y} = l_{x+t,y} / l_{x,y}$$

and

$\pi_{x+t,y} =$ disability prevalence at age $x+t$, in year y.

The disabled life expectancy value provides a summarization of the age-specific disability prevalence rates in a given population at a given time; as for life expectancy, it does not require the selection of a standard population.

In actual applications, the disability prevalence rates are typically assumed to be constant for 5-year age intervals up to some terminal age w. Under the assumption that the survival function is known, the variance of the disabled life expectancy is

$$\mathrm{var}(e_{D\,x,y}) = \sum_{z=x(m)}^{w-m} \left(\int_z^{z+m} {}_t p_{x,y} \; dt \right)^2 \times \mathrm{var}(\pi_{z,y}),$$

where $x(m)$ indicates that the increment to each z in the summation is m (where m = 5), and $\mathrm{var}(\pi_{z,y})$ can be estimated using Potthoff's formula shown above. For the special case where the oldest age group is an open-ended age interval, the upper limit of the integral in the final term of the above summation is set to ∞.

The change from year y_0 to year y in disabled life expectancy at age x can be decomposed into two components: (1) a *survival increment* (SI) which reflects the increase in DLE that would have occurred had the disability prevalence rates remained constant; and (2) a *morbidity decrement*

(MD) which reflects the decrease in DLE that would have occurred had the survival function remained constant. Hence,

$$
\begin{aligned}
e_{Dx,y} - e_{Dx,y_0} &= \int_0^{\infty} \left({}_t p_{x,y} \ \ \pi_{x+t,y} - {}_t p_{x,y_0} \ \ \pi_{x+t,y_0} \right) \, dt \\
&= \int_0^{\infty} \left({}_t p_{x,y} - {}_t p_{x,y_0} \ \right) \pi_{x+t,y_0} \ dt \qquad \text{(Survival Increment)} \\
&\quad - \int_0^{\infty} {}_t p_{x,y} \left(\ \pi_{x+t,y_0} - \pi_{x+t,y} \right) \, dt \qquad - \text{ (Morbidity Decrement).}
\end{aligned}
$$

The following comments are relevant (assuming that $y > y_0$):

1. For the DLE to decline from y_0 to y, the morbidity decrement must be larger than the survival increment.
2. If the morbidity decrement is positive but smaller than the survival increment, the DLE will increase despite the fact that morbidity has improved.
3. The case where the morbidity decrement is negative is not of interest in our analysis.

The first and second cases are the two possible forms of *morbidity improvement*. The first case is of particular interest to LTCI actuaries because it is the only case where the total lifetime days of chronic disability at and beyond age x decline. It constitutes a special form of morbidity improvement which is called *morbidity compression* (Fries, 1980, 1983, 1989).

The variances of the DLE components (SI and MD) are computed like the variance of the disabled life expectancy:

$$
\text{var(SI)} = \sum_{z=x(m)}^{w-m} \left(\int_z^{z+m} \ ({}_t p_{x,y} - {}_t p_{x,y_0}) dt \ \right)^2 \times \text{var}(\pi_{z,y_0}),
$$

$$
\text{var(MD)} = \sum_{z=x(m)}^{w-m} \left(\int_z^{z+m} \ {}_t p_{x,y} \ dt \ \right)^2 \times \left(\text{var}(\pi_{z,y_0}) + \text{var}(\pi_{z,y}) \right).
$$

9. Logistic Regression Model

Information regarding the presence or absence of a caregiver report of cognitive impairment (CI) (i.e., Alzheimer's disease, dementia, or other cognition problems sufficient to prevent completion of the SPMSQ) was fully known for the non-SPMSQ institutional residents in the 2004 NLTCS but was missing for earlier years, except 1999. We estimated a family of logistic regression models for the presence/absence of CI for non-SPMSQ institutional residents in the 2004 NLTCS, using age, sex, ADL status, and institutional LOS as predictors; these models were used to impute cognitive status for non-SPMSQ institutional residents in the 1984 NLTCS who did not have the requisite caregiver reports.

Let x_i be the vector of predictors for the i^{th} person in the 2004 sample of non-SPMSQ institutional residents and let w_i be corresponding the Potthoff survey weight. Let π_i be the probability of cognitive impairment in the non-SPMSQ sample, conditional on x_i. The logistic regression model assumes that π_i and x_i are functionally related as follows:

$$\text{logit}(\pi_i) = \log\left(\frac{\pi_i}{1-\pi_i}\right) = \alpha + \beta^T x_i,$$

which implies that

$$\pi_i = \frac{\exp(\alpha + \beta^T x_i)}{1 + \exp(\alpha + \beta^T x_i)},$$

where α is a scalar constant and β is a vector of regression parameters.

Let Y_i be the 0–1 covariate indicating the presence (y_i = 1) or absence (y_i = 0) of cognitive impairment for the i^{th} person in the non-SPMSQ sample. The weighted likelihood function for the sample can be written as:

$$L = \prod_i \pi_i^{w_i y_i} \times (1-\pi_i)^{w_i(1-y_i)}.$$

Estimates of the parameters α and β and the associated test statistics can be obtained using the SAS 9.2 Procedures LOGISTIC or SURVEYLOGISTIC to solve for the MLE parameter values that yield the maximum of the above equation.

Odds Ratio

The logit function shown above represents the log of the odds of CI conditional on x_i, where the odds are defined as: $\rho_i = \pi_i / (1-\pi_i)$. Hence,

$$\rho_i = \exp(\alpha + \beta^T x_i).$$

The results of logistic regression are frequently presented as odds ratios, comparing ρ_i with some alternative odds $\rho_{i'}$. For a unit change in the j^{th} covariate in x_i, the odds ratio is usually written as:

$$\text{OR}_j = \exp(\beta_j).$$

10. CONFIDENCE INTERVALS, *t*-TESTS, PRECISION, AND ACTUARIAL CREDIBILITY

Our approach to estimation of ADL and CI morbidity improvement used *t*-statistics to test the changes over time in the respective prevalence rates and related statistics. The *t*-statistics were defined as the signed ratios of the respective parameter estimates to their standard errors, with negative values indicating decreases over time in the respective parameters. In each case, the null hypothesis was that the population value of the respective parameter was 0.

The *t*-statistics were evaluated by comparing them with conventional sets of critical values from the approximating normal distribution, i.e., ±1.645, ±1.960, ±2.576, and ±3.291, respectively, for 10%, 5%, 1%, and 0.1% levels of significance. In much of the literature, only the significance level is provided, using special symbols, e.g., †: $p < 0.10$; *: $p < 0.05$; **: $p < 0.01$; and ***: $p < 0.001$. In other cases, only the 95% confidence limits are provided, corresponding to $|t'| \le 1.960$, where t' is centered at the parameter estimate; the null hypothesis is rejected if the 0-value is not contained in the indicated confidence interval.

In many cases our *t*-values are far in excess of the critical value (3.29) for the 0.1% level of significance: the corresponding confidence intervals are very small and the estimates are very precise.

Actuarial credibility is typically based on the relative size of the 90% confidence interval for a given parameter, corresponding to $|t'| \le 1.645$, with *full credibility* achieved when that relative size is 5% or less. Longley-Cook (1962) used these conditions to derive the well known result that 1,082 or more claims are needed for full credibility in claim frequency applications. The corresponding conditions on the *t*-statistic are that $|t| > |t'|/0.05 = 32.90$, where the divisor is the relative size of the indicated 90% confidence interval (5%).

Levels of precision of this size ($|t| \approx 32.90$) were obtained for the aggregate prevalence rates in this report, but not for the change parameters. Useful criteria for characterizing the relative precision of positive (or negative) parameter estimates can be derived by broadening the relative size of Longley-Cook's 90% confidence interval to be 10%, 20%, 33.3%, or 50% of the estimated parameter value, yielding cut points at $|t| > 16.45$, $|t| > 8.23$, $|t| > 4.94$, or $|t| > 3.29$, respectively, where the last (and smallest) threshold (3.29) corresponds to $p < 0.001$, a level which we characterize as being statistically *highly significant*.

Thus, *high statistical significance* is a prerequisite for precise estimation. Based on the above discussion, we use the following terminology for describing *t*-statistics and the range of relative sizes (±) of the 90% confidence intervals for the associated parameter estimates:

Highest precision	±(0–5%)	$32.900 < \|t\|$
Very high precision	±(5–10%)	$16.450 < \|t\| \le 32.900$
High precision	±(10–20%)	$8.225 < \|t\| \le 16.450$
Medium precision	±(20–33.3%)	$4.940 < \|t\| \le 8.225$
Low precision	±(33.3–50%)	$3.291 < \|t\| \le 4.940$
Very low precision	±(50–84%)	$1.960 < \|t\| \le 3.291$
Lacking precision	±(84–100%)	$1.645 < \|t\| \le 1.960$.

SECTION 1: ADL MORBIDITY IMPROVEMENT

The primary focus of the study was on the changes over time in the HIPAA ADL morbidity rates and the impact of those changes on lifetime disability. The ADL trigger was modeled using a threshold of two of six ADL impairments (bathing, continence, dressing, eating, toileting, and transferring). Calculations based on the HIPAA ADL trigger were compared with calculations based on the traditional NLTCS ADL triggers, which include ADL impairments that could have been resolved through the use of special equipment (Manton et al., 2006).

The reported ADL morbidity rates are *estimates* derived from analysis of the NLTCS data, using survey weights developed by the Duke University research team responsible for the design and conduct of the survey.

Limitations of the design of the 1982 NLTCS necessitated that the primary starting point for the HIPAA trend analyses should be the 1984 NLTCS. The treatment of institutionalized persons in the 1982 NLTCS was different from their treatment in 1984 and in all later surveys. Treatment differences occurred at both the screener and the detailed interviews, with the goal in 1982 being to identify and then eliminate institutionalized persons so that the interviewers could focus on the community disabled population.

ADL morbidity rates were calculated for the 1982 community population alone and for the community and institutional populations separately and combined for 1984, 1989, 1994, 1999, and 2004. ADL tables prepared using the 1982 data exhibited only minor differences from the corresponding tables using the 1984 data, so the 2-year shift in the primary starting point for the HIPAA trend analyses was not a significant loss.

This section has five parts. *First*, we present unisex disability rates based on the traditional NLTCS ADL triggers for each of the six NLTCS survey years in the period 1982–2004. *Second*, we present unisex and sex-specific disability rates based on the HIPAA ADL trigger for 1984 and 2004. *Third*, we present the unisex and sex-specific life expectancies and disabled life expectancies associated with the HIPAA ADL disability rates for 1984 and 2004. *Fourth*, we compare the traditional NLTCS and HIPAA classification rules with respect to their impacts on disability rate estimates for the 1984 and 2004 unisex populations. *Fifth*, we compare the 1984 and 2004 HIPAA ADL disability rates within the community and institutional subpopulations.

1. NLTCS ADLs

Most publications based on the NLTCS employ a broader definition of ADL disability than used in HIPAA. Specifically, the traditional NLTCS classification rules count an ADL as impaired if the respondent needs and uses any of several types of special equipment to accomplish the activity. In addition, the traditional NLTCS classification rules substitute inside mobility (walking) for continence so that both the traditional and the HIPAA-based tabulations report the results for six ADLs, five of which are in common.

We began our assessment of the ADL morbidity trends by reviewing published results based on the traditional NLTCS classification rules (Manton et al., 2006). The rationale for this was our expectation that the trends we are examining should be sufficiently robust with respect to the noted differences in classification rules that the main findings can be readily identified from the traditional NLTCS classifications.

Table 1.1 displays the age-standardized disability estimates by year based on the traditional NLTCS classification rules, where the ADL groups were restricted to community residents and a separate category was used for institutionalized persons. Also included is a community IADL group (IADL Only) which includes only those community residents with no ADL impairments. The nondisabled group includes community residents with no IADL or ADL impairments.

Table 1.1
Disability Group Estimates (%), NLTCS 1982 to 2004, Age-Standardized to 2004 U.S. Population

Disability Status \ Year	1982	1984	1989	1994	1999	2004	Relative Change (%)
Nondisabled	73.53	73.78	75.23	76.83	78.74	81.00	10.2
IADL Only	5.73	6.01	4.49	4.43	3.30	2.38	-58.5
Any ADLs	13.20	13.23	13.35	12.40	13.10	12.60	-4.6
1-2 ADLs	6.81	6.87	6.60	6.15	6.32	5.56	-18.3
3-4 ADLs	2.94	3.03	3.69	3.35	3.73	3.81	29.6
5-6 ADLs	3.46	3.33	3.05	2.91	3.04	3.22	-6.9
Institutionalized	7.53	6.97	6.93	6.33	4.87	4.02	-46.6
Disabled	26.47	26.22	24.77	23.17	21.26	19.00	-28.2
Annualized Rate of Decline in Disability (%)							
By Interval	–	0.47	1.13	1.32	1.70	2.22	
Cumulative from 1982	–	0.47	0.94	1.10	1.28	1.50	

Note: The traditional NLTCS ADL trigger is based on use of equipment and/or human assistance.

Source: Data from Manton, K.G., Gu, X, and Lamb, V.L. Change in chronic disability from 1982 to 2004/2005 as measured by long-term changes in function and health in the U.S. elderly population. *Proceedings of the National Academy of Sciences, U.S.A.* 103(48):18374–18379, 2006.

Table 1.1 shows that the nondisabled subpopulation increased from 73.5% to 81.0% of the total between 1982 and 2004; the disabled subpopulation exhibited a compensating decrease, from 26.5% to 19.0%, for a relative decrease of 28.2%. The largest relative changes were a decrease of 58.5% for IADL Only, followed by a 46.6% decrease for institutionalization. The three ADL groups had mixed trends with an increase of 29.6% for 3–4 ADLs but decreases for the other two groups; the combination of the three ADL groups decreased from 13.2% to 12.6%, a relative decrease of 4.6%.

Manton et al. (2006) reported that the disability declines from 1984–1989, 1989–1994, 1994–1999, and 1999–2004, but not from 1982–1984, were each statistically significant, as was the decline for the overall period 1982–2004.

The difference in the proportion disabled between 1982 and 1984 was relatively small at 0.25% on a base of 26.5%.

In contrast, the difference in the proportion institutionalized was relatively large at 0.56% on a base of 7.5%. Part of the institutionalization difference was attributed to design differences between the 1982 and 1984 NLTCS with respect to the treatment of institutionalized respondents. The combination of the three ADL groups was 13.2% for 1982 and 1984.

Table 1.2 displays the age-standardized disability estimates for three broad age groupings (65–74, 75–84, and 85+) by year using the same traditional NLTCS classification rules.

Table 1.2
Disability Group Estimates (%) by Age, NLTCS 1982 to 2004, Age-Standardized to 2004 U.S. Population

Disability Status \ Year	1982	1984	1989	1994	1999	2004	Relative Change (%)
			Age 65-74				
Nondisabled	85.81	86.66	88.08	88.22	89.31	91.09	6.2
IADL Only	4.33	4.06	2.99	3.16	2.47	1.79	-58.7
Any ADLs	7.87	7.53	7.07	7.04	6.80	6.22	-21.0
1-2 ADLs	4.10	3.99	3.79	3.74	3.41	3.05	-25.6
3-4 ADLs	1.77	1.81	1.74	1.67	1.99	1.62	-8.4
5-6 ADLs	2.00	1.73	1.54	1.62	1.40	1.55	-22.8
Institutionalized	1.99	1.74	1.86	1.58	1.42	0.90	-54.6
Disabled	14.19	13.34	11.92	11.78	10.69	8.91	-37.2
			Age 75-84				
Nondisabled	69.34	70.24	70.60	73.79	76.58	78.11	12.6
IADL Only	7.05	7.52	5.78	5.25	3.57	2.54	-63.9
Any ADLs	15.51	15.16	16.62	14.66	15.52	15.20	-2.0
1-2 ADLs	8.23	8.08	8.63	7.55	8.00	6.70	-18.6
3-4 ADLs	3.38	3.45	4.52	4.12	4.16	4.52	33.5
5-6 ADLs	3.90	3.63	3.47	3.00	3.36	3.99	2.4
Institutionalized	8.11	7.08	7.00	6.29	4.33	4.15	-48.8
Disabled	30.66	29.76	29.40	26.21	23.42	21.89	-28.6
			Age 85+				
Nondisabled	37.90	34.09	38.63	41.50	44.39	50.27	32.6
IADL Only	7.53	9.43	6.78	7.10	5.48	4.23	-43.9
Any ADLs	27.38	29.83	28.51	26.84	30.66	29.92	9.3
1-2 ADLs	13.34	14.61	11.88	11.56	12.94	12.12	-9.2
3-4 ADLs	6.21	6.57	8.93	7.70	9.24	10.24	64.9
5-6 ADLs	7.83	8.65	7.70	7.58	8.48	7.56	-3.4
Institutionalized	27.18	26.65	26.08	24.56	19.47	15.58	-42.7
Disabled	62.10	65.91	61.37	58.50	55.61	49.73	-19.9

Note: The traditional NLTCS ADL trigger is based on use of equipment and/or human assistance.

Source: Data from Manton, K.G., Gu, X, and Lamb, V.L. Change in chronic disability from 1982 to 2004/2005 as measured by long-term changes in function and health in the U.S. elderly population. *Proceedings of the National Academy of Sciences, U.S.A.* 103(48):18374–18379, 2006.

Manton et al. (2006) reported that the disability declines in Table 1.2 for the overall period 1982–2004 were statistically highly significant for each of the three age groups. The increases for 3–4 ADLs were restricted to ages 75–84 and 85+ where they were countered by correspondingly large decreases in IADL Only and institutionalization.

Table 1.3 displays the disability prevalence rates and trends for the disability data underlying Table 1.1, for low vs. high levels of disability.

Manton et al. (2006) reported that the disability trends in the rightmost panel were statistically significantly different across disability level and time periods, indicating that the relative rates of decline were accelerating over time and were larger for the high disability level.

Table 1.3
Declines in Low and High Disability Levels, NLTCS 1982-1994, 1994-2004, Age-Standardized to 2004 U.S. Population

Disablity Level	Disabled (%) 1982	1994	2004	Disability Change (%) 1982-1994	1994-2004	1982-2004	Annualized Rate of Decline 1982-1994	1994-2004	1982-2004
Low (IADL, 1-4 ADLs)	15.48	13.93	11.75	-1.55	-2.18	-3.73	0.88%	1.69%	1.25%
High (5-6 ADLs, Institutionalized)	10.99	9.24	7.24	-1.75	-2.00	-3.75	1.43%	2.41%	1.88%

Note: The traditional NLTCS ADL Trigger is based on use of equipment and/or human assistance.

Source: Data from Manton, K.G., Gu, X, and Lamb, V.L. Change in chronic disability from 1982 to 2004/2005 as measured by long-term changes in function and health in the U.S. elderly population. *Proceedings of the National Academy of Sciences, U.S.A.* 103(48):18374–18379, 2006.

2. HIPAA ADLs

Unweighted tabulations of the number of respondents who did or did not meet the simulated HIPAA ADL trigger in the 1984 and 2004 surveys are shown in Tables 1.4 and 1.5, respectively, stratified by 5-year groups based on attained age at the time of each survey.

Table 1.4
Unweighted Number and Percent of Persons Meeting HIPAA ADL Trigger, 1984 NLTCS, Unisex, Age 65 and Above, by Age

Age	Meets HIPAA ADL Trigger: No	Yes	Total	Percent	Std Error (Pct)
65-69	7,442	315	7,757	4.06%	0.22%
70-74	4,501	388	4,889	7.94%	0.39%
75-79	3,273	491	3,764	13.04%	0.55%
80-84	2,019	549	2,568	21.38%	0.81%
85-89	1,034	543	1,577	34.43%	1.20%
90-94	306	344	650	52.92%	1.96%
95+	60	134	194	69.07%	3.33%
Total	18,635	2,764	21,399	12.92%	0.21%

Note: The HIPAA ADL Trigger is based on 2+ ADL Impairments.

Source: Authors' calculations based on the 1984 NLTCS.

Table 1.4 shows that for 1984 the percent disabled increased from 4.1% at age 65–69 to 69.1% at age 95 and older. The number disabled increased from 315 at age 65–69 to 549 at age 80–84, and then decreased to 134 at age 95 and older. The standard errors of the percent disabled were small relative to the percent-values, falling within a range representing 3.3–5.5% of the percent-values. However, they were not negligible; their sizes indicate that standard errors should be reported as the data are further stratified.[8]

[8] The usual standard for "full credibility" is 1,082 claims (Longley-Cook, 1962), which in Table 1.4 would correspond to 1,082 "Yes" responses. This standard was met for the total number, but not for the age-specific numbers. A

Table 1.5 shows that for 2004 the percent disabled increased from 2.5% at age 65–69 to 53.7% at age 95 and older. The number disabled increased from 104 at age 65–69 to 448 at age 85–89, and then decreased to 192 at age 90–94, increasing to 520 at age 95 and older. The latter increase reflected an oversampling of the 95+ population in 2004. Also note that the sample size at age 65–69 was substantially smaller in 2004 than in 1984 due to the different sized gaps between the first two and all later surveys, combined with a targeted replenishment of 5,000 "aged-in" respondents at each survey (i.e., defined as the subpopulation reaching age 65 between the surveys). Survey weights were needed to control for these and other survey design effects that can create biases in unweighted analyses.

Table 1.5
Unweighted Number and Percent of Persons Meeting HIPAA ADL Trigger, 2004 NLTCS, Unisex, Age 65 and Above, by Age

	Meets HIPAA ADL Trigger				
Age	No	Yes	Total	Percent	Std Error (Pct)
65-69	4,008	104	4,112	2.53%	0.24%
70-74	2,731	140	2,871	4.88%	0.40%
75-79	2,400	164	2,564	6.40%	0.48%
80-84	2,314	284	2,598	10.93%	0.61%
85-89	1,798	448	2,246	19.95%	0.84%
90-94	442	192	634	30.28%	1.83%
95+	448	520	968	53.72%	1.60%
Total	14,141	1,852	15,993	11.58%	0.23%

Note: The HIPAA ADL Trigger is based on 2+ ADL Impairments.

Source: Authors' calculations based on the 2004 NLTCS.

Table 1.6 presents the weighted tabulation of the unisex data for 1984 in Table 1.4, using the same format. The primary changes were the large declines in the age-specific and total prevalence rates, with modest increases in the relatively small standard errors (SEs). The overall prevalence rate was 9.2% with a 0.2% SE, computed using Potthoff et al.'s (1992) method with $c_{s,1984} = (1486.075)^{-1}$ (see Subsection 5 of Introduction for details).

Table 1.6
Number and Percent of Persons Meeting HIPAA ADL Trigger, United States 1984, Unisex, Age 65 and Above, by Age

	Meets HIPAA ADL Trigger				
Age	No	Yes	Total	Percent	Std Error (Pct)
65-69	8,449,660	285,558	8,735,218	3.27%	0.23%
70-74	7,173,626	380,409	7,554,035	5.04%	0.31%
75-79	5,065,338	473,580	5,538,918	8.55%	0.46%
80-84	2,908,882	524,112	3,432,994	15.27%	0.75%
85-89	1,419,003	504,335	1,923,337	26.22%	1.22%
90-94	370,717	302,329	673,046	44.92%	2.34%
95+	63,540	113,824	177,364	64.18%	4.41%
Total	25,450,767	2,584,148	28,034,914	9.22%	0.20%

Note: The HIPAA ADL Trigger is based on 2+ ADL Impairments.

Source: Authors' calculations based on the 1984 NLTCS.

"relaxed" standard of 271 claims, which was met by all but one of the age-specific numbers, would be associated with a doubling of the confidence-interval for full credibility under Longley-Cook's assumptions.

Table 1.7 presents the corresponding weighted tabulation for 2004. The overall prevalence rate was 8.2% with a 0.2% SE, computed using Potthoff's method with $c_{s,2004} = (2690.624)^{-1}$.

Table 1.7
Number and Percent of Persons Meeting HIPAA ADL Trigger, United States 2004, Unisex, Age 65 and Above, by Age

	Meets HIPAA ADL Trigger				
Age	No	Yes	Total	Percent	Std Error (Pct)
65-69	8,302,057	186,582	8,488,639	2.20%	0.26%
70-74	8,404,035	333,111	8,737,147	3.81%	0.34%
75-79	7,139,472	484,462	7,623,934	6.35%	0.46%
80-84	5,389,370	639,477	6,028,847	10.61%	0.65%
85-89	2,782,747	669,256	3,452,003	19.39%	1.10%
90-94	1,058,680	423,553	1,482,233	28.58%	1.93%
95+	211,606	220,917	432,523	51.08%	3.96%
Total	33,287,967	2,957,359	36,245,325	8.16%	0.23%

Note: The HIPAA ADL Trigger is based on 2+ ADL Impairments.

Source: Authors' calculations based on the 2004 NLTCS.

Table 1.8 presents various comparisons of the age-specific and total prevalence rates for 1984 and 2004 shown in Tables 1.6 and 1.7.

Table 1.8
Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.27	2.20	-1.07	-32.8	1.97%
70-74	5.04	3.81	-1.22	-24.3	1.38%
75-79	8.55	6.35	-2.20	-25.7	1.47%
80-84	15.27	10.61	-4.66	-30.5	1.80%
85-89	26.22	19.39	-6.83	-26.1	1.50%
90-94	44.92	28.58	-16.34	-36.4	2.24%
95+	64.18	51.08	-13.10	-20.4	1.13%
Total	9.22	8.16	-1.06	-11.5	0.61%
1984 ASDR	9.22	6.61	-2.61	-28.3	1.65%
2004 ASDR	11.42	8.16	-3.26	-28.5	1.67%
		Standard Error			
Total	0.20	0.23	0.30		
1984 ASDR	0.20	0.19	0.28		
2004 ASDR	0.24	0.23	0.33		
		t-statistic			
Total	46.31	36.20	-3.52		
1984 ASDR	46.31	33.94	-9.38		
2004 ASDR	47.13	36.20	-9.85		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

The overall relative rate of decline (in Total) was 11.5%, but this was a poor summary of the age-specific relative rates of decline which ranged from 20.4% to 36.4%. The two sets of age-standardized prevalence rates yielded comparable relative rates of decline: 28.3% vs. 28.5%.

These two sets differed according to the choice of the standard population: 1984 vs. 2004, which explains why, for example, the 1984 ASDR matched the Total of 9.2% for 1984. The absolute value of the prevalence rate clearly depends on the choice of the standard population, but once that choice is made, the relative rate of decline is relatively robust with respect to that choice.[9]

The standard errors of the unstandardized totals and ASDRs ranged from 0.19% to 0.24%; the standard errors of the differences (i.e., changes) are the square roots of the sums of squares of the adjacent standard errors which ranged from 0.28% to 0.33%.

The *t*-statistics are the ratios of the unstandardized totals, ASDRs, and their differences, to the corresponding standard errors.

For the unstandardized totals and ASDRs, the *t*-statistics are interpreted as measures of their precision, with values above 32.90 signifying the highest precision and values in the range 3.29–16.45 associated with low ($|t| > 3.29$), medium ($|t| > 4.94$), and high precision ($|t| > 8.23$); values in the range 16.45–32.90 are associated with very high precision (see Subsection 10 of Introduction).

For the differences in unstandardized totals and ASDRs, the *t*-statistics provide signed two-tailed tests of the statistical significance of the corresponding changes under the assumption that the changes were asymptotically normally distributed with mean 0 and variance = SE^2. The reference cut-points for the *t*-statistics were ±1.96, ±2.58, and ±3.29, respectively, for the 5%, 1%, and 0.1% levels of significance, the last of which we term *statistically highly significant*.

All of the *t*-statistics in Table 1.8 were statistically highly significant but the *t*-statistics for the changes in the ASDRs were substantially larger than for the change in the unstandardized totals – a pattern which will be repeated throughout this report.

When the *t*-statistics for the differences in unstandardized totals and ASDRs are statistically highly significant, we make a secondary use of the *t*-statistics as measures of the precision of the estimated absolute and relative changes using the criteria described above for low ($|t| > 3.29$), medium ($|t| > 4.94$), and high precision ($|t| > 8.23$). Doing so takes full advantage of the large size of the NLTCS sample and the long 20-year interval used in assessing these changes.

Under these criteria, the change in the unstandardized totals in Table 1.8 had low precision ($|t| = 3.52$), whereas the ASDR changes both had high precision ($|t| = 9.38$ and 9.85; 1984 and 2004).

Tables 1.9 and 1.10 present the corresponding sex-specific changes, in the same format.

The age-standardized relative rates of decline were larger for males than females (34.8% vs. 24.5%; 2004 ASDR). The annualized relative rates of decline were 2.11% for males vs. 1.39% for females.

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[9] Throughout this report, we define pairs of standard populations in such a way that the first value in the 1984 ASDR row (i.e., the entry under the 1984 column heading) exactly matches the Total for 1984 and the second value in the 2004 ASDR row (i.e., the entry under the 2004 column heading) exactly matches the Total for 2004. This yields the simplest forms of age standardization that adequately summarize the changes in the age specific prevalence rates.

Table 1.9

Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.06	2.12	-0.94	-30.6	1.81%
70-74	5.37	3.68	-1.68	-31.4	1.87%
75-79	8.29	5.94	-2.34	-28.3	1.65%
80-84	13.34	8.73	-4.61	-34.5	2.10%
85-89	21.26	11.80	-9.46	-44.5	2.90%
90-94	35.32	21.72	-13.60	-38.5	2.40%
95+	48.81	31.40	-17.41	-35.7	2.18%
Total	7.28	5.84	-1.44	-19.8	1.10%
1984 ASDR	7.28	4.83	-2.45	-33.6	2.03%
2004 ASDR	8.95	5.84	-3.11	-34.8	2.11%
		Standard Error			
Total	0.29	0.31	0.42		
1984 ASDR	0.29	0.27	0.40		
2004 ASDR	0.36	0.31	0.48		
		t-statistic			
Total	24.80	19.03	-3.40		
1984 ASDR	24.80	17.90	-6.14		
2004 ASDR	24.53	19.03	-6.53		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.10

Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.44	2.27	-1.2	-34.1	2.06%
70-74	4.80	3.92	-0.88	-18.3	1.01%
75-79	8.71	6.66	-2.06	-23.6	1.34%
80-84	16.28	11.82	-4.46	-27.4	1.59%
85-89	28.12	23.29	-4.83	-17.2	0.94%
90-94	47.81	31.36	-16.45	-34.4	2.09%
95+	67.39	56.09	-11.30	-16.8	0.91%
Total	10.48	9.84	-0.64	-6.1	0.31%
1984 ASDR	10.48	7.91	-2.56	-24.5	1.39%
2004 ASDR	13.02	9.84	-3.19	-24.5	1.39%
		Standard Error			
Total	0.27	0.32	0.41		
1984 ASDR	0.27	0.27	0.38		
2004 ASDR	0.32	0.32	0.45		
		t-statistic			
Total	39.24	31.01	-1.54		
1984 ASDR	39.24	28.99	-6.71		
2004 ASDR	40.32	31.01	-7.04		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

The corresponding unisex annualized relative rate of decline was 1.67%, which can be compared with the 1.88% annualized relative rate of decline for severe disability in Table 1.3, or the 1.50% overall relative rate of decline for all forms of disability in Table 1.1.

The *t*-statistics indicated that the ASDR changes were statistically highly significant for both sexes; for the unstandardized total changes, the *t*-statistics were smaller and failed to reach the 10% level of significance for females.

The ASDR changes for females had medium precision ($|t|$ = 6.71 and 7.04; 1984 and 2004). This was also the case for the ASDR changes for males which, though substantially larger in absolute value, still had only medium precision ($|t|$ = 6.14 and 6.53; 1984 and 2004) – a pattern of sex differences which will be repeated throughout this report.

The *t*-statistics for the ASDR changes for males were smaller than for females primarily due to the smaller sample sizes for males (i.e., 8,310 males vs. 13,089 females in 1984; 6,425 males vs. 9,568 females in 2004), which in turn were based on their lower representation in the U.S. elderly population (e.g., based on the weighted NLTCS estimates: 11.0 million males vs. 17.0 million females in 1984; 15.2 million males vs. 21.1 million females in 2004).

The impact of the smaller number of males can also be seen in the *t*-statistics in the first two columns of Table 1.9 which were substantially smaller than the corresponding values in the first two columns of Table 1.10.

Comments

Whereas the standard errors of the changes are independent of the lengths of the time intervals between the observations (i.e., 1984 to 2004), the *t*-statistics are roughly proportional to those lengths. This means that changes in the unstandardized unisex and male totals over 5-year and 10-year subintervals would be unlikely to be statistically significant (even at the 5% level of significance). For the ASDRs, the 10-year periods should be long enough to detect statistically significant changes at the 5% level for males and females. Moreover, the 5-year periods may be long enough to detect statistically significant changes for the female and unisex ASDRs (based on their similarities to the corresponding ASDRs in Manton et al. (2006)).

We focused the current analysis on the 20-year changes in the ASDRs. The ASDR changes best summarized the age-specific relative rates of decline. The 20-year interval yielded estimated ASDR changes having relatively much higher levels of precision than attainable using 5- or 10-year intervals, a property based on the approximately linear increases with interval length in the associated *t*-statistics.

3. LIFE EXPECTANCIES AND DISABLED LIFE EXPECTANCIES

Table 1.11 presents the unisex life expectancies (LEs) and disabled life expectancies (DLEs), and the decompositions of the DLE changes into the survival increments and morbidity decrements, as described in Subsections 7 and 8 of Introduction.

Table 1.11
Components of Change in Unisex Life Expectancy and HIPAA ADL Expectancy (in Years at Age 65), United States 1984 and 2004

At Age 65	Year 1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	16.64	18.11	1.48	1.48	–
HIPAA ADL Expectancy	1.79	1.46	-0.33	0.25	0.58
Standard Error	0.04	0.04	0.06	0.01	0.06
t-statistic	47.62	36.37	-5.99	42.44	9.90

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

The unisex life tables used to generate Table 1.11 were based on the sex-specific life tables for the U.S. population developed by the Social Security Administration (Bell et al., 2008). These life tables were selected to be consistent with the NLTCS sample which was designed to be representative of the general population.

The unisex LE at age 65 in 1984 was 16.64 years, of which 1.79 years was estimated to be lived at a disability level that met the HIPAA ADL trigger. The unisex LE in 2004 increased to 18.11 years, of which 1.46 years was estimated to have been lived at a disability level that met the HIPAA ADL trigger. The decline in DLE was 0.33 years, which represented the balance between a survival increment of 0.25 years and a morbidity decrement of 0.58 years.

The t-statistic ($|t|$ = 5.99) indicated that the change in DLE was statistically highly significant with medium precision. The component survival increment and morbidity decrement were even more highly significant: t = 42.44 and 9.90 with highest and high precision, respectively.

The corresponding sex-specific results are presented in Tables 1.12 and 1.13. The DLEs for males were 1.19 years in 1984 and 0.98 years in 2004. The corresponding DLEs for females were 2.32 and 1.88 years, respectively.

The declines in DLE were 0.21 years for males and 0.44 years for females, which represented, respectively, 17.5% of the 1984 DLE for males and 19.0% of the 1984 DLE for females. The t-statistics indicated that the changes in DLE were statistically significant for males ($|t|$ = 2.96; very low precision), and statistically highly significant for females ($|t|$ = 5.31; medium precision), as were the component survival increments (t = 20.40 and 35.96 for males and females, respectively, with very high and highest precision) and morbidity decrements (t = 6.55 and 7.11 for males and females, respectively, both with medium precision).

Thus, both sexes exhibited substantial declines in their expected total lifetime days of chronic disability at and beyond age 65, a finding which confirms the morbidity compression hypothesis originally proposed by Fries (1980, 1983, 1989).

Table 1.12
Components of Change in Male Life Expectancy and HIPAA ADL Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	14.41	16.67	2.26	2.26	–
HIPAA ADL Expectancy	1.19	0.98	-0.21	0.32	0.53
Standard Error	0.05	0.05	0.07	0.02	0.08
t-statistic	24.84	19.04	-2.96	20.40	6.55

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.13
Components of Change in Female Life Expectancy and HIPAA ADL Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	18.66	19.50	0.84	0.84	–
HIPAA ADL Expectancy	2.32	1.88	-0.44	0.17	0.61
Standard Error	0.06	0.06	0.08	0.00	0.09
t-statistic	40.70	31.17	-5.31	35.96	7.11

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

4. TRADITIONAL NLTCS VS. HIPAA CLASSIFICATION RULES

The results presented above showed that there were substantial improvements in ADL morbidity over the 20-year period 1984–2004 and that those improvements occurred under both the traditional NLTCS and the HIPAA classification rules. We now present more detailed analyses of the differences in these classification rules and show why the 3–4 ADL disability category showed an anomalous increase in prevalence for community residents under the traditional NLTCS classification rules but not under the HIPAA classification rules.

Table 1.14 contains three panels each of which compares the traditional NLTCS disability classification for the 2004 NLTCS unisex weighted population with an alternative classification based on:

(1) The traditional NLTCS ADL Trigger with a modified IADL category that explicitly excluded heavy housework but included help with medications. This modification

corrected a minor design flaw in the traditional NLTCS disability classification which excluded help with medications from its list of IADLs, even though the screener questionnaire asked about need for such help, but included heavy housework, even though the screener questionnaire did not ask about need for such help.

(2) A modification of the NLTCS ADL Trigger in (1) that excluded ADLs at level 2 of the impairment hierarchy (i.e., performed the activity with special equipment, without active or standby help).

(3) The HIPAA ADL Trigger with an IADL category as in (1) which was extended to include respondents with impairments in inside mobility at levels 2–5 of the impairment hierarchy; without this extension, such respondents would be classified as nondisabled.

Table 1.14
Number and Percent of Persons Meeting the Traditional NLTCS ADL Trigger and Alternatives to that Trigger based on the HIPAA Classification Rules, 2004 NLTCS, Unisex, Age 65 and Above

	Alternative Classification of Disability Status									Percent		
Traditional NLTCS Classification	Nondis-abled	IADL/ Inside-Mobility/ Institut-ional	1 ADL	2 ADLs	3 ADLs	4 ADLs	5 ADLs	6 ADLs	Total	Tradi-tional	Alter-native	Differ-ence
					Traditional NLTCS ADL Trigger							
Nondisabled	29,327,619	30,573							29,358,192	81.0	81.2	0.2
IADL Only	95,256	768,463							863,719	2.4	2.2	-0.2
1-2 ADL			1,168,755	848,126					2,016,880	5.6	5.6	0.0
3-4 ADL					805,436	574,487			1,379,923	3.8	3.8	0.0
5-6 ADL							434,219	734,327	1,168,546	3.2	3.2	0.0
Institutional		27,342	60,597	88,833	132,282	181,405	477,593	490,012	1,458,065	4.0	4.0	0.0
Total	29,422,875	826,378	1,229,352	936,959	937,718	755,892	911,812	1,224,339	36,245,325	100.0	100.0	0.0
					Modified NLTCS ADL Trigger Excluding Special Equipment							
Nondisabled	29,327,619	30,573							29,358,192	81.0	82.2	1.2
IADL Only	95,256	768,463							863,719	2.4	6.6	4.2
1-2 ADL	353,394	1,061,492	453,035	148,959					2,016,880	5.6	3.0	-2.6
3-4 ADL	18,230	524,341	278,916	164,929	217,542	175,966			1,379,923	3.8	1.4	-2.4
5-6 ADL	2,619	5,940	17,610	24,687	49,203	77,814	307,244	683,430	1,168,546	3.2	2.7	-0.5
Institutional		75,834	153,850	131,133	106,912	203,603	343,129	443,604	1,458,065	4.0	4.0	0.0
Total	29,797,117	2,466,644	903,411	469,708	373,657	457,383	650,372	1,127,034	36,245,325	100.0	100.0	0.0
					HIPAA ADL Trigger							
Nondisabled	29,322,812	30,573	4,807						29,358,192	81.0	82.1	1.1
IADL Only	93,140	763,906	6,673						863,719	2.4	7.0	4.6
1-2 ADL	321,575	1,144,316	462,740	82,751	5,498				2,016,880	5.6	3.2	-2.4
3-4 ADL	2,073	577,230	299,157	244,131	180,773	72,067	4,491		1,379,923	3.8	1.6	-2.2
5-6 ADL		8,559	17,610	29,698	75,251	241,154	408,282	387,992	1,168,546	3.2	2.2	-1.0
Institutional		73,255	159,540	113,992	161,992	205,787	322,287	421,211	1,458,065	4.0	4.0	0.0
Total	29,739,601	2,597,840	950,526	470,573	423,514	519,009	735,060	809,204	36,245,325	100.0	100.0	0.0

Note: For all three triggers, IADL/Inside-Mobility/Institutional includes any IADL impairments and institutionalization without any ADL impairments; for the HIPAA ADL Trigger, it also includes impairments in inside mobility at levels 2–5 .

Source: Authors' calculations based on the 2004 NLTCS.

The three rightmost columns contain the percentage distributions under the traditional NLTCS disability classification (repeated identically for all three panels), followed by the corresponding percentages and differences under the panel-specific alternative classification rules. The traditional NLTCS disability classification rules group the ADL limitations in pairs (1–2, 3–4, and 5–6) and provide a single category for institutionalized respondents. The same groupings were applied to the tabulations for the alternative classification rules to generate the comparable percentages in the second column from the right.

The top panel shows that the first alternative was almost identical to the traditional NLTCS disability classification, the only changes being the IADL modifications for heavy housework and medications noted above.

The second panel shows the impact of the exclusion of special equipment as a trigger for ADL disability among community residents. The ADL counts dropped sharply while the counts for IADL Only increased by about 175%. Note especially that the 3–4 ADL category dropped from 3.8% to 1.4%, indicating that most of this disability was equipment related.

The third panel shows the impact of the replacement of inside mobility with continence in the HIPAA trigger. The 5–6 ADL category dropped from 2.7% to 2.2% while the IADL Only category increased further from 6.6% to 7.0%. The 3–4 ADL category increased from 1.4% to 1.6%, still substantially below the 3.8% in the first panel.

Similar tabulations were generated for the 1984 NLTCS unisex weighted population (not shown). These tables were further manipulated to produce sets of age-standardized disability rates comparable to those in Table 1.14. The various rates were assembled in the format shown in Table 1.15.

Table 1.15
Percent of Persons Meeting the Traditional NLTCS ADL Trigger and Alternatives to that Trigger based on the HIPAA Classification Rules, 1984 and 2004 NLTCS, Unisex, Age 65 and Above, with 1984 Percentages Age-Standardized to the 2004 NLTCS Weighted Unisex Population.

	Alternative Classification of Disability Status											
	Traditional NLTCS Classification			Traditional NLTCS ADL Trigger			Modified NLTCS ADL Trigger Excluding Special Equipment			HIPAA ADL Trigger		
ADL/IADL Disability Level	1984	1984 ASDR	2004	1984	1984 ASDR	2004	1984	1984 ASDR	2004	1984	1984 ASDR	2004
Nondisabled	76.30	72.08	81.00	76.92	72.68	81.18	77.36	73.12	82.21	77.31	73.07	82.05
IADL/IM/INST	5.84	6.41	2.38	5.21	5.81	2.20	8.87	10.07	6.60	9.12	10.33	6.97
1-2 ADL	6.46	7.40	5.56	6.46	7.40	5.56	4.14	4.74	3.00	4.28	4.92	3.17
3-4 ADL	2.86	3.28	3.81	2.86	3.28	3.81	1.39	1.59	1.44	1.72	1.97	1.59
5-6 ADL	3.08	3.65	3.22	3.08	3.65	3.22	2.77	3.29	2.73	2.11	2.52	2.21
Institutional	5.47	7.19	4.02	5.47	7.19	4.02	5.47	7.19	4.02	5.47	7.19	4.02
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: For all four triggers, IADL/IM/INST includes any IADL impairments and institutionalization without any ADL impairments; for the HIPAA ADL Trigger, it also includes impairments in inside mobility at levels 2–5.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

As noted above, the first two sets of classification rules in Table 1.15 were almost identical. The 2004 values matched those of Table 1.1. The 1984 ASDRs differed somewhat from Table 1.1 because we used the standard set of NLTCS survey weights in our calculations whereas Manton et al. (2006) used a revised set. We will comment further on the impact of revisions to the survey weights in Section 3 of this report.

Table 1.15 shows that the 3–4 ADL category increased from 3.28% to 3.81% under the traditional classification rules. In contrast, the same category decreased from 1.59% to 1.44% under the modified NLTCS ADL trigger and from 1.97% to 1.59% under the HIPAA ADL trigger. Thus, once the effect of special equipment was removed, this category reversed its direction of change. In other words, the anomalous increase in the prevalence of the 3–4 ADL category for community residents was associated only with the increased use of special equipment.

Table 1.15 also shows that the improvements in morbidity at each of the ADL/IADL disability levels under the HIPAA ADL trigger were replicated for the modified NLTCS ADL trigger, which indicates that the substitution of continence for inside mobility in the HIPAA trigger did not produce a different pattern of change.

5. HIPAA ADLs for Community and Institutional Subpopulations

This subsection presents age-specific and total HIPAA ADL prevalence rates for 1984 and 2004 for the community and institutional subpopulations separately. We begin by examining the corresponding changes in institutionalization rates. Table 1.16 presents the age-specific and total institutionalization rates for 1984 and 2004 (shown in aggregate in Table 1.15). The age-standardized rates declined over 44%; small differences from Table 1.1 are due to the methodological changes noted in the comments following Table 1.15.

Table 1.16

Percent of Population Residing in Institutions, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.07	0.32	-0.75	-70.1	5.86%
70-74	2.16	1.15	-1.01	-46.7	3.10%
75-79	4.48	2.61	-1.86	-41.6	2.65%
80-84	9.85	5.32	-4.52	-45.9	3.03%
85-89	19.31	11.83	-7.48	-38.7	2.42%
90-94	34.13	18.58	-15.56	-45.6	3.00%
95+	50.54	29.11	-21.43	-42.4	2.72%
Total	5.47	4.02	-1.45	-26.5	1.53%
1984 ASDR	5.47	3.02	-2.45	-44.8	2.93%
2004 ASDR	7.19	4.02	-3.17	-44.1	2.86%
		Standard Error			
Total	0.16	0.16	0.23		
1984 ASDR	0.16	0.13	0.20		
2004 ASDR	0.20	0.16	0.26		
		t-statistic			
Total	35.02	24.65	-6.41		
1984 ASDR	35.02	23.63	-12.14		
2004 ASDR	35.35	24.65	-12.15		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.17 presents the age-specific and total institutionalization rates for 1984 and 2004, for the case where the 2004 rates were redefined to include residents in assisted living communities (ALCs)[10]. With this redefinition, the total rate exhibited a 2% increase, while the age-standardized rates declined over 22%, indicating as first noted by Bishop (1999) that ALCs only partially account for the decline in nursing home use seen in Table 1.16.

Table 1.17

Percent of Population Residing in Institutions or Assisted Living Communities, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.07	0.64	-0.43	-40.6	2.57%
70-74	2.16	1.54	-0.62	-28.8	1.68%
75-79	4.48	3.65	-0.83	-18.5	1.02%
80-84	9.85	7.60	-2.25	-22.9	1.29%
85-89	19.31	16.54	-2.77	-14.4	0.77%
90-94	34.13	23.30	-10.83	-31.7	1.89%
95+	50.54	42.19	-8.35	-16.5	0.90%
Total	5.47	5.58	0.11	2.0	-0.10%
1984 ASDR	5.47	4.23	-1.25	-22.8	1.28%
2004 ASDR	7.19	5.58	-1.61	-22.4	1.26%
		Standard Error			
Total	0.16	0.19	0.24		
1984 ASDR	0.16	0.15	0.22		
2004 ASDR	0.20	0.19	0.28		
		t-statistic			
Total	35.02	29.69	0.45		
1984 ASDR	35.02	28.21	-5.76		
2004 ASDR	35.35	29.69	-5.80		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. Assisted Living Communiites were an option only in 2004; this category includes Assisted Living Facilities, Continuing Care Retirement Communities, Congregate Care Facilitites, Retirement Homes, Group Homes, and Elderly Communities, each with varying degrees of assistance.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Tables 1.18 and 1.19 present unisex HIPAA ADL prevalence rates for 1984 and 2004 for community residents including and excluding, respectively, ALC residents in 2004. Exclusion of ALC residents in 2004 yielded a 2.9% increase in both ASDR changes (e.g., the 2004 ASDR decline of 24.1% in Table 1.18 changed to a decline of 27.0% in Table 1.19).

Tables 1.20 and 1.21 present the corresponding results for institutional residents excluding and including, respectively, ALC residents in 2004. Inclusion of ALC residents in 2004 reversed the direction of both ASDR changes (e.g., the 2004 ASDR increase of 7.8% in Table 1.20 reversed to a decline of 14.2% in Table 1.21).

[10] The NLTCS used a separate variable to code ALC which allowed institutional residents to be jointly coded as residing in a nursing home and in an ALC. This report does not employ this joint coding. Instead, ALC information is used only for the non-institutional population. To assess the impact of ALC, we exclude ALC from the community population in some tables and include ALC with the institutional population in others.

Table 1.18

Percent of Community Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.49	2.00	-0.49	-19.7	1.09%
70-74	3.75	2.80	-0.95	-25.3	1.45%
75-79	5.30	4.65	-0.64	-12.2	0.65%
80-84	8.56	6.43	-2.14	-25.0	1.43%
85-89	13.77	10.17	-3.60	-26.2	1.51%
90-94	26.10	16.30	-9.80	-37.5	2.33%
95+	42.69	33.48	-9.21	-21.6	1.21%
Total	5.30	4.98	-0.32	-6.0	0.31%
1984 ASDR	5.30	4.09	-1.21	-22.8	1.29%
2004 ASDR	6.56	4.98	-1.58	-24.1	1.37%
		Standard Error			
Total	0.16	0.19	0.25		
1984 ASDR	0.16	0.17	0.23		
2004 ASDR	0.21	0.19	0.28		
		t-statistic			
Total	32.24	26.51	-1.28		
1984 ASDR	32.24	24.74	-5.18		
2004 ASDR	31.52	26.51	-5.63		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community unisex population.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.19

Percent of Non-ALC Community Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.49	1.96	-0.53	-21.3	1.19%
70-74	3.75	2.76	-0.99	-26.5	1.53%
75-79	5.30	4.46	-0.83	-15.7	0.85%
80-84	8.56	5.92	-2.64	-30.8	1.83%
85-89	13.77	9.71	-4.06	-29.5	1.73%
90-94	26.10	16.15	-9.95	-38.1	2.37%
95+	42.69	32.65	-10.04	-23.5	1.33%
Total	5.30	4.69	-0.61	-11.5	0.61%
1984 ASDR	5.30	3.94	-1.36	-25.7	1.47%
2004 ASDR	6.43	4.69	-1.73	-27.0	1.56%
		Standard Error			
Total	0.16	0.18	0.25		
1984 ASDR	0.16	0.16	0.23		
2004 ASDR	0.20	0.18	0.27		
		t-statistic			
Total	32.24	25.45	-2.46		
1984 ASDR	32.24	24.00	-5.86		
2004 ASDR	31.71	25.45	-6.33		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted non-ALC community unisex population. ALC residents were excluded only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.20

Percent of Institutional Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	75.41	64.49	-10.92	-14.5	0.78%
70-74	63.06	90.26	27.19	43.1	-1.81%
75-79	77.98	69.76	-8.22	-10.5	0.56%
80-84	76.63	84.96	8.32	10.9	-0.52%
85-89	78.25	88.11	9.86	12.6	-0.59%
90-94	81.24	82.38	1.14	1.4	-0.07%
95+	85.21	93.93	8.73	10.2	-0.49%
Total	76.91	84.03	7.12	9.3	-0.44%
1984 ASDR	76.91	82.72	5.80	7.5	-0.36%
2004 ASDR	77.92	84.03	6.11	7.8	-0.38%
		Standard Error			
Total	1.31	1.55	2.03		
1984 ASDR	1.31	1.81	2.23		
2004 ASDR	1.32	1.55	2.04		
		t-statistic			
Total	58.91	54.08	3.51		
1984 ASDR	58.91	45.81	2.60		
2004 ASDR	59.10	54.08	3.00		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional unisex population.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.21

Percent of Institutional/ALC Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	75.41	39.53	-35.88	-47.6	3.18%
70-74	63.06	71.15	8.09	12.8	-0.61%
75-79	77.98	56.28	-21.70	-27.8	1.62%
80-84	76.63	67.58	-9.05	-11.8	0.63%
85-89	78.25	68.21	-10.05	-12.8	0.68%
90-94	81.24	69.48	-11.77	-14.5	0.78%
95+	85.21	76.32	-8.88	-10.4	0.55%
Total	76.91	66.80	-10.11	-13.1	0.70%
1984 ASDR	76.91	65.37	-11.54	-15.0	0.81%
2004 ASDR	77.90	66.80	-11.10	-14.2	0.77%
		Standard Error			
Total	1.31	1.71	2.15		
1984 ASDR	1.31	1.81	2.23		
2004 ASDR	1.31	1.71	2.15		
		t-statistic			
Total	58.91	39.13	-4.70		
1984 ASDR	58.91	36.17	-5.18		
2004 ASDR	59.36	39.13	-5.15		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional/ALC unisex population. ALC residents were included only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

The community results in Table 1.18 are of interest because they are the only results that will continue to be directly comparable with other sources of information on ADL morbidity trends among the U.S. elderly, which are generally restricted to the non-institutionalized population (Freedman et al., 2013).

The decrease in the unstandardized HIPAA ADL prevalence rate from 5.3% in 1984 to 5.0% in 2004 produced a *t*-statistic ($|t| = 1.28$) that was not statistically significant. This contrasts with both ASDRs for which the *t*-statistics ($|t| = 5.18$ and 5.63) were statistically highly significant.

Thus, our results for the unstandardized HIPAA ADL prevalence rates implied that one should not expect to find significant temporal trends when looking at similarly defined ADL prevalence rates in other studies. This is consistent with the findings of relatively flat unstandardized prevalence rates for 1+ ADL limitations for the period 2000–2008 in four other national surveys in Freedman et al. (2013).

In contrast, our results for the HIPAA ADL ASDRs implied that one should expect to find significant temporal trends when looking at similarly defined ASDRs in other studies only if the study interval is on the order of 10+ years, but not for 5-year intervals, unless the sample sizes are substantially larger than those of the NLTCS.

The results in Table 1.20 show that the decline in the rates of institutionalization (Table 1.16) was accompanied by an increase in the HIPAA ADL ASDRs among institutionalized persons, with the 2004 ASDRs increasing from 77.9% to 84.0% for which the *t*-statistic (3.00) was statistically significant. The increase in disability and post-acute care needs among nursing home residents was first noted by Bishop (1999).

Tables 1.22–1.25 and Tables 1.26–1.29 present corresponding results for males and females, respectively.

Tables 1.22 and 1.26 jointly show that the relative and absolute rates of morbidity improvement among community residents were much larger for males than females. Indeed, for males the decline in the unstandardized HIPAA ADL prevalence rate was large enough to yield a statistically significant *t*-statistic ($|t| = 2.40$).

Tables 1.24 and 1.28 jointly show that the relative and absolute rates of morbidity deterioration among institutional residents were much larger for females than males, with the *t*-statistics for all three aggregate measures being statistically significant for females and not statistically significant for males.

Table 1.22

Percent of Community Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.40	1.80	-0.60	-24.9	1.42%
70-74	4.21	2.76	-1.45	-34.4	2.09%
75-79	5.65	4.74	-0.90	-16.0	0.87%
80-84	8.69	5.82	-2.87	-33.0	1.98%
85-89	13.45	7.14	-6.31	-46.9	3.12%
90-94	22.92	14.09	-8.83	-38.5	2.40%
95+	37.15	17.43	-19.72	-53.1	3.71%
Total	4.96	4.08	-0.88	-17.7	0.97%
1984 ASDR	4.96	3.45	-1.51	-30.5	1.80%
2004 ASDR	6.04	4.08	-1.96	-32.4	1.94%
		Standard Error			
Total	0.25	0.26	0.37		
1984 ASDR	0.25	0.24	0.35		
2004 ASDR	0.32	0.26	0.42		
		t-statistic			
Total	19.59	15.42	-2.40		
1984 ASDR	19.59	14.52	-4.35		
2004 ASDR	18.83	15.42	-4.71		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community male population.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.23

Percent of Non-ALC Community Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.40	1.80	-0.60	-24.9	1.42%
70-74	4.21	2.73	-1.49	-35.3	2.15%
75-79	5.65	4.77	-0.88	-15.6	0.85%
80-84	8.69	5.34	-3.35	-38.5	2.40%
85-89	13.45	7.08	-6.37	-47.4	3.16%
90-94	22.92	14.70	-8.22	-35.8	2.20%
95+	37.15	16.19	-20.96	-56.4	4.07%
Total	4.96	3.97	-0.99	-19.9	1.10%
1984 ASDR	4.96	3.39	-1.57	-31.6	1.88%
2004 ASDR	5.97	3.97	-2.00	-33.5	2.02%
		Standard Error			
Total	0.25	0.26	0.36		
1984 ASDR	0.25	0.24	0.35		
2004 ASDR	0.32	0.26	0.41		
		t-statistic			
Total	19.59	15.15	-2.71		
1984 ASDR	19.59	14.33	-4.51		
2004 ASDR	18.94	15.15	-4.88		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted non-ALC community male population. ALC residents were excluded only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.24

Percent of Institutional Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	71.48	64.44	-7.05	-9.9	0.52%
70-74	63.32	86.72	23.40	36.9	-1.58%
75-79	76.14	57.45	-18.69	-24.5	1.40%
80-84	80.04	78.39	-1.65	-2.1	0.10%
85-89	77.58	85.93	8.35	10.8	-0.51%
90-94	70.34	80.62	10.28	14.6	-0.68%
95+	65.64	85.41	19.77	30.1	-1.33%
Total	73.62	76.46	2.84	3.9	-0.19%
1984 ASDR	73.62	75.76	2.14	2.9	-0.14%
2004 ASDR	74.38	76.46	2.09	2.8	-0.14%
		Standard Error			
Total	2.80	3.60	4.56		
1984 ASDR	2.80	3.82	4.74		
2004 ASDR	2.85	3.60	4.59		
		t-statistic			
Total	26.29	21.24	0.62		
1984 ASDR	26.29	19.83	0.45		
2004 ASDR	26.13	21.24	0.45		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional male population.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.25

Percent of Institutional/ALC Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	71.48	59.20	-12.28	-17.2	0.94%
70-74	63.32	66.36	3.04	4.8	-0.23%
75-79	76.14	48.02	-28.12	-36.9	2.28%
80-84	80.04	66.32	-13.72	-17.1	0.94%
85-89	77.58	60.60	-16.98	-21.9	1.23%
90-94	70.34	53.32	-17.02	-24.2	1.38%
95+	65.64	69.71	4.07	6.2	-0.30%
Total	73.62	59.84	-13.78	-18.7	1.03%
1984 ASDR	73.62	59.45	-14.17	-19.2	1.06%
2004 ASDR	74.35	59.84	-14.51	-19.5	1.08%
		Standard Error			
Total	2.80	3.60	4.56		
1984 ASDR	2.80	3.87	4.78		
2004 ASDR	2.90	3.60	4.62		
		t-statistic			
Total	26.29	16.62	-3.02		
1984 ASDR	26.29	15.35	-2.96		
2004 ASDR	25.65	16.62	-3.14		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional/ALC male population. ALC residents were included only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.26

Percent of Community Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.56	2.17	-0.39	-15.1	0.82%
70-74	3.42	2.84	-0.58	-17.0	0.93%
75-79	5.08	4.58	-0.49	-9.7	0.51%
80-84	8.49	6.83	-1.67	-19.6	1.09%
85-89	13.91	11.89	-2.02	-14.5	0.78%
90-94	27.21	17.31	-9.90	-36.4	2.24%
95+	44.13	38.21	-5.93	-13.4	0.72%
Total	5.53	5.65	0.12	2.2	-0.11%
1984 ASDR	5.53	4.57	-0.96	-17.3	0.95%
2004 ASDR	6.94	5.65	-1.30	-18.7	1.03%
		Standard Error			
Total	0.22	0.26	0.34		
1984 ASDR	0.22	0.23	0.31		
2004 ASDR	0.28	0.26	0.38		
		t-statistic			
Total	25.60	21.61	0.35		
1984 ASDR	25.60	20.02	-3.04		
2004 ASDR	25.15	21.61	-3.41		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community female population.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.27

Percent of Non-ALC Community Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.56	2.10	-0.46	-18.0	0.99%
70-74	3.42	2.79	-0.63	-18.5	1.02%
75-79	5.08	4.24	-0.84	-16.5	0.90%
80-84	8.49	6.31	-2.18	-25.7	1.47%
85-89	13.91	11.27	-2.64	-19.0	1.05%
90-94	27.21	16.80	-10.41	-38.3	2.38%
95+	44.13	38.18	-5.95	-13.5	0.72%
Total	5.53	5.23	-0.29	-5.3	0.27%
1984 ASDR	5.53	4.35	-1.18	-21.4	1.19%
2004 ASDR	6.77	5.23	-1.53	-22.7	1.28%
		Standard Error			
Total	0.22	0.26	0.33		
1984 ASDR	0.22	0.23	0.31		
2004 ASDR	0.27	0.26	0.37		
		t-statistic			
Total	25.60	20.49	-0.88		
1984 ASDR	25.60	19.25	-3.78		
2004 ASDR	25.30	20.49	-4.14		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted non-ALC community female population. ALC residents were excluded only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.28

Percent of Institutional Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	77.97	64.65	-13.32	-17.1	0.93%
70-74	62.91	92.88	29.97	47.6	-1.97%
75-79	78.83	76.96	-1.87	-2.4	0.12%
80-84	75.63	87.71	12.08	16.0	-0.74%
85-89	78.40	88.55	10.16	13.0	-0.61%
90-94	83.59	82.76	-0.83	-1.0	0.05%
95+	88.39	95.36	6.97	7.9	-0.38%
Total	77.97	86.59	8.63	11.1	-0.53%
1984 ASDR	77.97	85.40	7.43	9.5	-0.46%
2004 ASDR	79.11	86.59	7.48	9.5	-0.45%
		Standard Error			
Total	1.47	1.69	2.24		
1984 ASDR	1.47	2.53	2.93		
2004 ASDR	1.49	1.69	2.25		
		t-statistic			
Total	52.88	51.20	3.84		
1984 ASDR	52.88	33.69	2.53		
2004 ASDR	53.15	51.20	3.32		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional female population.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 1.29

Percent of Institutional/ALC Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	77.97	25.74	-52.24	-67.0	5.39%
70-74	62.91	74.88	11.98	19.0	-0.88%
75-79	78.83	60.11	-18.72	-23.7	1.35%
80-84	75.63	68.09	-7.54	-10.0	0.52%
85-89	78.40	69.89	-8.51	-10.9	0.57%
90-94	83.59	74.17	-9.42	-11.3	0.60%
95+	88.39	77.37	-11.02	-12.5	0.66%
Total	77.97	69.13	-8.84	-11.3	0.60%
1984 ASDR	77.97	67.54	-10.43	-13.4	0.72%
2004 ASDR	79.03	69.13	-9.90	-12.5	0.67%
		Standard Error			
Total	1.47	1.93	2.43		
1984 ASDR	1.47	2.02	2.50		
2004 ASDR	1.47	1.93	2.43		
		t-statistic			
Total	52.88	35.85	-3.64		
1984 ASDR	52.88	33.38	-4.17		
2004 ASDR	53.68	35.85	-4.08		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional/ALC female population. ALC residents were included only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

SECTION 2: CI MORBIDITY IMPROVEMENT

The secondary focus of the study was on the changes over time in the HIPAA CI morbidity rates and the impact of those changes on lifetime disability both separately and in combination with the HIPAA ADL morbidity rates. This was important because the HIPAA CI trigger accounted for an additional 23.6% morbidity beyond that attributable to the HIPAA ADL trigger, based on data from the 2004 NLTCS in Tables 1.7 and 2.20. Analyses of the changes over time in the CI and ADL/CI morbidity rates required estimation of comparable tables from the 1984 NLTCS.

Subsection 3 of Introduction identified two analytic challenges in implementing the simulated HIPAA CI trigger across the multiple waves of the NLTCS:

1. The NLTCS screener component of the substantial supervision criteria was fully known for the 1982 and 2004 surveys but was missing information for the other years, including our targeted year 1984.
2. The NLTCS institutional component of the caregiver report for non-completion of the SPMSQ or MMSE was fully known for the 1999 and 2004 surveys but was missing information for the other years, also including our targeted year 1984.

The first challenge was considered to be of minor significance for the 1984 NLTCS because the same information was queried at the time of the 1984 detailed interview for respondents designated to receive that interview without screening, due to their either (1) having screened in during the 1982 NLTCS or (2) having been institutionalized at the time of the 1984 NLTCS screening.

The second challenge was of greater significance because the NLTCS was originally designed to assess ADL and IADL disabilities without fully considering how those disabilities would interact with cognitive impairment.

The 1984 expansion of the protocol for the detailed interview to include institutionalized persons meant that the NLTCS became representative of the entire elderly population. The 1984 institutional interview, however, was not identical to the 1984 community interview, nor was it made so for any later year: differences involved the IADL and cognitive assessments. The IADL differences were considered to be of minor significance because institutionalized persons typically did not perform such activities (except getting around outdoors, which was queried) during episodes of institutionalization.

The differences in cognitive assessment were of greater significance and they did not appear to be easily resolvable prior to the current study, during which they were examined in detail and a resolution developed.

Table 2.1 compares the relevant protocols used in the 1984 and 2004 NLTCS. The only difference was the lack of information regarding the presence or absence of a caregiver report of CI (i.e., Alzheimer's disease, dementia, or other cognition problems sufficient to prevent completion of the SPMSQ) for institutionalized respondents who did not complete the SPMSQ in 1984. This information was collected in 2004 and was used in a weighted logistic regression model to evaluate the missing fractions of the respective subpopulation that would have been cognitively impaired in 1984, conditional on age, sex, ADL status, and length of stay (LOS).

Table 2.1
Cognitive Assessment Protocols in the 1984 and 2004 NLTCS

	Year and Survey Component			
	1984		2004	
Protocol	Community Interview	Institutional Interview	Community Interview	Institutional Interview
SPMSQ was Administered (Self-respondent Only)	Yes	Yes	Yes	Yes
Caregiver Report of CI was Taken	Yes	**No**	Yes	Yes

Source: http://www.nltcs.aas.duke.edu

This section has eight parts. *First*, we present statistics from the 2004 NLTCS to motivate the logistic regression model for imputing the missing CI fractions for the 1984 institutionalized respondents. *Second*, we present the HIPAA CI morbidity rates and their changes for the combined community/institutional populations aged 65+ for 1984 and 2004. *Third*, we present the corresponding results for the combined HIPAA ADL and CI triggers. *Fourth*, we present the disabled life expectancies (DLEs) for 1984 and 2004, and their changes, based on the HIPAA CI trigger and the combined ADL/CI triggers. *Fifth*, we present the HIPAA CI morbidity rates for the community and institutional subpopulations for 1984 and 2004. *Sixth*, we present the corresponding combined HIPAA ADL/CI morbidity rates for the same subpopulations and years. *Seventh*, we present the corresponding results for two alternative forms of the HIPAA CI trigger, based on 4+ and 5+ SPMSQ errors. *Eighth*, we present alternative sets of DLE changes using 5+ SPMSQ errors in the CI trigger.

1. Imputing the Missing Cognitive Status of Institutional Residents in the 1984 NLTCS

Table 2.2 displays unweighted unisex tabulations of the number of respondents in the 2004 survey stratified by combinations of the simulated HIPAA ADL and CI triggers.

The rows of the table were stratified according to the number of ADLs that were impaired using the HIPAA criterion of active or standby personal assistance (impairment levels 3–5), or if none, according to whether the respondents were institutionalized, or if not, whether they were impaired with respect to any IADL or inside mobility.

The category *IADL/Inside-Mobility/Institutional* was defined (see Section 1.4) to include certain respondents with low levels of disability that did not meet the HIPAA ADL criteria. Inside mobility was not included among the six ADLs that comprised the HIPAA ADL trigger but it was one of the six ADLs in the traditional NLTCS disability classification. By grouping inside mobility with the IADLs, we could ensure that community respondents with impairments only in inside mobility were not erroneously classified as nondisabled. Institutionalized respondents with no ADL impairments were also included in this group to ensure that they were classified as disabled in these tabulations.

Table 2.2
Unweighted Distribution of HIPAA Triggers by ADL/IADL Disability Level, 2004 NLTCS, Unisex, Age 65 and Above

	HIPAA Trigger				
ADL/IADL Disability Level	Neither	CI Only	ADL Only	ADL & CI	Total
	Number of Persons				
Nondisabled	11,990	28			12,018
IADL/Inside-Mobility/Institutional	1,303	243			1,546
1 ADL	413	164			577
2 ADLs			144	122	266
3 ADLs			136	119	255
4 ADLs			151	163	314
5 ADLs			180	300	480
6 ADLs			101	436	537
Total	13,706	435	712	1,140	15,993

Note: IADL/Inside-Mobility/Institutional describes certain NLTCS respondents with with no ADL impairments at the time of the detailed interview: it includes community residents with IADL or inside-mobility impairments and institutional residents. All other community residents with no ADL impairments were classified as nondisabled. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.3 displays the corresponding unweighted unisex tabulations for the subsample of 970 institutional residents in the 2004 survey. All were coded as disabled using the ADL/IADL disability criteria described above. However, 6.2% (60/970) met neither HIPAA trigger and 7.1% (69/970) met only the HIPAA CI trigger. The remaining 86.7% met the HIPAA ADL trigger alone or in combination with the CI trigger.

Table 2.3
Unweighted Distribution of HIPAA Triggers by ADL/IADL Disability Level, 2004 NLTCS, Unisex, Age 65 and Above, Institutional Residents

	HIPAA Trigger				
ADL/IADL Disability Level	Neither	CI Only	ADL Only	ADL & CI	Total
	Number of Persons				
Nondisabled					
IADL/Inside-Mobility/Institutional	19	25			44
1 ADL	41	44			85
2 ADLs			22	50	72
3 ADLs			33	67	100
4 ADLs			47	93	140
5 ADLs			53	181	234
6 ADLs			26	269	295
Total	60	69	181	660	970

Note: IADL/Inside-Mobility/Institutional describes certain NLTCS respondents with with no ADL impairments at the time of the detailed interview: it includes community residents with IADL or inside-mobility impairments and institutional residents. All other community residents with no ADL impairments were classified as nondisabled. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.4 displays the corresponding unweighted unisex tabulations for the subsample of 595 institutional residents in the 2004 survey for whom the SPMSQ was not administered. Only 1.5%

(9/595) met neither HIPAA trigger; 3.9% (23/595) met only the HIPAA CI trigger. The remaining 94.6% met the HIPAA ADL trigger alone or in combination with the CI trigger.

Table 2.4
Unweighted Distribution of HIPAA Triggers by ADL/IADL Disability Level, 2004 NLTCS, Unisex, Age 65 and Above, Institutional Residents without SPMSQ Results

	HIPAA Trigger				
ADL/IADL Disability Level	Neither	CI Only	ADL Only	ADL & CI	Total
	Number of Persons				
Nondisabled					
IADL/Inside-Mobility/Institutional	1	7			8
1 ADL	8	16			24
2 ADLs			4	26	30
3 ADLs			9	42	51
4 ADLs			9	64	73
5 ADLs			21	134	155
6 ADLs			14	240	254
Total	9	23	57	506	595

Note: IADL/Inside-Mobility/Institutional describes certain NLTCS respondents with with no ADL impairments at the time of the detailed interview: it includes community residents with IADL or inside-mobility impairments and institutional residents. All other community residents with no ADL impairments were classified as nondisabled. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.5 displays the corresponding weighted unisex tabulations for the 595 institutional residents (shown as unweighted counts in Table 2.4) in the 2004 survey for whom the SPMSQ was not administered. The bottom panel of the table provides the weighted percentages for the corresponding weighted counts.

Only 1.8% of the non-SPMSQ institutional residents met neither HIPAA trigger (vs. 1.5% unweighted); 4.5% met only the CI trigger (vs. 3.9% unweighted). The remaining 93.7% met the ADL trigger alone (9.2%) or in combination with the CI trigger (84.5%).

Thus, 89.0% of the non-SPMSQ institutional residents met the HIPAA CI trigger. This supports the assumption often made during the early waves of the NLTCS that the lack of a completed SPMSQ was indicative of cognitive impairment. However, the assumption was only an approximation which can now be improved upon by explicitly modeling the relative frequency of cognitive impairment among such persons.

Also note that 98.2% of the non-SPMSQ institutional residents met at least one HIPAA trigger. This strongly supports the more expansive assumption that the lack of a completed SPMSQ was indicative of physical and/or cognitive impairment at a level consistent with the HIPAA criteria.

Table 2.6 displays the corresponding weighted tabulations for all institutional residents: 7.8% met neither HIPAA trigger, implying that 92.2% met at least one trigger. While 64.9% of institutional residents met both HIPAA triggers, an additional 8.2% met only the CI trigger, underscoring the importance of the CI trigger and motivating our effort to estimate the missing CI fractions for the 1984 non-SPMSQ institutional residents to facilitate analysis of the cross-temporal changes involving the CI trigger.

Table 2.5
Distribution of HIPAA Triggers by ADL/IADL Disability Level, United States 2004, Unisex, Age 65 and Above, Institutional Residents without SPMSQ Results

	HIPAA Trigger					
ADL/IADL Disability Level	Neither	CI Only	ADL Only	ADL & CI	Total	Std Error (%-CI)
			Number of Persons			
Nondisabled						
IADL/Inside-Mobility/Institutional	419	8,967			9,386	
1 ADL	15,057	29,860			44,917	
2 ADLs			3,061	40,570	43,631	
3 ADLs			14,350	69,475	83,824	
4 ADLs			15,180	92,840	108,020	
5 ADLs			25,384	185,941	211,325	
6 ADLs			20,754	334,118	354,872	
Total	15,475	38,827	78,730	722,943	855,976	
			Percent Distribution			
Nondisabled						
IADL/Inside-Mobility/Institutional	4.5	95.5			100.0	11.1
1 ADL	33.5	66.5			100.0	11.6
2 ADLs			7.0	93.0	100.0	6.3
3 ADLs			17.1	82.9	100.0	6.7
4 ADLs			14.1	85.9	100.0	5.5
5 ADLs			12.0	88.0	100.0	3.7
6 ADLs			5.8	94.2	100.0	2.0
Total	1.8	4.5	9.2	84.5	100.0	1.8
Std Error (Tot Pct)	0.7	1.2	1.6	2.0		

Note: IADL/Inside-Mobility/Institutional describes certain NLTCS respondents with with no ADL impairments at the time of the detailed interview: it includes community residents with IADL or inside-mobility impairments and institutional residents. All other community residents with no ADL impairments were classified as nondisabled. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.7 displays the weighted tabulations for all institutional residents, stratified by SPMSQ status: missing the SPMSQ assessment (non-SPMSQ respondents) vs. those with 0–2 or 3+ errors. Among the non-SPMSQ institutional residents, 4.5% (38,827 persons) met only the CI trigger; this contrasts with 26.6% of the subpopulation with 3+ SPMSQ errors who met only the CI trigger.

Table 2.8 displays the corresponding weighted tabulations for the combined community and institutional populations. A total of 3.66 million persons met at least one HIPAA trigger; the 38,827 non-SPMSQ institutional residents in Table 2.7 that met only the CI trigger represented 1.1% of this total. Similarly, a total of 2.42 million persons met the CI trigger (with or without meeting the ADL trigger); the 38,827 non-SPMSQ institutional residents represented 1.6% of this total. In both cases, the relatively small size of the non-SPMSQ institutional resident subpopulation that met only the CI trigger indicates that the potential impact of any biases in estimation of their CI triggers should be small.

The 12.5% in Table 2.8 with 3+ errors on the SPMSQ (168,054 persons) who met neither HIPAA trigger represented rejections due to the substantial supervision criterion, as described in Subsection 3 of Introduction. All of these persons were community residents with no IADL or ADL impairments at the screener or detailed interviews.

Table 2.6
Distribution of HIPAA Triggers by ADL/IADL Disability Level, United States 2004, Unisex, Age 65 and Above, Institutional Residents

	HIPAA Trigger					
ADL/IADL Disability Level	Neither	CI Only	ADL Only	ADL & CI	Total	Std Error (%-CI)
			Number of Persons			
Nondisabled						
IADL/Inside-Mobility/Institutional	32,560	40,695			73,255	
1 ADL	80,468	79,072			159,540	
2 ADLs			36,101	77,891	113,992	
3 ADLs			54,686	107,306	161,992	
4 ADLs			73,779	132,009	205,787	
5 ADLs			74,079	248,208	322,287	
6 ADLs			40,252	380,960	421,211	
Total	113,029	119,767	278,896	946,373	1,458,065	
			Percent Distribution			
Nondisabled						
IADL/Inside-Mobility/Institutional	44.4	55.6			100.0	9.5
1 ADL	50.4	49.6			100.0	6.5
2 ADLs			31.7	68.3	100.0	7.1
3 ADLs			33.8	66.2	100.0	6.1
4 ADLs			35.9	64.1	100.0	5.5
5 ADLs			23.0	77.0	100.0	3.8
6 ADLs			9.6	90.4	100.0	2.3
Total	7.8	8.2	19.1	64.9	100.0	1.9
Std Error (Tot Pct)	1.1	1.2	1.7	2.1		

Note: IADL/Inside-Mobility/Institutional describes certain NLTCS respondents with with no ADL impairments at the time of the detailed interview: it includes community residents with IADL or inside-mobility impairments and institutional residents. All other community residents with no ADL impairments were classified as nondisabled. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.7
Distribution of HIPAA Triggers by SPMSQ Score, United States 2004, Unisex, Age 65 and Above, Institutional Residents

	HIPAA Trigger					
SPMSQ Score	Neither	CI Only	ADL Only	ADL & CI	Total	Std Error (%-CI)
			Number of Persons			
Missing	15,475	38,827	78,730	722,943	855,976	
0-2 Errors	97,553		200,166		297,719	
3+ Errors		80,939		223,430	304,370	
Total	113,029	119,767	278,896	946,373	1,458,065	
			Percent Distribution			
Missing	1.8	4.5	9.2	84.5	100.0	1.8
0-2 Errors	32.8		67.2		100.0	0.0
3+ Errors		26.6		73.4	100.0	0.0
Total	7.8	8.2	19.1	64.9	100.0	1.9
Std Error (Tot Pct)	1.1	1.2	1.7	2.1		

Note: The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.8
Distribution of HIPAA Triggers by SPMSQ Score, United States 2004, Unisex, Age 65 and Above

SPMSQ Score	HIPAA Trigger Neither	CI Only	ADL Only	ADL & CI	Total	Std Error (%-CI)
			Number of Persons			
Missing	24,546,440	149,057	302,665	1,100,733	26,098,896	
0-2 Errors	7,875,225		928,932		8,804,156	
3+ Errors	168,054	549,190		625,029	1,342,273	
Total	32,589,719	698,247	1,231,597	1,725,762	36,245,325	
			Percent Distribution			
Missing	94.1	0.6	1.2	4.2	100.0	0.2
0-2 Errors	89.4		10.6		100.0	0.0
3+ Errors	12.5	40.9		46.6	100.0	1.5
Total	89.9	1.9	3.4	4.8	100.0	0.2
Std Error (Tot Pct)	0.3	0.1	0.2	0.2		

Note: The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.9 displays weighted tabulations for the combined community and institutional populations stratified by ADL/IADL disability levels, as in Tables 2.5 and 2.6. The CI triggering rates for the combined population exhibited a monotonic increase over the ADL counts, increasing from 26.5% to 78.2% at 1 and 6 ADLs, respectively.

Table 2.9
Distribution of HIPAA Triggers by ADL/IADL Disability Level, United States 2004, Unisex, Age 65 and Above

ADL/IADL Disability Level	HIPAA Trigger Neither	CI Only	ADL Only	ADL & CI	Total	Std Error (%-CI)
			Number of Persons			
Nondisabled	29,675,587	64,014			29,739,601	
IADL/Inside-Mobility/Institutional	2,215,298	382,542			2,597,840	
1 ADL	698,834	251,692			950,526	
2 ADLs			268,546	202,027	470,573	
3 ADLs			231,219	192,294	423,514	
4 ADLs			261,289	257,720	519,009	
5 ADLs			294,215	440,844	735,060	
6 ADLs			176,327	632,877	809,204	
Total	32,589,719	698,247	1,231,597	1,725,762	36,245,325	
			Percent Distribution			
Nondisabled	99.8	0.2			100.0	0.0
IADL/Inside-Mobility/Institutional	85.3	14.7			100.0	1.1
1 ADL	73.5	26.5			100.0	2.3
2 ADLs			57.1	42.9	100.0	3.7
3 ADLs			54.6	45.4	100.0	4.0
4 ADLs			50.3	49.7	100.0	3.6
5 ADLs			40.0	60.0	100.0	3.0
6 ADLs			21.8	78.2	100.0	2.4
Total	89.9	1.9	3.4	4.8	100.0	0.2
Std Error (Tot Pct)	0.3	0.1	0.2	0.2		

Note: IADL/Inside-Mobility/Institutional describes certain NLTCS respondents with with no ADL impairments at the time of the detailed interview: it includes community residents with IADL or inside-mobility impairments and institutional residents. All other community residents with no ADL impairments were classified as nondisabled. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

The corresponding CI triggering rates for institutional residents (Table 2.6) increased from 49.6% to 90.4% and, for the subpopulation of non-SPMSQ institutional residents (Table 2.5), the rates increased from 66.5% to 94.2%.

The CI triggering rates for the category *IADL/Inside-Mobility/Institutional* differed substantially between the different populations, increasing from 14.7% for the complete population (Table 2.9) to 55.6% for the institutionalized population (Table 2.6) to 95.5% for non-SPMSQ institutional residents (Table 2.5), indicating that this disability category should be considered separately from the ADL categories in the logistic regression model for the non-SPMSQ institutional residents.

Table 2.10 displays the logistic regression parameters and test statistics for the non-SPMSQ institutional residents based on the unweighted tabulations for combinations of age, sex, ADL status, and institutional LOS, computed using SAS 9.2 Procedure LOGISTIC.

Table 2.10
Unweighted Logistic Regression for HIPAA CI Trigger, United States 2004, Age 65 and Above, Institutional Residents without SPMSQ Results

	Model					
Predictors	0	1	2	3	4	5
			Parameter			
Intercept	2.081	0.784	0.568	0.701	0.686	0.724
#ADLs		0.290	0.334	0.314	0.314	0.337
No ADLs			1.378	1.337	1.345	1.431
Missing LOS				-0.415	-0.407	-0.349
Institutional LOS				0.003	0.003	0.004
Sex					0.062	-0.030
Age						-0.027
			Standard Error			
Intercept	0.131	0.343	0.373	0.389	0.398	0.402
#ADLs		0.075	0.082	0.084	0.084	0.086
No ADLs			1.132	1.136	1.137	1.139
Missing LOS				0.418	0.420	0.425
Institutional LOS				0.005	0.005	0.005
Sex					0.347	0.352
Age						0.018
			t-statistic			
Intercept	15.95	2.29	1.52	1.80	1.72	1.80
#ADLs		3.85	4.08	3.75	3.76	3.93
No ADLs			1.22	1.18	1.18	1.26
Missing LOS				-0.99	-0.97	-0.82
Institutional LOS				0.69	0.70	0.88
Sex					0.18	-0.08
Age						-1.48
No. of parameters	1	2	3	5	6	7
−2 log *L*	414.65	400.80	398.91	396.74	396.70	394.46
AIC	416.65	**404.80**	404.91	406.74	408.70	408.46
BIC	421.04	**413.57**	418.07	428.68	435.03	439.18

Note: Intercept reflects constant value for females aged 85 years old (last birthday) whose current length of stay (LOS) was 30 months. LOS was missing for 52 respondents (coded Missing LOS = 1). Actual sample size = 595; effective sample size = 390.63.

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.11 displays the corresponding results based on the weighted tabulations for the same combinations of predictors, computed using SAS 9.2 Procedure SURVEYLOGISTIC.

Table 2.11
Weighted Logistic Regression for HIPAA CI Trigger, United States 2004, Age 65 and Above, Institutional Residents without SPMSQ Results

	Model					
Predictors	0	1	2	3	4	5
			Parameter			
Intercept	2.090	0.883	0.674	0.754	0.661	0.664
#ADLs		0.274	0.317	0.308	0.312	0.309
No ADLs			2.390	2.468	2.554	2.561
Missing LOS				-0.266	-0.226	-0.232
Institutional LOS				0.005	0.005	0.005
Sex					0.346	0.383
Age						0.009
			Standard Error			
Intercept	0.164	0.403	0.435	0.454	0.474	0.471
#ADLs		0.089	0.097	0.101	0.102	0.101
No ADLs			1.179	1.194	1.203	1.212
Missing LOS				0.531	0.523	0.524
Institutional LOS				0.005	0.005	0.005
Sex					0.448	0.463
Age						0.025
			t-statistic			
Intercept	12.73	2.19	1.55	1.66	1.39	1.41
#ADLs		3.08	3.27	3.06	3.07	3.05
No ADLs			2.03	2.07	2.12	2.11
Missing LOS				-0.50	-0.43	-0.44
Institutional LOS				0.90	1.00	0.98
Sex					0.77	0.83
Age						0.36
No. of parameters	1	2	3	5	6	7
−2 log *L*	270.81	262.48	260.51	259.34	258.62	258.48
AIC	272.81	**266.48**	266.51	269.34	270.62	272.48
BIC	276.78	**274.41**	278.41	289.18	294.42	300.25

Note: Intercept reflects constant value for females aged 85 years old (last birthday) whose current length of stay (LOS) was 30 months. LOS was missing for 52 respondents (coded Missing LOS = 1). Actual sample size = 595; effective sample size = 390.63.

Source: Authors' calculations based on the 2004 NLTCS.

Each table displays the parameter estimates, standard errors, and *t*-statistics for the baseline (Model 0) and five alternative models of increasing complexity. The panel at the bottom of each table shows the standard model fit statistics: −2 log *L* (Wilks, 1938), AIC (Akaike, 1974), and BIC (Schwarz, 1978).

The predictor *#ADLs* represents the count of the number of impaired ADLs as shown in Tables 2.4 and 2.5. The predictor *No ADLs* is a 0–1 indicator which took the value 1 when the ADL count was 0; and the value 0 when the ADL count was 1–6. This predictor was designed to accommodate the relatively high CI triggering rates for the category *IADL/Inside-Mobility/Institutional* in Table 2.5.

Institutional LOS represents the length of stay in months of the ongoing episode of institutionalization. *Missing LOS* is a 0–1 indicator which took the value 1 when *Institutional LOS* was unknown; and the value 0 when *Institutional LOS* was known. This predictor was designed to accommodate the possibility that such information was not missing at random, but instead was informative concerning the respondent.

Sex was coded 1 = male and 0 = female. *Age* was coded in years as age at last birthday.

To minimize the impact on the *Intercept*, *Age* was centered at 85 years and *Institutional LOS* at 30 months. In addition, *Institutional LOS* was capped at 120 months to minimize the impact of extreme outliers.

We expected, based on Tables 2.4 and 2.5, that *#ADLs* and *No ADLs* would be potentially important predictors. We suspected that *Sex*, *Age*, and *LOS* might be important but we did not have strong opinions in this regard. The AIC and BIC statistics were designed for model selection among sets of alternatives, with the "best model" being the one with the smallest value. For the AIC and BIC statistics in Tables 2.10 and 2.11, Model 1 was consistently favored. For both tables, the AIC statistics for Model 2 were almost identical to those for Model 1, indicating that Model 2 was a plausible alternative.

The *t*-statistic for *No ADLs* in Model 2 was statistically significant at the 5% level of significance in Table 2.11, but not in Table 2.10; this difference was due to the larger parameter estimate for *No ADLs* in Table 2.11 (i.e., their standard errors were similar).

The signs of the parameter estimates for *Sex* and *Age* in Model 5 differed between Tables 2.10 and 2.11, confirming that they did not contribute useful information to the analysis. The *LOS* variables in Model 3 had consistent signs but the associated AIC and BIC statistics indicated that there was a substantial risk of over-fitting if this model was accepted for further use.

Table 2.12
Observed and Predicted HIPAA CI Triggering Rates and Goodness of Fit Chi-Squared Statistics, Unweighted Logistic Regression Models 0, 1 and 2, United States 2004, Age 65 and Above, Institutional Residents without SPMSQ Results

		Predicted Rate (%)			Observed	Chi-Squared		
ADL Disability Level	Actual *n*	Model 0	Model 1	Model 2	Rate (%)	Model 0	Model 1	Model 2
0 ADLs	8	88.9	68.6	87.5	87.5	0.02	1.32	0.00
1 ADL	24	88.9	74.5	71.1	66.7	12.04	0.78	0.23
2 ADLs	30	88.9	79.6	77.5	86.7	0.15	0.92	1.45
3 ADLs	51	88.9	83.9	82.8	82.4	2.22	0.09	0.01
4 ADLs	73	88.9	87.5	87.0	87.7	0.11	0.00	0.03
5 ADLs	155	88.9	90.3	90.3	86.5	0.95	2.63	2.69
6 ADLs	254	88.9	92.6	92.9	94.5	8.02	1.37	0.99
Total	595	88.9	88.9	88.9	88.9	23.51	7.11	5.39
d.f.						6	5	4

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.12 presents the observed and predicted HIPAA CI triggering rates and goodness of fit chi-squared statistics for the individual levels of the predictor *#ADLs* under the unweighted Models 1 and 2; Table 2.13 presents the corresponding results for the weighted models.

Table 2.13
Observed and Predicted HIPAA CI Triggering Rates and Goodness of Fit Chi-Squared Statistics, Weighted Logistic Regression Models 0, 1 and 2, United States 2004, Age 65 and Above, Institutional Residents without SPMSQ Results

		Predicted Rate (%)			Observed	Chi-Squared		
ADL Disability Level	Effective *n*	Model 0	Model 1	Model 2	Rate (%)	Model 0	Model 1	Model 2
0 ADLs	4.3	89.0	70.7	95.5	95.5	0.19	1.27	0.00
1 ADL	20.5	89.0	76.1	72.9	66.5	10.61	1.04	0.43
2 ADLs	19.9	89.0	80.7	78.7	93.0	0.32	1.93	2.42
3 ADLs	38.3	89.0	84.6	83.6	82.9	1.46	0.09	0.01
4 ADLs	49.3	89.0	87.9	87.5	85.9	0.47	0.17	0.10
5 ADLs	96.4	89.0	90.5	90.6	88.0	0.10	0.71	0.74
6 ADLs	161.9	89.0	92.6	92.9	94.2	4.40	0.56	0.36
Total	390.6	89.0	89.0	89.0	89.0	17.55	5.77	4.07
d.f.						6	5	4

Source: Authors' calculations based on the 2004 NLTCS.

The chi-squared goodness of fit statistics were statistically significant in both tables for Model 0, at the 1% level of significance (i.e., $\chi^2 > 16.81$), but were not statistically significant in either table for Models 1 and 2, even at the 10% level of significance (i.e., $\chi^2 < 9.24$ for 5 d.f.; $\chi^2 < 7.78$ for 4 d.f.). Thus, Model 0 did not fit the data; Models 1 and 2 did.

The only difference between Models 1 and 2 was that, for Model 2, the predicted rate for 0 ADLs was constrained to exactly reproduce the observed rate, which explains the 0.00 chi-squared values for Model 2 for 0 ADLs in both tables. With this constraint, Model 2 was free to fit a slightly steeper gradient in the predicted CI triggering rates, increasing from 71.1% to 92.9% (Table 2.12) or from 72.9% to 92.9% (Table 2.13), at 1 and 6 ADLs, respectively.

Thus, Model 2 was selected as the preferred model for use in imputing the cognitive status of non-SPMSQ institutional residents in the 1984 NLTCS; these respondents did not have the requisite caregiver reports needed to independently determine their cognitive status. Because Model 2 excluded *Sex* and *Age*, two variables which were part of the sampling design of the NLTCS, we used only the weighted results from Tables 2.11 and 2.13 in this imputation.

2. HIPAA CI MORBIDITY

Table 2.14 presents the weighted tabulation of the number and percent of persons meeting the HIPAA CI trigger for the 1984 unisex data, using the same format as in Table 1.6. The overall CI prevalence rate was 9.2% with a 0.2% SE – identical to the overall ADL prevalence rate of 9.2% with a 0.2% SE in Table 1.6.

Table 2.14
Number and Percent of Persons Meeting HIPAA CI Trigger, United States 1984, Unisex, Age 65 and Above, by Age

Age	Meets HIPAA CI Trigger: No	Yes	Total	Percent	Std Error (Pct)
65-69	8,533,586	201,632	8,735,218	2.3%	0.2%
70-74	7,193,033	361,002	7,554,035	4.8%	0.3%
75-79	5,062,386	476,532	5,538,918	8.6%	0.5%
80-84	2,857,440	575,554	3,432,994	16.8%	0.8%
85-89	1,352,165	571,172	1,923,337	29.7%	1.3%
90-94	369,078	303,968	673,046	45.2%	2.3%
95+	75,410	101,955	177,364	57.5%	4.5%
Total	25,443,100	2,591,815	28,034,914	9.2%	0.2%

Note: The HIPAA CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 NLTCS.

Table 2.15 presents the corresponding weighted tabulation for 2004, using the format for the HIPAA ADL trigger in Table 1.7. The overall prevalence rate was 6.7% with a 0.2% SE – significantly smaller than the overall ADL prevalence rate of 8.2% in Table 1.7.

Table 2.15
Number and Percent of Persons Meeting HIPAA CI Trigger, United States 2004, Unisex, Age 65 and Above, by Age

Age	Meets HIPAA CI Trigger: No	Yes	Total	Percent	Std Error (Pct)
65-69	8,384,960	103,679	8,488,639	1.2%	0.2%
70-74	8,539,577	197,570	8,737,147	2.3%	0.3%
75-79	7,247,763	376,171	7,623,934	4.9%	0.4%
80-84	5,482,051	546,796	6,028,847	9.1%	0.6%
85-89	2,840,985	611,018	3,452,003	17.7%	1.1%
90-94	1,086,664	395,569	1,482,233	26.7%	1.9%
95+	239,316	193,207	432,523	44.7%	3.9%
Total	33,821,316	2,424,010	36,245,325	6.7%	0.2%

Note: The HIPAA CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.16 presents various cross-temporal comparisons of the age-specific and total prevalence rates for 1984 and 2004 shown in Tables 2.14 and 2.15.

The overall relative rate of decline (in Total) was 27.7%; the age-specific relative rates of decline ranged from 22.3% to 52.7%. The two sets of age-standardized prevalence rates yielded comparable relative rates of decline: 43.6% vs. 42.6%.

The standard errors of the unstandardized totals and ASDRs ranged from 0.17% to 0.25%; the standard errors of the differences ranged from 0.26% to 0.32%.

Table 2.16
Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.31	1.22	-1.09	-47.1	3.13%
70-74	4.78	2.26	-2.52	-52.7	3.67%
75-79	8.60	4.93	-3.67	-42.6	2.74%
80-84	16.77	9.07	-7.70	-45.9	3.03%
85-89	29.70	17.70	-12.00	-40.4	2.55%
90-94	45.16	26.69	-18.48	-40.9	2.60%
95+	57.48	44.67	-12.81	-22.3	1.25%
Total	9.24	6.69	-2.56	-27.7	1.61%
1984 ASDR	9.24	5.21	-4.03	-43.6	2.82%
2004 ASDR	11.65	6.69	-4.96	-42.6	2.74%
		Standard Error			
Total	0.20	0.21	0.28		
1984 ASDR	0.20	0.17	0.26		
2004 ASDR	0.25	0.21	0.32		
		t-statistic			
Total	46.75	32.62	-8.98		
1984 ASDR	46.75	30.79	-15.49		
2004 ASDR	47.52	32.62	-15.53		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

All of the *t*-statistics in Table 2.16 were statistically significant at the 0.1% level of significance (with cut-point = ±3.29). The *t*-statistics for the changes in the ASDRs ($|t|$ = 15.49 and 15.53; 1984 and 2004) were substantially larger than for the change in the unstandardized totals ($|t|$ = 8.98). All three estimates had high precision.

Tables 2.17 and 2.18 present the corresponding sex-specific results, in the same format.

The age-standardized relative rates of decline were larger for males than females (43.9% vs. 40.9%; 2004 ASDRs). The annualized relative rates of decline in the 2004 ASDRs were 2.85% per year for males vs. 2.59% per year for females. The corresponding unisex annualized rate was 2.74% per year, which can be compared with the 1.67% per year annualized rate for the HIPAA ADL trigger in Table 1.8.

The *t*-statistics indicated that the unstandardized total and ASDR changes were statistically highly significant for both sexes. The ASDR changes had high precision for females ($|t|$ = 12.85 and 12.75; 1984 and 2004) and medium precision for males ($|t|$ = 7.99 and 8.15; 1984 and 2004), similar to the pattern for the ADL changes in Tables 1.9 and 1.10.

Table 2.17
Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.15	1.08	-1.07	-49.7	3.38%
70-74	4.54	2.61	-1.93	-42.5	2.72%
75-79	7.34	4.51	-2.83	-38.5	2.40%
80-84	12.83	6.74	-6.09	-47.4	3.16%
85-89	23.06	12.59	-10.47	-45.4	2.98%
90-94	34.88	20.24	-14.64	-42.0	2.68%
95+	47.69	28.55	-19.15	-40.1	2.53%
Total	6.57	4.68	-1.89	-28.8	1.68%
1984 ASDR	6.57	3.68	-2.88	-43.9	2.85%
2004 ASDR	8.34	4.68	-3.66	-43.9	2.85%
		Standard Error			
Total	0.28	0.27	0.39		
1984 ASDR	0.28	0.23	0.36		
2004 ASDR	0.36	0.27	0.45		
		t-statistic			
Total	23.63	17.01	-4.84		
1984 ASDR	23.63	16.01	-7.99		
2004 ASDR	23.45	17.01	-8.15		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.18
Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.43	1.34	-1.09	-44.7	2.92%
70-74	4.95	1.98	-2.98	-60.1	4.49%
75-79	9.37	5.24	-4.13	-44.1	2.86%
80-84	18.83	10.58	-8.25	-43.8	2.84%
85-89	32.24	20.33	-11.91	-36.9	2.28%
90-94	48.26	29.30	-18.95	-39.3	2.46%
95+	59.53	48.77	-10.75	-18.1	0.99%
Total	10.98	8.14	-2.84	-25.9	1.49%
1984 ASDR	10.98	6.33	-4.65	-42.4	2.72%
2004 ASDR	13.76	8.14	-5.63	-40.9	2.59%
		Standard Error			
Total	0.27	0.29	0.40		
1984 ASDR	0.27	0.24	0.36		
2004 ASDR	0.33	0.29	0.44		
		t-statistic			
Total	40.53	27.99	-7.15		
1984 ASDR	40.53	26.39	-12.85		
2004 ASDR	41.46	27.99	-12.75		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

3. Combined HIPAA ADL and CI Morbidity

Table 2.19 presents the weighted tabulation of the number and percent of persons meeting either of the HIPAA ADL and CI triggers for the 1984 unisex data, using the format in Tables 1.6 and 2.14. The overall combined ADL and CI prevalence rate was 13.0% with a 0.2% SE – significantly larger than the separate prevalence rates of 9.2% each in Tables 1.6 and 2.14, respectively.

Table 2.19
Number and Percent of Persons Meeting Either HIPAA Trigger, United States 1984, Unisex, Age 65 and Above, by Age

	Meets Either HIPAA Trigger				
Age	No	Yes	Total	Percent	Std Error (Pct)
65-69	8,359,909	375,310	8,735,218	4.30%	0.26%
70-74	6,972,483	581,552	7,554,035	7.70%	0.37%
75-79	4,848,302	690,617	5,538,918	12.47%	0.54%
80-84	2,667,720	765,275	3,432,994	22.29%	0.87%
85-89	1,199,094	724,244	1,923,337	37.66%	1.35%
90-94	283,592	389,454	673,046	57.86%	2.32%
95+	45,852	131,512	177,364	74.15%	4.02%
Total	24,376,952	3,657,963	28,034,914	13.05%	0.23%

Note: The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 NLTCS.

Table 2.20 presents the corresponding weighted tabulation for 2004. The overall combined ADL and CI prevalence rate was 10.1% with a 0.2% SE – significantly larger than the separate prevalence rates of 8.2% and 6.7% in Tables 1.7 and 2.15, respectively.

Table 2.20
Number and Percent of Persons Meeting Either HIPAA Trigger, United States 2004, Unisex, Age 65 and Above, by Age

	Meets Either HIPAA Trigger				
Age	No	Yes	Total	Percent	Std Error (Pct)
65-69	8,249,343	239,296	8,488,639	2.82%	0.29%
70-74	8,353,574	383,573	8,737,147	4.39%	0.36%
75-79	7,023,298	600,636	7,623,934	7.88%	0.51%
80-84	5,230,199	798,648	6,028,847	13.25%	0.72%
85-89	2,602,925	849,078	3,452,003	24.60%	1.20%
90-94	951,734	530,500	1,482,233	35.79%	2.04%
95+	178,647	253,875	432,523	58.70%	3.90%
Total	32,589,719	3,655,606	36,245,325	10.09%	0.25%

Note: The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 2.21 presents various comparisons of the age-specific and total prevalence rates for 1984 and 2004 shown in Tables 2.19 and 2.20.

The overall relative rate of decline (in Total) was 22.7%; the age-specific relative rates of decline ranged from 20.8% to 43.0%. The two sets of age-standardized prevalence rates yielded comparable relative rates of decline: 37.5% vs. 37.1%.

The standard errors of the unstandardized totals and ASDRs ranged from 0.21% to 0.27%; the standard errors of the differences ranged from 0.31% to 0.37%.

All of the *t*-statistics in Table 2.21 were statistically significant at the 0.1% level of significance. As in Tables 1.8 and 2.15, the *t*-statistics for the changes in the ASDRs (|*t*| = 15.68 and 16.27; 1984 and 2004) were substantially larger than for the change in the unstandardized totals (|*t*| = 8.85). All three estimates had high precision.

Table 2.21
Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	4.30	2.82	-1.48	-34.4	2.09%
70-74	7.70	4.39	-3.31	-43.0	2.77%
75-79	12.47	7.88	-4.59	-36.8	2.27%
80-84	22.29	13.25	-9.04	-40.6	2.57%
85-89	37.66	24.60	-13.06	-34.7	2.11%
90-94	57.86	35.79	-22.07	-38.1	2.37%
95+	74.15	58.70	-15.45	-20.8	1.16%
Total	13.05	10.09	-2.96	-22.7	1.28%
1984 ASDR	13.05	8.16	-4.89	-37.5	2.32%
2004 ASDR	16.03	10.09	-5.94	-37.1	2.29%
		Standard Error			
Total	0.23	0.25	0.33		
1984 ASDR	0.23	0.21	0.31		
2004 ASDR	0.27	0.25	0.37		
		t-statistic			
Total	57.26	41.15	-8.85		
1984 ASDR	57.26	38.31	-15.68		
2004 ASDR	59.14	41.15	-16.27		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Tables 2.22 and 2.23 present the corresponding sex-specific results, in the same format.

The age-standardized relative rates of decline were larger for males than females (39.7% vs. 34.8%; 2004 ASDR). The annualized relative rates of decline were 2.50% for males vs. 2.12% for females. The corresponding unisex annualized rate of decline was 2.29%, which can be compared with the annualized rates of decline, 1.67% and 2.74%, respectively, for the HIPAA ADL and CI triggers in Tables 1.8 and 2.16. The *t*-statistics indicated that the unstandardized total and ASDR changes were statistically highly significant for both sexes. The precision levels were high for the ASDR changes and medium for the unstandardized total changes.

Table 2.22
Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	4.01	2.50	-1.51	-37.7	2.34%
70-74	7.83	4.37	-3.45	-44.1	2.87%
75-79	11.24	7.56	-3.69	-32.8	1.97%
80-84	18.29	11.00	-7.30	-39.9	2.51%
85-89	30.50	17.41	-13.09	-42.9	2.76%
90-94	47.59	28.33	-19.26	-40.5	2.56%
95+	64.92	38.49	-26.44	-40.7	2.58%
Total	10.08	7.47	-2.61	-25.9	1.49%
1984 ASDR	10.08	6.10	-3.98	-39.5	2.48%
2004 ASDR	12.39	7.47	-4.92	-39.7	2.50%
		Standard Error			
Total	0.34	0.34	0.48		
1984 ASDR	0.34	0.30	0.45		
2004 ASDR	0.41	0.34	0.53		
		t-statistic			
Total	30.01	21.91	-5.45		
1984 ASDR	30.01	20.48	-8.87		
2004 ASDR	30.15	21.91	-9.21		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.23
Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	4.52	3.10	-1.42	-31.4	1.87%
70-74	7.61	4.41	-3.20	-42.1	2.69%
75-79	13.22	8.11	-5.10	-38.6	2.41%
80-84	24.39	14.70	-9.69	-39.7	2.50%
85-89	40.40	28.29	-12.10	-30.0	1.76%
90-94	60.96	38.82	-22.14	-36.3	2.23%
95+	76.08	63.84	-12.23	-16.1	0.87%
Total	14.97	11.97	-3.00	-20.0	1.11%
1984 ASDR	14.97	9.66	-5.32	-35.5	2.17%
2004 ASDR	18.38	11.97	-6.40	-34.8	2.12%
		Standard Error			
Total	0.31	0.34	0.46		
1984 ASDR	0.31	0.30	0.43		
2004 ASDR	0.36	0.34	0.50		
		t-statistic			
Total	49.03	35.07	-6.55		
1984 ASDR	49.03	32.51	-12.48		
2004 ASDR	51.11	35.07	-12.92		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Author's calculations based on the 1984 and 2004 NLTCS.

4. Life Expectancies and Disabled Life Expectancies

Table 2.24 presents the unisex life expectancies (LEs) and disabled life expectancies (DLEs), based on the HIPAA CI trigger, and the decompositions of the DLE changes into the survival increments and morbidity decrements, as described in Subsections 7 and 8 of Introduction.

Table 2.24
Components of Change in Unisex Life Expectancy and HIPAA CI Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	16.64	18.11	1.48	1.48	–
HIPAA CI Expectancy	1.81	1.20	-0.61	0.27	0.88
Standard Error	0.04	0.04	0.05	0.01	0.06
t-statistic	47.79	32.78	-11.61	43.76	15.47

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

As in Section 1, the unisex life tables used to generate Table 2.24 were based on the sex-specific life tables for the U.S. population developed by the Social Security Administration (Bell et al., 2008).

The unisex LE at age 65 in 1984 was 16.64 years, of which 1.81 years was estimated to be lived at a disability level that met the HIPAA CI trigger. The unisex LE in 2004 increased to 18.11 years, of which 1.20 years was estimated to have been lived at a disability level that met the HIPAA CI trigger. The decline in DLE was 0.61 years, which represented the balance between a survival increment of 0.27 years and a morbidity decrement of 0.88 years.

The t-statistic ($|t|$ = 11.61) indicated that the change in DLE was statistically highly significant with high precision. The component survival increment and morbidity decrement were even more highly significant: t = 43.76 and 15.47 with highest and high precision, respectively.

The corresponding sex-specific results are presented in Tables 2.25 and 2.26. The DLEs for males were 1.09 years in 1984 and 0.79 years in 2004. The corresponding DLEs for females were 2.43 and 1.55 years, respectively.

The declines in DLEs were 0.30 years for males and 0.88 years for females, which represented, respectively, 27.7% of the 1984 DLE for males and 36.1% of the 1984 DLE for females. The changes in DLE were statistically highly significant for males ($|t|$ = 4.63; low precision) and females ($|t|$ = 10.91; high precision).

Hence, both sexes exhibited substantial declines in their expected total lifetime days of chronic disability at and beyond age 65, a finding which expands the morbidity compression hypothesis originally proposed by Fries (1980, 1983, 1989) to include severe cognitive impairment.

Table 2.25
Components of Change in Male Life Expectancy and HIPAA CI Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	14.41	16.67	2.26	2.26	–
HIPAA CI Expectancy	1.09	0.79	-0.30	0.31	0.62
Standard Error	0.05	0.05	0.07	0.02	0.08
t-statistic	23.69	17.02	-4.63	20.01	8.10

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.26
Components of Change in Female Life Expectancy and HIPAA CI Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	18.66	19.50	0.84	0.84	–
HIPAA CI Expectancy	2.43	1.55	-0.88	0.18	1.06
Standard Error	0.06	0.06	0.08	0.00	0.08
t-statistic	41.63	28.13	-10.91	37.91	12.69

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.27 presents the unisex LEs and DLEs, based on the combined HIPAA ADL and CI triggers, and the decompositions of the DLE changes into the survival increments and morbidity decrements. The unisex LE at age 65 in 1984 was 16.64 years, of which 2.50 years was at a disability level that met at least one HIPAA trigger. The unisex LE in 2004 increased to 18.11 years, of which 1.81 years was at a disability level that met at least one HIPAA trigger. The decline in DLE was 0.70 years ($|t|$ = 11.53; high precision), which represented 27.9% of the 1984 DLE, reflecting a survival increment of 0.35 years (t = 54.47; highest precision) and a morbidity decrement of 1.05 years (t = 16.25; high precision).

The corresponding sex-specific results are presented in Tables 2.28 and 2.29. The DLEs for males were 1.64 years in 1984 and 1.26 years in 2004. The corresponding DLEs for females were 3.26 and 2.29 years, respectively. The declines in DLEs were 0.39 years for males and 0.97 years for females, which represented, respectively, 23.5% of the 1984 DLE for males and 29.8% of the 1984 DLE for females. The changes in DLE were statistically highly significant for males ($|t|$ = 4.93; low precision) and females ($|t|$ = 10.70; high precision), as were the component survival increments (t = 25.75 and 47.01 for males and females, with very high and highest precision, respectively,) and morbidity decrements (t = 9.25 and 12.87 for males and females, respectively, both with high precision).

Table 2.27
Components of Change in Unisex Life Expectancy and HIPAA ADL/CI Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	16.64	18.11	1.48	1.48	–
HIPAA ADL/CI Expectancy	2.50	1.81	-0.70	0.35	1.05
Standard Error	0.04	0.04	0.06	0.01	0.06
t-statistic	59.70	41.38	-11.53	54.47	16.25

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.28
Components of Change in Male Life Expectancy and HIPAA ADL/CI Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	14.41	16.67	2.26	2.26	–
HIPAA ADL/CI Expectancy	1.64	1.26	-0.39	0.44	0.83
Standard Error	0.05	0.06	0.08	0.02	0.09
t-statistic	30.54	21.97	-4.93	25.75	9.25

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.29
Components of Change in Female Life Expectancy and HIPAA ADL/CI Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	18.66	19.50	0.84	0.84	–
HIPAA ADL/CI Expectancy	3.26	2.29	-0.97	0.24	1.21
Standard Error	0.06	0.06	0.09	0.01	0.09
t-statistic	51.54	35.28	-10.70	47.01	12.87

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

5. HIPAA CI Triggers for Community and Institutional Subpopulations

This subsection presents age-specific and total HIPAA CI prevalence rates for 1984 and 2004 for the community and institutional subpopulations separately. The tables are comparable to those for the ADL triggers in Tables 1.18–1.29.

Tables 2.30 and 2.31 present unisex HIPAA CI prevalence rates for 1984 and 2004 for community residents including and excluding, respectively, ALC residents in 2004. Exclusion of ALC residents in 2004 yielded 4.5% and 5.0% increases, respectively, in ASDR changes (e.g., the 2004 ASDR decline of 42.1% in Table 2.30 changed to a decline of 47.1% in Table 2.31).

Tables 2.32 and 2.33 present the corresponding results for institutional residents excluding and including, respectively, ALC residents in 2004. Inclusion of ALC residents in 2004 increased the sizes of both ASDR changes (e.g., the 2004 ASDR decline of 7.2% in Table 2.32 changed to a decline of 23.0% in Table 2.33).

Table 2.32 shows a decrease in the HIPAA CI ASDRs for institutional residents with the 2004 ASDRs declining from 78.8% in 1984 to 73.1% in 2004, for which the t-statistic ($|t| = 2.46$) was statistically significant at the 5%, but not 1%, level of significance. This contrasts with the statistically significant increase in the HIPAA ADL ASDRs for institutional residents in Table 1.20. Together, the opposing ADL and CI trends for institutional residents cancel when the two triggers are combined in the next subsection.

Tables 2.34–2.37 and Tables 2.38–2.41 present corresponding results for males and females, respectively.

Comments

The community results in Table 2.30 are of particular interest because they will continue to be directly comparable with other sources of information on CI trends among the U.S. elderly, which are generally restricted to the non-institutionalized population (Freedman et al., 2013).

The decrease in the unstandardized HIPAA CI prevalence rates from 5.3% in 1984 to 3.9% in 2004 produced a t-statistic ($|t| = 5.95$) that was statistically highly significant. The decreases in the two ASDRs produced t-statistics ($|t| = 10.73$ and 10.52) that were even more highly significant. Thus, our results for the unstandardized HIPAA CI prevalence rates implied that one should expect to find statistically significant temporal trends when looking at similarly defined CI prevalence rates in other studies if the study interval is 10+ years. Our results for the HIPAA CI ASDRs also implied that one should expect to find statistically significant temporal trends when looking at similarly defined ASDRs in other studies if the study interval is 5+ years.

These expectations were actually exceeded by Langa et al. (2008) who found larger statistically significant declines in CI in community respondents aged 70+ years in the Health and Retirement Study (HRS) over the 9-year study interval 1993–2002, using a logistic regression model to introduce controls for age, sex, and other explanatory covariates. Langa's odds ratio for the unstandardized CI prevalence rates was 0.68 with a 95% confidence interval 0.60–0.77. The corresponding odds ratio from Table 2.30 was 0.727, which would fall within Langa's 95% confidence interval were it not for the different length study intervals. After controlling for this difference (using the 9/20th power of 0.727, where the 9/20 ratio adjusts for the 9-year vs. 20-year study intervals; see Subsection 9 of Introduction), the resulting NLTCS odds ratio, 0.866, indicated a substantially slower rate of improvement than in the HRS.

Langa's odds ratio for the age- and sex-standardized CI prevalence rates was 0.65 with a 95% confidence interval 0.58–0.73. The corresponding age-standardized odds ratio from Table 2.30 was 0.562, which increased to 0.771 after controlling for the study interval difference, much closer to Langa's results.

One minor difference was that the ASDRs in Table 2.30 were standardized for age but not for sex differences over time. The same calculations performed on Tables 2.34 and 2.38 yielded sex-specific age-standardized odds ratios of 0.777 and 0.774, respectively, with an average age-standardized value of 0.776, slightly larger than the 0.771 value obtained from Table 2.30.

Langa et al.'s (2008) odds ratio for the age- and sex-standardized CI prevalence rates implied an annualized relative rate of decline of 4.7%. The associated 95% confidence interval produced a *t*-statistic with an approximate value of 9.15, which was statistically highly significant and indicated that Langa's annualized numerical value (4.7%) had high precision. Similarly, the *t*-statistic for the decline in the 2004 ASDR in Table 2.30 was $|t| = 10.52$, which was also statistically highly significant and indicated that the annualized relative rate of decline (2.70%) had high precision. This raised the question: Which was correct, Langa's 4.7% or our 2.7%?

Several characteristics of Langa's HRS analysis might account for its larger rates of improvement. *First*, our NLTCS analysis used ages 65+ whereas Langa's HRS analysis used ages 70+. *Second*, our NLTCS analysis used the 10-point SPMSQ with 3+ errors defined as impaired at a level that *excluded* mild CI (see Subsection 3 of Introduction) whereas Langa's HRS analysis used a 35-point CI scale with 25+ errors defined as impaired at a level that *included* mild CI (Langa et al., 2008). *Third*, the odds ratios in our NLTCS analysis were based on weighted prevalence rates whereas those in Langa's HRS analysis were based on weighted logistic regression models. *Fourth*, our NLTCS analysis used consistent definitions of the community population at both ends of the study interval whereas the HRS started as a community study but then followed the respondents into institutions, with the final community subpopulation defined in Langa's HRS analysis to exclude institutional residents. However, the HRS institutional definition included "dependent care facilities" as well as nursing homes, possibly leading to inconsistent treatment of ALC residents compared to their treatment in the NLTCS (Freedman et al., 2001). The impact of excluding ALC in our NLTCS analysis would substantially lower our original odds ratio for the unstandardized CI prevalence rates, 0.727 (based on Table 2.30), to 0.649 (based on Table 2.31). *Fifth*, the elderly sample in the 1993 HRS was based on a different sampling design (AHEAD) with modifications to the cognitive assessment instrument, which may have generated additional differences (Rodgers et al., 2003).

Some resolution of these issues was provided by Sheffield and Peek (2011) who found more comparable declines in CI in community respondents aged 70+ years in the HRS over the 11-year study interval 1993–2004, also using a logistic regression model to introduce controls for age, sex, and other explanatory covariates.

Sheffield and Peek (2011) altered Langa et al.'s (2008) assumptions in three important ways. *First*, the cut-point for impairment on the 35-point CI scale was set at 27+ errors, which was chosen to exclude most cases of mild CI. *Second*, ALC residents were explicitly retained in the analyses, which more closely matched the definitions used to construct Table 2.30 and similar tables for the NLTCS community population. *Third*, to control for the much shorter intervals between HRS interviews (generally repeated every two years), Sheffield and Peek (2011) added a measure of prior test exposure which was statistically highly significant. With these changes, they obtained an odds ratio for the age- and sex-standardized CI prevalence rates which, after conversion to match the 9-year study interval used above, was 0.73 with a 95% confidence interval 0.58–0.93, which included the 0.771 value obtained from Table 2.30.

The odds ratio obtained from Sheffield and Peek (2011) was 0.05 higher than Langa's 0.68 value; the lower bounds of the 95% confidence intervals were the same but Sheffield and Peek's upper bound increased by 0.20, from 0.73 to 0.93. The average age-standardized value of 0.776 obtained from Tables 2.34 and 2.38 also fell well within Sheffield and Peek's 95% confidence interval.

Sheffield and Peek's annualized relative rate of decline of 3.4% had an associated t-statistic of 2.61, which was statistically significant, but the annualized relative rate itself (3.4%) had very low precision. In contrast, the annualized relative rate of decline in the 2004 ASDR in Table 2.30 was 2.70%, with an associated t-statistic of $|t| = 10.52$, indicating high statistical significance and high precision.

While the above comparisons do not *prove* that our results were correct, they do provide compelling evidence that our results were highly plausible, were unlikely to contain serious biases, and could be reconciled with published results from the HRS. Moreover, these comparisons reflect changes only for non-institutionalized persons; hence, they were not dependent on the imputation procedures described above in Subsection 1 for the 1984 institutionalized respondents who did not complete the SPMSQ.

Further support for our results derives from changes in the prevalence of dementia at ages 65+ in the U.K. over the 20-year period 1991–2011 (Matthews et al., 2013). The study interval was comparable to ours and the study included both community and institutional residents. Matthews' odds ratio for the decline in dementia prevalence rates (standardized for age, sex, geographic area, and neighborhood deprivation status) was 0.7, reported to one significant digit, with a 95% confidence interval 0.6–0.9. Our estimate of the corresponding age- and sex-standardized odds ratio was 0.55 (using the average of the age-standardized values from Tables 2.17 and 2.18), just below the lower bound (0.6) of Matthews' 95% confidence interval.

Table 2.30
Percent of Community Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.56	1.07	-0.49	-31.4	1.87%
70-74	3.36	1.48	-1.87	-55.8	4.00%
75-79	5.56	3.33	-2.23	-40.1	2.53%
80-84	10.16	5.32	-4.84	-47.6	3.18%
85-89	17.42	10.22	-7.20	-41.3	2.63%
90-94	26.28	15.32	-10.96	-41.7	2.66%
95+	27.31	30.06	2.75	10.1	-0.48%
Total	5.29	3.90	-1.39	-26.2	1.51%
1984 ASDR	5.29	3.00	-2.29	-43.2	2.79%
2004 ASDR	6.74	3.90	-2.84	-42.1	2.70%
		Standard Error			
Total	0.16	0.17	0.23		
1984 ASDR	0.16	0.14	0.21		
2004 ASDR	0.21	0.17	0.27		
		t-statistic			
Total	32.40	23.47	-5.95		
1984 ASDR	32.40	21.90	-10.73		
2004 ASDR	31.73	23.47	-10.52		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community unisex population. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.31
Percent of Non-ALC Community Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.56	1.03	-0.53	-33.9	2.05%
70-74	3.36	1.38	-1.98	-58.9	4.34%
75-79	5.56	3.02	-2.54	-45.6	3.00%
80-84	10.16	4.82	-5.34	-52.6	3.66%
85-89	17.42	9.48	-7.94	-45.6	3.00%
90-94	26.28	13.86	-12.42	-47.2	3.15%
95+	27.31	28.07	0.76	2.8	-0.14%
Total	5.29	3.50	-1.79	-33.9	2.05%
1984 ASDR	5.29	2.77	-2.52	-47.7	3.19%
2004 ASDR	6.61	3.50	-3.12	-47.1	3.14%
		Standard Error			
Total	0.16	0.16	0.23		
1984 ASDR	0.16	0.13	0.21		
2004 ASDR	0.21	0.16	0.26		
		t-statistic			
Total	32.40	21.91	-7.85		
1984 ASDR	32.40	20.70	-11.96		
2004 ASDR	31.92	21.91	-11.92		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted non-ALC community unisex population. The CI trigger used 3+ errors on the SPMSQ. ALC residents were excluded only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.32
Percent of Institutional Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	71.62	48.79	-22.83	-31.9	1.90%
70-74	69.06	68.78	-0.28	-0.4	0.02%
75-79	73.58	64.71	-8.87	-12.1	0.64%
80-84	77.20	75.67	-1.53	-2.0	0.10%
85-89	80.99	73.44	-7.56	-9.3	0.49%
90-94	81.60	76.50	-5.11	-6.3	0.32%
95+	87.02	80.26	-6.76	-7.8	0.40%
Total	77.56	73.12	-4.44	-5.7	0.29%
1984 ASDR	77.56	71.37	-6.18	-8.0	0.41%
2004 ASDR	78.78	73.12	-5.66	-7.2	0.37%
		Standard Error			
Total	1.29	1.90	2.30		
1984 ASDR	1.29	2.13	2.49		
2004 ASDR	1.29	1.90	2.30		
		t-statistic			
Total	59.92	38.43	-1.93		
1984 ASDR	59.92	33.51	-2.48		
2004 ASDR	60.84	38.43	-2.46		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional unisex population. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.33
Percent of Institutional/ALC Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	71.62	31.23	-40.39	-56.4	4.07%
70-74	69.06	58.49	-10.56	-15.3	0.83%
75-79	73.58	55.46	-18.12	-24.6	1.40%
80-84	77.20	60.78	-16.42	-21.3	1.19%
85-89	80.99	59.18	-21.81	-26.9	1.56%
90-94	81.60	68.90	-12.70	-15.6	0.84%
95+	87.02	67.42	-19.60	-22.5	1.27%
Total	77.56	60.64	-16.92	-21.8	1.22%
1984 ASDR	77.56	59.09	-18.47	-23.8	1.35%
2004 ASDR	78.72	60.64	-18.08	-23.0	1.30%
		Standard Error			
Total	1.29	1.77	2.20		
1984 ASDR	1.29	1.86	2.27		
2004 ASDR	1.29	1.77	2.19		
		t-statistic			
Total	59.92	34.20	-7.70		
1984 ASDR	59.92	31.78	-8.15		
2004 ASDR	61.07	34.20	-8.25		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional/ALC unisex population. The CI trigger used 3+ errors on the SPMSQ. ALC residents were included only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.34
Percent of Community Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.49	0.84	-0.65	-43.8	2.84%
70-74	3.25	1.68	-1.57	-48.2	3.24%
75-79	4.69	2.90	-1.79	-38.2	2.38%
80-84	7.96	4.28	-3.67	-46.2	3.05%
85-89	15.08	8.81	-6.27	-41.6	2.65%
90-94	18.08	13.49	-4.59	-25.4	1.45%
95+	24.08	16.60	-7.48	-31.0	1.84%
Total	4.10	3.02	-1.08	-26.3	1.52%
1984 ASDR	4.10	2.35	-1.75	-42.7	2.75%
2004 ASDR	5.17	3.02	-2.15	-41.6	2.65%
		Standard Error			
Total	0.23	0.23	0.32		
1984 ASDR	0.23	0.19	0.30		
2004 ASDR	0.30	0.23	0.38		
		t-statistic			
Total	17.76	13.26	-3.33		
1984 ASDR	17.76	12.40	-5.87		
2004 ASDR	17.09	13.26	-5.68		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community male population. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.35
Percent of Non-ALC Community Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.49	0.84	-0.65	-43.7	2.84%
70-74	3.25	1.52	-1.73	-53.2	3.72%
75-79	4.69	2.76	-1.93	-41.2	2.62%
80-84	7.96	4.00	-3.95	-49.7	3.37%
85-89	15.08	8.25	-6.83	-45.3	2.97%
90-94	18.08	12.09	-6.00	-33.2	1.99%
95+	24.08	14.66	-9.42	-39.1	2.45%
Total	4.10	2.78	-1.32	-32.1	1.92%
1984 ASDR	4.10	2.20	-1.89	-46.3	3.06%
2004 ASDR	5.11	2.78	-2.33	-45.6	3.00%
		Standard Error			
Total	0.23	0.22	0.32		
1984 ASDR	0.23	0.18	0.30		
2004 ASDR	0.30	0.22	0.37		
		t-statistic			
Total	17.76	12.63	-4.13		
1984 ASDR	17.76	11.90	-6.41		
2004 ASDR	17.20	12.63	-6.30		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted non-ALC community male population. The CI trigger used 3+ errors on the SPMSQ. ALC residents were excluded only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.36
Percent of Institutional Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	70.62	48.43	-22.19	-31.4	1.87%
70-74	68.98	86.17	17.19	24.9	-1.12%
75-79	75.55	73.84	-1.72	-2.3	0.12%
80-84	82.83	65.75	-17.07	-20.6	1.15%
85-89	80.64	72.61	-8.03	-10.0	0.52%
90-94	82.34	72.36	-9.98	-12.1	0.64%
95+	81.81	74.74	-7.06	-8.6	0.45%
Total	77.31	71.39	-5.92	-7.7	0.40%
1984 ASDR	77.31	71.34	-5.97	-7.7	0.40%
2004 ASDR	78.56	71.39	-7.16	-9.1	0.48%
		Standard Error			
Total	2.66	3.90	4.72		
1984 ASDR	2.66	4.02	4.82		
2004 ASDR	2.65	3.90	4.72		
		t-statistic			
Total	29.05	18.29	-1.25		
1984 ASDR	29.05	17.73	-1.24		
2004 ASDR	29.65	18.29	-1.52		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional male population. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.37
Percent of Institutional/ALC Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	70.62	44.49	-26.13	-37.0	2.28%
70-74	68.98	73.78	4.80	7.0	-0.34%
75-79	75.55	67.16	-8.39	-11.1	0.59%
80-84	82.83	53.36	-29.47	-35.6	2.17%
85-89	80.64	57.40	-23.24	-28.8	1.69%
90-94	82.34	57.01	-25.33	-30.8	1.82%
95+	81.81	63.54	-18.27	-22.3	1.26%
Total	77.31	59.63	-17.69	-22.9	1.29%
1984 ASDR	77.31	60.22	-17.09	-22.1	1.24%
2004 ASDR	78.85	59.63	-19.22	-24.4	1.39%
		Standard Error			
Total	2.66	3.60	4.48		
1984 ASDR	2.66	3.81	4.65		
2004 ASDR	2.67	3.60	4.48		
		t-statistic			
Total	29.05	16.56	-3.95		
1984 ASDR	29.05	15.79	-3.67		
2004 ASDR	29.50	16.56	-4.29		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional/ALC male population. The CI trigger used 3+ errors on the SPMSQ. ALC residents were included only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.38
Percent of Community Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.61	1.27	-0.34	-21.0	1.17%
70-74	3.43	1.32	-2.11	-61.5	4.66%
75-79	6.09	3.65	-2.45	-40.1	2.53%
80-84	11.39	6.01	-5.37	-47.2	3.14%
85-89	18.43	11.02	-7.41	-40.2	2.54%
90-94	29.15	16.16	-12.99	-44.6	2.91%
95+	28.15	34.02	5.87	20.9	-0.95%
Total	6.09	4.56	-1.53	-25.2	1.44%
1984 ASDR	6.09	3.49	-2.60	-42.7	2.75%
2004 ASDR	7.78	4.56	-3.22	-41.4	2.63%
		Standard Error			
Total	0.22	0.24	0.33		
1984 ASDR	0.22	0.19	0.30		
2004 ASDR	0.29	0.24	0.37		
		t-statistic			
Total	27.13	19.39	-4.72		
1984 ASDR	27.13	18.02	-8.78		
2004 ASDR	26.66	19.39	-8.58		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community female population. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.39
Percent of Non-ALC Community Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.61	1.20	-0.41	-25.6	1.47%
70-74	3.43	1.27	-2.17	-63.1	4.87%
75-79	6.09	3.22	-2.88	-47.2	3.14%
80-84	11.39	5.37	-6.02	-52.9	3.69%
85-89	18.43	10.21	-8.23	-44.6	2.91%
90-94	29.15	14.65	-14.50	-49.7	3.38%
95+	28.15	32.57	4.42	15.7	-0.73%
Total	6.09	4.04	-2.06	-33.8	2.04%
1984 ASDR	6.09	3.19	-2.91	-47.7	3.19%
2004 ASDR	7.61	4.04	-3.57	-46.9	3.12%
		Standard Error			
Total	0.22	0.23	0.32		
1984 ASDR	0.22	0.19	0.29		
2004 ASDR	0.28	0.23	0.36		
		t-statistic			
Total	27.13	17.93	-6.47		
1984 ASDR	27.13	16.91	-9.90		
2004 ASDR	26.84	17.93	-9.86		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted non-ALC community female population. The CI trigger used 3+ errors on the SPMSQ. ALC residents were excluded only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.40
Percent of Institutional Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	72.28	49.90	-22.38	-31.0	1.84%
70-74	69.11	55.88	-13.23	-19.1	1.06%
75-79	72.66	59.37	-13.29	-18.3	1.01%
80-84	75.54	79.84	4.30	5.7	-0.28%
85-89	81.06	73.61	-7.46	-9.2	0.48%
90-94	81.44	77.39	-4.05	-5.0	0.25%
95+	87.87	81.18	-6.68	-7.6	0.39%
Total	77.63	73.70	-3.93	-5.1	0.26%
1984 ASDR	77.63	71.34	-6.29	-8.1	0.42%
2004 ASDR	79.01	73.70	-5.31	-6.7	0.35%
		Standard Error			
Total	1.49	2.18	2.64		
1984 ASDR	1.49	2.97	3.32		
2004 ASDR	1.49	2.18	2.64		
		t-statistic			
Total	52.23	33.87	-1.49		
1984 ASDR	52.23	24.05	-1.90		
2004 ASDR	52.95	33.87	-2.01		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional female population. The CI trigger used 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.41
Percent of Institutional/ALC Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	72.28	21.93	-50.34	-69.7	5.79%
70-74	69.11	46.59	-22.51	-32.6	1.95%
75-79	72.66	50.04	-22.63	-31.1	1.85%
80-84	75.54	63.77	-11.77	-15.6	0.84%
85-89	81.06	59.58	-21.49	-26.5	1.53%
90-94	81.44	72.36	-9.08	-11.2	0.59%
95+	87.87	68.04	-19.83	-22.6	1.27%
Total	77.63	60.98	-16.65	-21.5	1.20%
1984 ASDR	77.63	58.80	-18.84	-24.3	1.38%
2004 ASDR	78.81	60.98	-17.83	-22.6	1.27%
		Standard Error			
Total	1.49	2.03	2.52		
1984 ASDR	1.49	2.12	2.59		
2004 ASDR	1.48	2.03	2.51		
		t-statistic			
Total	52.23	30.06	-6.62		
1984 ASDR	52.23	27.75	-7.28		
2004 ASDR	53.40	30.06	-7.11		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional/ALC female population. The CI trigger used 3+ errors on the SPMSQ. ALC residents were included only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

6. Combined HIPAA ADL/CI Triggers for Community and Institutional Subpopulations

This subsection presents age-specific and total combined HIPAA ADL/CI prevalence rates for 1984 and 2004 for the community and institutional subpopulations separately. The tables are comparable to the ADL tables (1.18–1.29) and the CI tables (2.30–2.41).

Tables 2.42 and 2.43 present unisex combined HIPAA ADL/CI prevalence rates for 1984 and 2004 for community residents including and excluding, respectively, ALC residents in 2004. Exclusion of ALC residents in 2004 yielded 3.3% and 3.6% increases, respectively, in ASDR changes (e.g., the 2004 ASDR decline of 38.2% in Table 2.42 changed to a decline of 41.8% in Table 2.43).

Tables 2.44 and 2.45 present the corresponding results for institutional residents excluding and including, respectively, ALC residents in 2004. Inclusion of ALC residents in 2004 reversed the direction of both ASDR changes (e.g., the 2004 ASDR increase of 2.7% in Table 2.44 reversed to a decline of 14.4% in Table 2.45). As expected, the 2.7% increase in Table 2.44 was not statistically significant, given the opposing trends for ADLs in Tables 1.20 and CI in Table 2.32.

Tables 2.46–2.49 and Tables 2.50–2.53 present the corresponding results for males and females, respectively.

Comments

The community results in Table 2.42 are of interest because they will continue to be directly comparable with other sources of information on ADL/CI trends among the U.S. elderly, which, like those in Table 2.30, are generally restricted to the non-institutionalized population (Freedman et al., 2013).

The decrease in the unstandardized HIPAA ADL/CI prevalence rate from 8.6% in 1984 to 6.6% in 2004 had a *t*-statistic ($|t|$ = 6.81) that was statistically highly significant, indicating that the corresponding unstandardized annualized relative rate of decline, 1.31%, had medium precision.

The decreases in the two ASDRs produced *t*-statistics ($|t|$ = 11.86 and 12.42) that were more highly statistically significant. Here, the associated annualized relative rates of decline in the ASDRs for ADL/CI disability, 2.35% and 2.38%, had high precision; they fell in-between the annualized relative rates of decline for the separately computed ADL and CI triggers in Tables 1.18 and 2.30 (1.29% and 1.37%, respectively, for the ADL trigger; and 2.79% and 2.70%, respectively, for the CI trigger).

The temporal rates of decline in the community population were statistically highly significant for males and females, for both the unstandardized rates and the ASDRs (Tables 2.46 and 2.50); females had larger absolute declines in ASDRs but males had larger relative declines.

In contrast, the overall temporal changes in the institutional population in the age-standardized ADL/CI prevalence rates were not statistically significant for either sex (Tables 2.48 and 2.52).

Table 2.42
Percent of Community Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.40	2.57	-0.83	-24.3	1.38%
70-74	6.05	3.35	-2.70	-44.6	2.91%
75-79	8.90	5.82	-3.08	-34.6	2.10%
80-84	15.05	8.72	-6.33	-42.1	2.69%
85-89	25.00	15.34	-9.66	-38.6	2.41%
90-94	40.25	22.86	-17.39	-43.2	2.79%
95+	53.35	42.74	-10.61	-19.9	1.10%
Total	8.64	6.64	-2.00	-23.2	1.31%
1984 ASDR	8.64	5.38	-3.27	-37.8	2.35%
2004 ASDR	10.75	6.64	-4.11	-38.2	2.38%
		Standard Error			
Total	0.20	0.21	0.29		
1984 ASDR	0.20	0.19	0.28		
2004 ASDR	0.25	0.21	0.33		
		t-statistic			
Total	42.56	31.20	-6.81		
1984 ASDR	42.56	28.88	-11.86		
2004 ASDR	42.46	31.20	-12.42		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.43
Percent of Non-ALC Community Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.40	2.51	-0.89	-26.1	1.50%
70-74	6.05	3.25	-2.79	-46.2	3.05%
75-79	8.90	5.46	-3.44	-38.7	2.42%
80-84	15.05	8.06	-6.99	-46.4	3.07%
85-89	25.00	14.45	-10.55	-42.2	2.70%
90-94	40.25	21.31	-18.94	-47.1	3.13%
95+	53.35	40.31	-13.04	-24.4	1.39%
Total	8.64	6.14	-2.50	-29.0	1.70%
1984 ASDR	8.64	5.09	-3.55	-41.1	2.61%
2004 ASDR	10.55	6.14	-4.41	-41.8	2.67%
		Standard Error			
Total	0.20	0.21	0.29		
1984 ASDR	0.20	0.18	0.27		
2004 ASDR	0.25	0.21	0.32		
		t-statistic			
Total	42.56	29.56	-8.62		
1984 ASDR	42.56	27.72	-12.97		
2004 ASDR	42.59	29.56	-13.64		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted non-ALC community unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ. ALC residents were excluded only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.44
Percent of Institutional Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	86.88	79.14	-7.74	-8.9	0.47%
70-74	82.35	93.55	11.19	13.6	-0.64%
75-79	88.60	84.60	-4.01	-4.5	0.23%
80-84	88.55	93.71	5.16	5.8	-0.28%
85-89	90.56	93.60	3.04	3.4	-0.16%
90-94	91.85	92.47	0.62	0.7	-0.03%
95+	94.51	97.56	3.05	3.2	-0.16%
Total	89.13	92.25	3.12	3.5	-0.17%
1984 ASDR	89.13	91.34	2.22	2.5	-0.12%
2004 ASDR	89.80	92.25	2.45	2.7	-0.13%
		Standard Error			
Total	0.97	1.15	1.50		
1984 ASDR	0.97	1.41	1.71		
2004 ASDR	0.95	1.15	1.49		
		t-statistic			
Total	92.08	80.52	2.08		
1984 ASDR	92.08	64.98	1.30		
2004 ASDR	94.17	80.52	1.64		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.45
Percent of Institutional/ALC Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	86.88	50.55	-36.33	-41.8	2.67%
70-74	82.35	77.04	-5.31	-6.4	0.33%
75-79	88.60	71.85	-16.75	-18.9	1.04%
80-84	88.55	76.34	-12.21	-13.8	0.74%
85-89	90.56	75.82	-14.75	-16.3	0.88%
90-94	91.85	83.46	-8.39	-9.1	0.48%
95+	94.51	83.89	-10.62	-11.2	0.59%
Total	89.13	76.83	-12.30	-13.8	0.74%
1984 ASDR	89.13	75.50	-13.63	-15.3	0.83%
2004 ASDR	89.77	76.83	-12.94	-14.4	0.78%
		Standard Error			
Total	0.97	1.53	1.81		
1984 ASDR	0.97	1.66	1.92		
2004 ASDR	0.95	1.53	1.80		
		t-statistic			
Total	92.08	50.18	-6.79		
1984 ASDR	92.08	45.50	-7.10		
2004 ASDR	94.48	50.18	-7.18		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional/ALC unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ. ALC residents were included only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.46
Percent of Community Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.25	2.10	-1.15	-35.4	2.16%
70-74	6.35	3.37	-2.98	-46.9	3.12%
75-79	8.30	5.80	-2.49	-30.1	1.77%
80-84	13.23	7.69	-5.53	-41.8	2.67%
85-89	22.43	12.80	-9.63	-43.0	2.77%
90-94	32.82	20.68	-12.14	-37.0	2.28%
95+	51.94	24.03	-27.92	-53.7	3.78%
Total	7.39	5.46	-1.94	-26.2	1.51%
1984 ASDR	7.39	4.46	-2.93	-39.6	2.49%
2004 ASDR	9.08	5.46	-3.63	-39.9	2.52%
		Standard Error			
Total	0.30	0.30	0.43		
1984 ASDR	0.30	0.26	0.40		
2004 ASDR	0.38	0.30	0.49		
		t-statistic			
Total	24.45	18.10	-4.53		
1984 ASDR	24.45	16.88	-7.29		
2004 ASDR	23.89	18.10	-7.47		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.47
Percent of Non-ALC Community Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.25	2.10	-1.15	-35.3	2.16%
70-74	6.35	3.22	-3.13	-49.3	3.34%
75-79	8.30	5.68	-2.62	-31.6	1.88%
80-84	13.23	7.25	-5.98	-45.2	2.96%
85-89	22.43	12.25	-10.18	-45.4	2.98%
90-94	32.82	19.32	-13.50	-41.1	2.61%
95+	51.94	22.22	-29.73	-57.2	4.16%
Total	7.39	5.18	-2.21	-29.9	1.76%
1984 ASDR	7.39	4.30	-3.09	-41.7	2.67%
2004 ASDR	8.98	5.18	-3.80	-42.3	2.71%
		Standard Error			
Total	0.30	0.30	0.42		
1984 ASDR	0.30	0.26	0.40		
2004 ASDR	0.37	0.30	0.48		
		t-statistic			
Total	24.45	17.50	-5.22		
1984 ASDR	24.45	16.44	-7.72		
2004 ASDR	23.99	17.50	-7.96		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted non-ALC community male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ. ALC residents were excluded only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.48
Percent of Institutional Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	82.73	79.45	-3.28	-4.0	0.20%
70-74	81.79	94.45	12.66	15.5	-0.72%
75-79	87.02	82.76	-4.26	-4.9	0.25%
80-84	91.08	90.20	-0.88	-1.0	0.05%
85-89	88.74	90.81	2.08	2.3	-0.12%
90-94	89.33	87.44	-1.89	-2.1	0.11%
95+	83.67	94.41	10.74	12.8	-0.61%
Total	87.00	88.57	1.56	1.8	-0.09%
1984 ASDR	87.00	88.21	1.21	1.4	-0.07%
2004 ASDR	87.69	88.57	0.88	1.0	-0.05%
		Standard Error			
Total	2.15	2.77	3.50		
1984 ASDR	2.15	2.97	3.66		
2004 ASDR	2.13	2.77	3.49		
		t-statistic			
Total	40.56	32.01	0.45		
1984 ASDR	40.56	29.74	0.33		
2004 ASDR	41.22	32.01	0.25		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.49
Percent of Institutional/ALC Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	82.73	72.99	-9.74	-11.8	0.62%
70-74	81.79	79.82	-1.97	-2.4	0.12%
75-79	87.02	74.63	-12.40	-14.2	0.77%
80-84	91.08	74.84	-16.25	-17.8	0.98%
85-89	88.74	70.78	-17.95	-20.2	1.12%
90-94	89.33	68.94	-20.38	-22.8	1.29%
95+	83.67	79.49	-4.19	-5.0	0.26%
Total	87.00	73.80	-13.21	-15.2	0.82%
1984 ASDR	87.00	74.24	-12.76	-14.7	0.79%
2004 ASDR	87.82	73.80	-14.02	-16.0	0.87%
		Standard Error			
Total	2.15	3.25	3.90		
1984 ASDR	2.15	3.46	4.07		
2004 ASDR	2.15	3.25	3.90		
		t-statistic			
Total	40.56	22.67	-3.39		
1984 ASDR	40.56	21.48	-3.14		
2004 ASDR	40.88	22.67	-3.60		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional/ALC male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ. ALC residents were included only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.50
Percent of Community Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.52	2.99	-0.53	-15.1	0.81%
70-74	5.83	3.33	-2.50	-42.8	2.76%
75-79	9.27	5.83	-3.44	-37.1	2.29%
80-84	16.07	9.40	-6.66	-41.5	2.64%
85-89	26.10	16.78	-9.32	-35.7	2.18%
90-94	42.86	23.86	-19.00	-44.3	2.89%
95+	53.71	48.25	-5.46	-10.2	0.54%
Total	9.49	7.52	-1.96	-20.7	1.15%
1984 ASDR	9.49	6.05	-3.44	-36.3	2.23%
2004 ASDR	11.88	7.52	-4.36	-36.7	2.26%
		Standard Error			
Total	0.27	0.30	0.40		
1984 ASDR	0.27	0.26	0.38		
2004 ASDR	0.34	0.30	0.45		
		t-statistic			
Total	34.87	25.46	-4.89		
1984 ASDR	34.87	23.40	-9.16		
2004 ASDR	34.99	25.46	-9.68		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.51
Percent of Non-ALC Community Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.52	2.88	-0.64	-18.3	1.01%
70-74	5.83	3.28	-2.54	-43.7	2.83%
75-79	9.27	5.29	-3.98	-43.0	2.77%
80-84	16.07	8.61	-7.46	-46.4	3.07%
85-89	26.10	15.75	-10.36	-39.7	2.50%
90-94	42.86	22.20	-20.66	-48.2	3.24%
95+	53.71	46.39	-7.33	-13.6	0.73%
Total	9.49	6.86	-2.63	-27.7	1.61%
1984 ASDR	9.49	5.68	-3.81	-40.2	2.54%
2004 ASDR	11.62	6.86	-4.76	-40.9	2.60%
		Standard Error			
Total	0.27	0.29	0.40		
1984 ASDR	0.27	0.25	0.37		
2004 ASDR	0.33	0.29	0.44		
		t-statistic			
Total	34.87	23.86	-6.64		
1984 ASDR	34.87	22.28	-10.23		
2004 ASDR	35.10	23.86	-10.85		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted non-ALC community female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ. ALC residents were excluded only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.52

Percent of Institutional Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	89.58	78.18	-11.40	-12.7	0.68%
70-74	82.70	92.88	10.18	12.3	-0.58%
75-79	89.34	85.67	-3.67	-4.1	0.21%
80-84	87.81	95.18	7.38	8.4	-0.40%
85-89	90.95	94.17	3.22	3.5	-0.17%
90-94	92.39	93.56	1.17	1.3	-0.06%
95+	96.27	98.09	1.82	1.9	-0.09%
Total	89.81	93.49	3.69	4.1	-0.20%
1984 ASDR	89.81	92.43	2.62	2.9	-0.14%
2004 ASDR	90.49	93.49	3.00	3.3	-0.16%
		Standard Error			
Total	1.08	1.23	1.64		
1984 ASDR	1.08	2.08	2.34		
2004 ASDR	1.07	1.23	1.63		
		t-statistic			
Total	83.05	75.97	2.25		
1984 ASDR	83.05	44.45	1.12		
2004 ASDR	84.95	75.97	1.84		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.53

Percent of Institutional/ALC Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	89.58	34.81	-54.77	-61.1	4.62%
70-74	82.70	74.88	-7.81	-9.4	0.50%
75-79	89.34	70.57	-18.77	-21.0	1.17%
80-84	87.81	76.94	-10.86	-12.4	0.66%
85-89	90.95	76.93	-14.02	-15.4	0.83%
90-94	92.39	87.68	-4.71	-5.1	0.26%
95+	96.27	84.59	-11.68	-12.1	0.64%
Total	89.81	77.84	-11.96	-13.3	0.71%
1984 ASDR	89.81	76.03	-13.78	-15.3	0.83%
2004 ASDR	90.44	77.84	-12.60	-13.9	0.75%
		Standard Error			
Total	1.08	1.73	2.04		
1984 ASDR	1.08	1.88	2.16		
2004 ASDR	1.05	1.73	2.02		
		t-statistic			
Total	83.05	45.10	-5.87		
1984 ASDR	83.05	40.55	-6.36		
2004 ASDR	85.81	45.10	-6.23		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional/ALC female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ. ALC residents were included only in 2004.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

7. HIPAA CI AND COMBINED ADL/CI TRIGGERS BASED ON 4+ AND 5+ SPMSQ ERRORS

This subsection presents selected results for two alternative forms of the HIPAA CI trigger based on 4+ and 5+ SPMSQ errors. These alternatives increased the likelihood that only cases of severe cognitive impairment would be included in our simulations of the HIPAA CI trigger (see Subsection 3 of Introduction).

Tables 2.54 and 2.55 present unisex HIPAA CI prevalence rates for 1984 and 2004 for the total population based, respectively, on the use of 4+ and 5+ SPMSQ errors in defining the CI trigger. The relative declines in the CI ASDRs for 4+ and 5+ errors were statistically highly significant, highly precise, and nearly as large as the relative declines for 3+ errors (Table 2.16). The annualized relative rates of decline in the 2004 ASDRs were 2.74%, 2.66%, and 2.58% per year, respectively, for 3+, 4+, and 5+ errors.

Comment: The 2.58% per year decline for 5+ SPMSQ errors was similar to the statistically highly significant 2.55% per year decline (t = 3.44) for severe CI (MMSE <18 correct) derived from Christensen et al. (2013, Table 2) for two Danish cohorts born 10 years apart and assessed in 1998 and 2010 at ages 92–93 and 94–95, respectively.

The increases in the SPMSQ cut-points produced substantial reductions in the absolute levels of the CI ASDRs. For 2004, these decreased from 6.7% (Table 2.16) to 5.6% (Table 2.54), to 5.0% (Table 2.55), representing a 25% relative decrease when shifting from 3+ errors to 5+ errors. The corresponding relative decrease for 1984 was larger: 30%.

Tables 2.56 and 2.57 present the corresponding results for the combined HIPAA ADL/CI prevalence rates. The declines in the combined ADL/CI ASDRs for 4+ and 5+ errors were statistically highly significant, highly precise, and nearly as large as the relative declines for 3+ SPMSQ errors (Table 2.21). The annualized relative rates of decline in the 2004 ASDRs were 2.29%, 2.14%, and 2.04% per year, respectively, for 3+, 4+, and 5+ errors.

The increases in the SPMSQ cut-points produced smaller, yet substantial, reductions in the absolute levels of the combined ADL/CI ASDRs. For 2004, these decreased from 10.1% (Table 2.21) to 9.4% (Table 2.56), to 9.2% (Table 2.57), representing a 9.3% relative decrease when shifting from 3+ errors to 5+ errors. The corresponding relative decrease for 1984 was larger: 14%.

The 9.3% reduction for the combined ADL/CI trigger in 2004 was substantially smaller than the corresponding 25% reduction for the CI trigger alone.

Thus, the relative impacts of shifting from 3+ to 5+ errors were larger in 1984 than 2004, and were larger for the CI trigger alone than for the combined ADL/CI trigger.

Tables 2.58–2.61 and Tables 2.62–2.65 present the corresponding results for males and females, respectively. For both sexes, the relative rates of decline in the CI ASDRs were nearly as large as the corresponding rates in Tables 2.17 and 2.18. Similarly, the relative rates of decline in the combined ADL/CI ASDRs were nearly as large as the corresponding rates in Tables 2.22 and 2.23.

Tables 2.66–2.69 present the corresponding unisex results for community residents. The relative declines in CI ASDRs for 4+ and 5+ errors (Tables 2.66 and 2.67) were statistically highly significant, with medium precision, and were nearly as large as the highly precise relative declines for 3+ SPMSQ errors (Table 2.30). The annualized relative rates of decline in the 2004 ASDRs were 2.70%, 2.48%, and 2.38% per year, respectively, for 3+, 4+, and 5+ errors.

The increases in the SPMSQ cut-points produced substantial reductions among community residents in the absolute levels of the CI ASDRs. For 2004, these decreased from 3.9% (Table 2.30) to 3.0% (Table 2.66), to 2.5% (Table 2.67), representing a 37% relative decrease when shifting from 3+ errors to 5+ errors. The corresponding relative decrease for 1984 was larger: 44%.

Likewise, for the combined ADL/CI ASDRs among community residents, when shifting from 3+ errors to 5+ errors there were smaller, yet substantial, reductions for 2004 from 6.6% (Table 2.42) to 6.0% (Table 2.68), to 5.8% (Table 2.69), representing a 13% relative decrease. The corresponding relative decrease for 1984 was larger: 21%.

Tables 2.70–2.73 present the corresponding unisex results for institutional residents. In contrast to the results for 3+ SPMSQ errors in Table 2.32, the temporal declines in CI ASDRs for 4+ and 5+ errors in Tables 2.70 and 2.71 were not statistically significant at the 5% level of significance.

The increases in the SPMSQ cut-points produced substantial reductions among institutional residents in the absolute levels of the CI ASDRs. For 2004, these decreased from 73.1% (Table 2.32) to 68.5% (Table 2.70), to 66.2% (Table 2.71), representing a 9.5% relative decrease when shifting from 3+ errors to 5+ errors. The corresponding relative decrease for 1984 was larger: 12.7%.

For the combined ADL/CI ASDRs among institutional residents, none of the temporal changes shown in Tables 2.44, 2.72, or 2.73 were statistically significant at the 5% level of significance.

The increases in the SPMSQ cut-points produced much smaller reductions among institutional residents in the absolute levels of the combined ADL/CI ASDRs. For 2004, these decreased from 92.2% (Table 2.44) to 90.3% (Table 2.72), to 89.8% (Table 2.73), representing a 2.7% relative decrease when shifting from 3+ errors to 5+ errors. The corresponding relative decrease for 1984 was larger: 3.9%.

Thus, the relative impacts of shifting from 3+ to 5+ errors varied substantially between community and institutional residents and between the separate and combined triggers.

The corresponding results for males in community residences are in Tables 2.74–2.77; for males in institutional residences, in Tables 2.78–2.81; for females in community residences, in Tables 2.82–2.85; and for females in institutional residences, in Tables 2.86–2.89.

Table 2.54
Percent of Population Meeting HIPAA CI Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.79	0.81	-0.98	-54.8	3.89%
70-74	3.31	1.96	-1.35	-40.8	2.59%
75-79	6.41	3.91	-2.51	-39.1	2.45%
80-84	13.73	7.83	-5.90	-43.0	2.77%
85-89	24.89	14.52	-10.37	-41.6	2.66%
90-94	41.58	22.78	-18.79	-45.2	2.96%
95+	53.65	40.20	-13.45	-25.1	1.43%
Total	7.44	5.58	-1.86	-25.0	1.43%
1984 ASDR	7.44	4.31	-3.13	-42.1	2.70%
2004 ASDR	9.56	5.58	-3.98	-41.6	2.66%
		Standard Error			
Total	0.18	0.19	0.26		
1984 ASDR	0.18	0.15	0.24		
2004 ASDR	0.23	0.19	0.30		
		t-statistic			
Total	41.48	29.46	-7.13		
1984 ASDR	41.48	27.94	-13.25		
2004 ASDR	42.04	29.46	-13.45		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The CI trigger used 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.55
Percent of Population Meeting HIPAA CI Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.40	0.70	-0.70	-50.1	3.41%
70-74	2.62	1.58	-1.04	-39.7	2.50%
75-79	5.64	3.49	-2.15	-38.1	2.37%
80-84	12.18	7.05	-5.13	-42.1	2.70%
85-89	22.44	13.45	-8.99	-40.1	2.53%
90-94	37.95	20.35	-17.60	-46.4	3.07%
95+	49.03	37.42	-11.60	-23.7	1.34%
Total	6.51	5.01	-1.50	-23.0	1.30%
1984 ASDR	6.51	3.84	-2.66	-40.9	2.60%
2004 ASDR	8.44	5.01	-3.43	-40.7	2.58%
		Standard Error			
Total	0.17	0.18	0.25		
1984 ASDR	0.17	0.15	0.22		
2004 ASDR	0.22	0.18	0.28		
		t-statistic			
Total	38.46	27.75	-6.05		
1984 ASDR	38.46	26.40	-11.93		
2004 ASDR	38.84	27.75	-12.15		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The CI trigger used 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.56

Percent of Population Meeting Either HIPAA Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.95	2.52	-1.43	-36.2	2.22%
70-74	6.63	4.24	-2.40	-36.2	2.22%
75-79	10.87	7.36	-3.51	-32.3	1.93%
80-84	19.95	12.39	-7.56	-37.9	2.35%
85-89	34.27	22.64	-11.63	-33.9	2.05%
90-94	55.48	33.72	-21.77	-39.2	2.46%
95+	72.64	56.36	-16.28	-22.4	1.26%
Total	11.75	9.43	-2.32	-19.8	1.10%
1984 ASDR	11.75	7.62	-4.13	-35.2	2.14%
2004 ASDR	14.53	9.43	-5.10	-35.1	2.14%
		Standard Error			
Total	0.22	0.24	0.32		
1984 ASDR	0.22	0.21	0.30		
2004 ASDR	0.26	0.24	0.35		
		t-statistic			
Total	53.83	39.50	-7.18		
1984 ASDR	53.83	36.87	-13.75		
2004 ASDR	55.48	39.50	-14.39		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.57

Percent of Population Meeting Either HIPAA Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.72	2.45	-1.27	-34.0	2.06%
70-74	6.14	4.12	-2.01	-32.8	1.97%
75-79	10.34	7.21	-3.13	-30.2	1.78%
80-84	18.91	11.91	-7.00	-37.0	2.29%
85-89	32.83	21.98	-10.85	-33.0	1.99%
90-94	53.83	32.63	-21.20	-39.4	2.47%
95+	69.81	55.12	-14.69	-21.0	1.17%
Total	11.16	9.15	-2.01	-18.0	0.99%
1984 ASDR	11.16	7.40	-3.76	-33.7	2.03%
2004 ASDR	13.83	9.15	-4.68	-33.8	2.04%
		Standard Error			
Total	0.21	0.24	0.32		
1984 ASDR	0.21	0.20	0.30		
2004 ASDR	0.26	0.24	0.35		
		t-statistic			
Total	52.18	38.79	-6.30		
1984 ASDR	52.18	36.24	-12.71		
2004 ASDR	53.63	38.79	-13.39		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.58
Percent of Population Meeting HIPAA CI Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.64	0.83	-0.81	-49.4	3.34%
70-74	3.42	2.56	-0.85	-25.0	1.43%
75-79	5.65	3.67	-1.97	-35.0	2.13%
80-84	10.37	5.87	-4.50	-43.4	2.81%
85-89	17.81	9.37	-8.44	-47.4	3.16%
90-94	32.21	16.24	-15.97	-49.6	3.36%
95+	36.21	25.29	-10.92	-30.2	1.78%
Total	5.16	3.90	-1.25	-24.3	1.38%
1984 ASDR	5.16	3.11	-2.05	-39.8	2.50%
2004 ASDR	6.62	3.90	-2.72	-41.1	2.61%
		Standard Error			
Total	0.25	0.25	0.36		
1984 ASDR	0.25	0.21	0.33		
2004 ASDR	0.32	0.25	0.41		
		t-statistic			
Total	20.69	15.39	-3.53		
1984 ASDR	20.69	14.55	-6.25		
2004 ASDR	20.42	15.39	-6.61		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The CI trigger used 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.59
Percent of Population Meeting HIPAA CI Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.30	0.78	-0.52	-40.0	2.52%
70-74	2.77	2.07	-0.70	-25.2	1.44%
75-79	4.95	3.20	-1.75	-35.4	2.16%
80-84	9.51	4.99	-4.52	-47.5	3.17%
85-89	14.54	7.86	-6.68	-46.0	3.03%
90-94	27.28	12.67	-14.60	-53.5	3.76%
95+	36.21	22.13	-14.07	-38.9	2.43%
Total	4.40	3.29	-1.11	-25.2	1.44%
1984 ASDR	4.40	2.63	-1.77	-40.2	2.54%
2004 ASDR	5.69	3.29	-2.40	-42.2	2.70%
		Standard Error			
Total	0.23	0.23	0.33		
1984 ASDR	0.23	0.20	0.30		
2004 ASDR	0.31	0.23	0.38		
		t-statistic			
Total	18.97	14.03	-3.37		
1984 ASDR	18.97	13.30	-5.80		
2004 ASDR	18.66	14.03	-6.25		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The CI trigger used 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.60
Percent of Population Meeting Either HIPAA Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.68	2.34	-1.33	-36.3	2.23%
70-74	7.06	4.37	-2.69	-38.1	2.37%
75-79	10.13	7.20	-2.93	-29.0	1.69%
80-84	16.69	10.41	-6.29	-37.7	2.34%
85-89	26.73	14.91	-11.83	-44.2	2.88%
90-94	45.96	26.05	-19.91	-43.3	2.80%
95+	58.93	37.59	-21.33	-36.2	2.22%
Total	9.13	7.00	-2.14	-23.4	1.32%
1984 ASDR	9.13	5.75	-3.38	-37.0	2.29%
2004 ASDR	11.24	7.00	-4.24	-37.8	2.34%
		Standard Error			
Total	0.32	0.33	0.46		
1984 ASDR	0.32	0.29	0.43		
2004 ASDR	0.40	0.33	0.52		
		t-statistic			
Total	28.32	21.08	-4.62		
1984 ASDR	28.32	19.76	-7.78		
2004 ASDR	28.34	21.08	-8.20		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.61
Percent of Population Meeting Either HIPAA Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.45	2.34	-1.11	-32.2	1.92%
70-74	6.63	4.28	-2.34	-35.4	2.16%
75-79	9.71	7.05	-2.67	-27.5	1.59%
80-84	15.90	9.84	-6.06	-38.1	2.37%
85-89	24.91	13.77	-11.14	-44.7	2.92%
90-94	43.20	25.10	-18.10	-41.9	2.68%
95+	58.93	36.16	-22.77	-38.6	2.41%
Total	8.64	6.73	-1.91	-22.1	1.24%
1984 ASDR	8.64	5.57	-3.08	-35.6	2.18%
2004 ASDR	10.64	6.73	-3.91	-36.7	2.26%
		Standard Error			
Total	0.32	0.33	0.45		
1984 ASDR	0.32	0.29	0.43		
2004 ASDR	0.39	0.33	0.51		
		t-statistic			
Total	27.41	20.60	-4.21		
1984 ASDR	27.41	19.34	-7.21		
2004 ASDR	27.36	20.60	-7.70		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.62
Percent of Population Meeting HIPAA CI Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.91	0.79	-1.12	-58.6	4.31%
70-74	3.24	1.47	-1.77	-54.5	3.86%
75-79	6.88	4.08	-2.80	-40.7	2.58%
80-84	15.49	9.10	-6.39	-41.3	2.63%
85-89	27.61	17.18	-10.43	-37.8	2.34%
90-94	44.40	25.44	-18.96	-42.7	2.75%
95+	57.29	44.00	-13.29	-23.2	1.31%
Total	8.93	6.79	-2.13	-23.9	1.36%
1984 ASDR	8.93	5.19	-3.73	-41.8	2.67%
2004 ASDR	11.43	6.79	-4.63	-40.6	2.57%
		Standard Error			
Total	0.25	0.27	0.37		
1984 ASDR	0.25	0.22	0.33		
2004 ASDR	0.31	0.27	0.41		
		t-statistic			
Total	36.15	25.26	-5.85		
1984 ASDR	36.15	23.98	-11.36		
2004 ASDR	36.89	25.26	-11.30		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The CI trigger used 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.63
Percent of Population Meeting HIPAA CI Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.47	0.62	-0.85	-57.7	4.21%
70-74	2.51	1.18	-1.33	-53.0	3.70%
75-79	6.06	3.70	-2.35	-38.8	2.43%
80-84	13.58	8.38	-5.20	-38.3	2.38%
85-89	25.47	16.32	-9.14	-35.9	2.20%
90-94	41.16	23.46	-17.70	-43.0	2.77%
95+	51.70	41.32	-10.39	-20.1	1.12%
Total	7.87	6.25	-1.62	-20.6	1.15%
1984 ASDR	7.87	4.75	-3.13	-39.7	2.50%
2004 ASDR	10.18	6.25	-3.93	-38.6	2.41%
		Standard Error			
Total	0.23	0.26	0.35		
1984 ASDR	0.23	0.21	0.31		
2004 ASDR	0.30	0.26	0.39		
		t-statistic			
Total	33.65	24.11	-4.64		
1984 ASDR	33.65	22.98	-10.02		
2004 ASDR	34.19	24.11	-9.95		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The CI trigger used 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.64
Percent of Population Meeting Either HIPAA Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	4.17	2.68	-1.49	-35.7	2.19%
70-74	6.33	4.13	-2.20	-34.8	2.12%
75-79	11.33	7.48	-3.84	-33.9	2.05%
80-84	21.66	13.68	-7.98	-36.9	2.27%
85-89	37.16	26.62	-10.54	-28.4	1.65%
90-94	58.35	36.83	-21.52	-36.9	2.27%
95+	75.51	61.14	-14.37	-19.0	1.05%
Total	13.45	11.18	-2.27	-16.9	0.92%
1984 ASDR	13.45	8.98	-4.47	-33.2	2.00%
2004 ASDR	16.65	11.18	-5.47	-32.8	1.97%
		Standard Error			
Total	0.29	0.33	0.44		
1984 ASDR	0.29	0.29	0.41		
2004 ASDR	0.35	0.33	0.48		
		t-statistic			
Total	46.03	33.65	-5.13		
1984 ASDR	46.03	31.28	-10.91		
2004 ASDR	47.91	33.65	-11.37		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.65
Percent of Population Meeting Either HIPAA Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.93	2.55	-1.38	-35.1	2.14%
70-74	5.79	3.99	-1.79	-31.0	1.84%
75-79	10.72	7.33	-3.39	-31.6	1.88%
80-84	20.49	13.25	-7.24	-35.3	2.16%
85-89	35.86	26.20	-9.66	-26.9	1.56%
90-94	57.02	35.69	-21.34	-37.4	2.32%
95+	72.08	59.95	-12.14	-16.8	0.92%
Total	12.79	10.90	-1.89	-14.8	0.80%
1984 ASDR	12.79	8.74	-4.05	-31.6	1.88%
2004 ASDR	15.88	10.90	-4.98	-31.4	1.87%
		Standard Error			
Total	0.29	0.33	0.44		
1984 ASDR	0.29	0.28	0.40		
2004 ASDR	0.34	0.33	0.48		
		t-statistic			
Total	44.64	33.12	-4.33		
1984 ASDR	44.64	30.83	-10.03		
2004 ASDR	46.32	33.12	-10.49		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.66
Percent of Community Population Meeting HIPAA CI Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.06	0.66	-0.39	-37.2	2.30%
70-74	2.00	1.21	-0.79	-39.7	2.50%
75-79	3.61	2.32	-1.29	-35.7	2.19%
80-84	7.46	4.27	-3.19	-42.7	2.75%
85-89	12.99	7.38	-5.60	-43.2	2.78%
90-94	23.03	12.05	-10.99	-47.7	3.19%
95+	21.38	25.43	4.04	18.9	-0.87%
Total	3.71	2.95	-0.77	-20.6	1.15%
1984 ASDR	3.71	2.23	-1.48	-39.8	2.51%
2004 ASDR	4.87	2.95	-1.93	-39.5	2.48%
		Standard Error			
Total	0.14	0.15	0.20		
1984 ASDR	0.14	0.12	0.18		
2004 ASDR	0.19	0.15	0.24		
		t-statistic			
Total	26.85	20.20	-3.81		
1984 ASDR	26.85	18.91	-8.13		
2004 ASDR	26.20	20.20	-8.15		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community unisex population. The CI trigger used 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.67
Percent of Community Population Meeting HIPAA CI Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	0.73	0.55	-0.17	-23.9	1.35%
70-74	1.45	0.82	-0.63	-43.3	2.80%
75-79	2.90	1.94	-0.96	-33.0	1.98%
80-84	6.19	3.57	-2.63	-42.4	2.72%
85-89	10.86	6.43	-4.43	-40.8	2.59%
90-94	19.14	9.96	-9.18	-47.9	3.21%
95+	19.47	22.62	3.15	16.2	-0.75%
Total	2.96	2.45	-0.52	-17.5	0.96%
1984 ASDR	2.96	1.83	-1.13	-38.2	2.38%
2004 ASDR	3.96	2.45	-1.51	-38.2	2.38%
		Standard Error			
Total	0.12	0.13	0.18		
1984 ASDR	0.12	0.11	0.16		
2004 ASDR	0.17	0.13	0.22		
		t-statistic			
Total	23.85	18.33	-2.84		
1984 ASDR	23.85	17.19	-6.91		
2004 ASDR	23.21	18.33	-6.98		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community unisex population. The CI trigger used 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.68
Percent of Community Population Meeting Either HIPAA Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.06	2.29	-0.78	-25.4	1.45%
70-74	5.04	3.19	-1.84	-36.6	2.25%
75-79	7.37	5.33	-2.04	-27.6	1.60%
80-84	12.80	7.97	-4.83	-37.7	2.34%
85-89	21.28	13.34	-7.94	-37.3	2.31%
90-94	37.39	20.97	-16.42	-43.9	2.85%
95+	50.30	39.73	-10.57	-21.0	1.17%
Total	7.41	6.04	-1.37	-18.5	1.02%
1984 ASDR	7.41	4.90	-2.51	-33.9	2.05%
2004 ASDR	9.27	6.04	-3.23	-34.8	2.12%
		Standard Error			
Total	0.19	0.20	0.28		
1984 ASDR	0.19	0.18	0.26		
2004 ASDR	0.24	0.20	0.31		
		t-statistic			
Total	39.01	29.57	-4.90		
1984 ASDR	39.01	27.43	-9.64		
2004 ASDR	38.75	29.57	-10.27		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.69
Percent of Community Population Meeting Either HIPAA Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.85	2.22	-0.64	-22.3	1.25%
70-74	4.59	3.08	-1.51	-32.8	1.97%
75-79	6.81	5.18	-1.63	-24.0	1.36%
80-84	11.75	7.54	-4.21	-35.9	2.20%
85-89	19.72	12.59	-7.13	-36.1	2.22%
90-94	35.05	19.86	-15.18	-43.3	2.80%
95+	48.38	37.99	-10.40	-21.5	1.20%
Total	6.84	5.77	-1.07	-15.7	0.85%
1984 ASDR	6.84	4.69	-2.15	-31.4	1.87%
2004 ASDR	8.58	5.77	-2.81	-32.7	1.96%
		Standard Error			
Total	0.18	0.20	0.27		
1984 ASDR	0.18	0.18	0.25		
2004 ASDR	0.23	0.20	0.31		
		t-statistic			
Total	37.31	28.81	-3.94		
1984 ASDR	37.31	26.77	-8.48		
2004 ASDR	36.95	28.81	-9.16		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.70

Percent of Institutional Population Meeting HIPAA CI Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	69.06	45.45	-23.61	-34.2	2.07%
70-74	62.58	66.58	4.00	6.4	-0.31%
75-79	66.22	63.07	-3.15	-4.8	0.24%
80-84	71.08	71.01	-0.07	-0.1	0.01%
85-89	74.65	67.75	-6.90	-9.2	0.48%
90-94	77.36	69.84	-7.52	-9.7	0.51%
95+	85.23	76.19	-9.04	-10.6	0.56%
Total	71.90	68.45	-3.44	-4.8	0.25%
1984 ASDR	71.90	67.03	-4.87	-6.8	0.35%
2004 ASDR	73.20	68.45	-4.75	-6.5	0.33%
		Standard Error			
Total	1.39	2.00	2.44		
1984 ASDR	1.39	2.20	2.60		
2004 ASDR	1.40	2.00	2.44		
		t-statistic			
Total	51.63	34.23	-1.41		
1984 ASDR	51.63	30.48	-1.87		
2004 ASDR	52.18	34.23	-1.94		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional unisex population. The CI trigger used 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.71

Percent of Institutional Population Meeting HIPAA CI Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	63.21	45.45	-17.77	-28.1	1.64%
70-74	55.54	66.58	11.03	19.9	-0.91%
75-79	63.96	61.03	-2.93	-4.6	0.23%
80-84	66.96	68.96	1.99	3.0	-0.15%
85-89	70.84	65.74	-5.10	-7.2	0.37%
90-94	74.24	65.85	-8.39	-11.3	0.60%
95+	77.96	73.47	-4.49	-5.8	0.30%
Total	67.70	66.17	-1.53	-2.3	0.11%
1984 ASDR	67.70	65.01	-2.70	-4.0	0.20%
2004 ASDR	69.10	66.17	-2.93	-4.2	0.22%
		Standard Error			
Total	1.45	2.04	2.50		
1984 ASDR	1.45	2.23	2.66		
2004 ASDR	1.47	2.04	2.51		
		t-statistic			
Total	46.73	32.47	-0.61		
1984 ASDR	46.73	29.20	-1.02		
2004 ASDR	46.96	32.47	-1.17		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional unisex population. The CI trigger used 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.72

Percent of Institutional Population Meeting Either HIPAA Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	86.01	75.79	-10.22	-11.9	0.63%
70-74	78.89	93.55	14.66	18.6	-0.86%
75-79	85.64	82.95	-2.69	-3.1	0.16%
80-84	85.40	90.95	5.55	6.5	-0.32%
85-89	88.55	91.95	3.40	3.8	-0.19%
90-94	90.41	89.59	-0.82	-0.9	0.05%
95+	94.51	96.85	2.34	2.5	-0.12%
Total	86.83	90.29	3.46	4.0	-0.20%
1984 ASDR	86.83	89.39	2.57	3.0	-0.15%
2004 ASDR	87.61	90.29	2.68	3.1	-0.15%
		Standard Error			
Total	1.05	1.27	1.65		
1984 ASDR	1.05	1.52	1.84		
2004 ASDR	1.04	1.27	1.64		
		t-statistic			
Total	82.70	71.13	2.10		
1984 ASDR	82.70	58.96	1.39		
2004 ASDR	84.63	71.13	1.64		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.73

Percent of Institutional Population Meeting Either HIPAA Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	83.52	75.79	-7.73	-9.3	0.48%
70-74	76.35	93.55	17.20	22.5	-1.02%
75-79	85.64	82.95	-2.69	-3.1	0.16%
80-84	84.43	89.60	5.17	6.1	-0.30%
85-89	87.61	91.95	4.34	5.0	-0.24%
90-94	90.07	88.57	-1.50	-1.7	0.08%
95+	90.78	96.85	6.07	6.7	-0.32%
Total	85.69	89.80	4.10	4.8	-0.23%
1984 ASDR	85.69	88.94	3.25	3.8	-0.19%
2004 ASDR	86.52	89.80	3.27	3.8	-0.19%
		Standard Error			
Total	1.09	1.30	1.69		
1984 ASDR	1.09	1.54	1.88		
2004 ASDR	1.08	1.30	1.69		
		t-statistic			
Total	78.86	69.20	2.42		
1984 ASDR	78.86	57.88	1.73		
2004 ASDR	80.27	69.20	1.94		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.74
Percent of Community Population Meeting HIPAA CI Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.01	0.58	-0.43	-42.4	2.72%
70-74	2.16	1.64	-0.53	-24.4	1.39%
75-79	3.10	2.14	-0.96	-30.9	1.83%
80-84	6.00	3.57	-2.43	-40.5	2.56%
85-89	10.03	6.07	-3.96	-39.5	2.48%
90-94	16.62	9.60	-7.03	-42.3	2.71%
95+	4.64	13.39	8.75	188.7	-5.44%
Total	2.83	2.35	-0.48	-17.1	0.93%
1984 ASDR	2.83	1.85	-0.98	-34.5	2.09%
2004 ASDR	3.61	2.35	-1.26	-35.0	2.13%
		Standard Error			
Total	0.19	0.20	0.28		
1984 ASDR	0.19	0.17	0.26		
2004 ASDR	0.26	0.20	0.33		
		t-statistic			
Total	14.62	11.60	-1.73		
1984 ASDR	14.62	10.91	-3.79		
2004 ASDR	14.03	11.60	-3.86		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community male population. The CI trigger used 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.75
Percent of Community Population Meeting HIPAA CI Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	0.70	0.54	-0.16	-23.1	1.30%
70-74	1.67	1.14	-0.53	-31.9	1.90%
75-79	2.45	1.65	-0.80	-32.6	1.95%
80-84	5.15	2.95	-2.20	-42.8	2.75%
85-89	7.60	4.66	-2.94	-38.7	2.41%
90-94	11.96	6.74	-5.22	-43.6	2.83%
95+	4.64	10.43	5.79	124.9	-4.14%
Total	2.21	1.81	-0.39	-17.8	0.98%
1984 ASDR	2.21	1.44	-0.77	-34.8	2.12%
2004 ASDR	2.83	1.81	-1.02	-35.9	2.20%
		Standard Error			
Total	0.17	0.18	0.25		
1984 ASDR	0.17	0.15	0.23		
2004 ASDR	0.23	0.18	0.29		
		t-statistic			
Total	12.83	10.14	-1.58		
1984 ASDR	12.83	9.56	-3.36		
2004 ASDR	12.28	10.14	-3.48		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community male population. The CI trigger used 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.76
Percent of Community Population Meeting Either HIPAA Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.93	1.94	-0.99	-33.7	2.03%
70-74	5.57	3.37	-2.20	-39.5	2.48%
75-79	7.18	5.54	-1.64	-22.9	1.29%
80-84	11.66	7.28	-4.39	-37.6	2.33%
85-89	18.14	10.25	-7.88	-43.5	2.81%
90-94	32.09	18.10	-13.99	-43.6	2.82%
95+	41.79	22.90	-18.89	-45.2	2.96%
Total	6.46	5.03	-1.43	-22.1	1.24%
1984 ASDR	6.46	4.17	-2.29	-35.5	2.17%
2004 ASDR	7.93	5.03	-2.89	-36.5	2.25%
		Standard Error			
Total	0.29	0.29	0.41		
1984 ASDR	0.29	0.26	0.38		
2004 ASDR	0.36	0.29	0.46		
		t-statistic			
Total	22.67	17.28	-3.50		
1984 ASDR	22.67	16.19	-5.96		
2004 ASDR	22.01	17.28	-6.25		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community male population. The HIPAA triggers are based on 2+ ADL Impariments or 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.77
Percent of Community Population Meeting Either HIPAA Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.71	1.94	-0.76	-28.2	1.64%
70-74	5.19	3.28	-1.90	-36.7	2.26%
75-79	6.75	5.39	-1.36	-20.2	1.12%
80-84	10.89	6.88	-4.01	-36.9	2.27%
85-89	16.63	9.05	-7.58	-45.6	3.00%
90-94	29.03	17.03	-12.00	-41.3	2.63%
95+	41.79	21.10	-20.70	-49.5	3.36%
Total	6.01	4.79	-1.22	-20.3	1.13%
1984 ASDR	6.01	4.01	-2.00	-33.3	2.01%
2004 ASDR	7.37	4.79	-2.58	-35.0	2.13%
		Standard Error			
Total	0.28	0.28	0.40		
1984 ASDR	0.28	0.25	0.37		
2004 ASDR	0.35	0.28	0.45		
		t-statistic			
Total	21.77	16.81	-3.07		
1984 ASDR	21.77	15.78	-5.34		
2004 ASDR	21.08	16.81	-5.72		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community male population. The HIPAA triggers are based on 2+ ADL Impariments or 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.78
Percent of Institutional Population Meeting HIPAA CI Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	66.22	48.43	-17.79	-26.9	1.55%
70-74	66.34	86.17	19.83	29.9	-1.32%
75-79	71.20	69.39	-1.81	-2.5	0.13%
80-84	73.17	60.95	-12.22	-16.7	0.91%
85-89	73.94	61.89	-12.05	-16.3	0.89%
90-94	76.26	67.58	-8.68	-11.4	0.60%
95+	81.81	71.29	-10.52	-12.9	0.69%
Total	71.69	66.44	-5.25	-7.3	0.38%
1984 ASDR	71.69	66.91	-4.79	-6.7	0.34%
2004 ASDR	72.57	66.44	-6.13	-8.4	0.44%
		Standard Error			
Total	2.87	4.07	4.98		
1984 ASDR	2.87	4.16	5.05		
2004 ASDR	2.91	4.07	5.00		
		t-statistic			
Total	24.94	16.33	-1.05		
1984 ASDR	24.94	16.09	-0.95		
2004 ASDR	24.92	16.33	-1.22		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional male population. The CI trigger used 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.79
Percent of Institutional Population Meeting HIPAA CI Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	64.04	48.43	-15.61	-24.4	1.39%
70-74	57.90	86.17	28.27	48.8	-2.01%
75-79	69.12	69.39	0.27	0.4	-0.02%
80-84	72.10	54.03	-18.07	-25.1	1.43%
85-89	64.66	58.77	-5.89	-9.1	0.48%
90-94	70.56	58.50	-12.06	-17.1	0.93%
95+	81.81	67.39	-14.41	-17.6	0.96%
Total	67.18	62.67	-4.50	-6.7	0.35%
1984 ASDR	67.18	63.81	-3.37	-5.0	0.26%
2004 ASDR	68.27	62.67	-5.60	-8.2	0.43%
		Standard Error			
Total	2.99	4.14	5.11		
1984 ASDR	2.99	4.21	5.16		
2004 ASDR	3.03	4.14	5.13		
		t-statistic			
Total	22.49	15.13	-0.88		
1984 ASDR	22.49	15.17	-0.65		
2004 ASDR	22.56	15.13	-1.09		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional male population. The CI trigger used 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.80
Percent of Institutional Population Meeting Either HIPAA Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	80.55	79.45	-1.10	-1.4	0.07%
70-74	81.79	94.45	12.66	15.5	-0.72%
75-79	85.98	78.32	-7.67	-8.9	0.47%
80-84	88.94	85.40	-3.54	-4.0	0.20%
85-89	88.74	88.91	0.17	0.2	-0.01%
90-94	85.14	87.44	2.30	2.7	-0.13%
95+	83.67	94.41	10.74	12.8	-0.61%
Total	85.67	86.08	0.41	0.5	-0.02%
1984 ASDR	85.67	85.95	0.28	0.3	-0.02%
2004 ASDR	86.25	86.08	-0.16	-0.2	0.01%
		Standard Error			
Total	2.24	3.00	3.74		
1984 ASDR	2.24	3.15	3.86		
2004 ASDR	2.24	3.00	3.74		
		t-statistic			
Total	38.27	28.71	0.11		
1984 ASDR	38.27	27.32	0.07		
2004 ASDR	38.43	28.71	-0.04		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional male population. The HIPAA triggers are based on 2+ ADL Impariments or 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.81
Percent of Institutional Population Meeting Either HIPAA Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Males, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	80.55	79.45	-1.10	-1.4	0.07%
70-74	78.89	94.45	15.57	19.7	-0.90%
75-79	85.98	78.32	-7.67	-8.9	0.47%
80-84	87.86	80.82	-7.04	-8.0	0.42%
85-89	84.61	88.91	4.30	5.1	-0.25%
90-94	83.24	87.44	4.20	5.0	-0.25%
95+	83.67	94.41	10.74	12.8	-0.61%
Total	84.04	84.90	0.86	1.0	-0.05%
1984 ASDR	84.04	85.01	0.97	1.2	-0.06%
2004 ASDR	84.60	84.90	0.30	0.4	-0.02%
		Standard Error			
Total	2.34	3.09	3.88		
1984 ASDR	2.34	3.21	3.97		
2004 ASDR	2.35	3.09	3.89		
		t-statistic			
Total	35.92	27.44	0.22		
1984 ASDR	35.92	26.52	0.24		
2004 ASDR	35.94	27.44	0.08		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional male population. The HIPAA triggers are based on 2+ ADL Impariments or 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.82

Percent of Community Population Meeting HIPAA CI Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	1.09	0.74	-0.36	-32.6	1.96%
70-74	1.89	0.86	-1.03	-54.5	3.86%
75-79	3.92	2.45	-1.47	-37.6	2.33%
80-84	8.27	4.74	-3.53	-42.7	2.75%
85-89	14.26	8.13	-6.13	-43.0	2.77%
90-94	25.28	13.17	-12.11	-47.9	3.21%
95+	25.74	28.97	3.23	12.6	-0.59%
Total	4.30	3.39	-0.91	-21.2	1.19%
1984 ASDR	4.30	2.51	-1.79	-41.6	2.65%
2004 ASDR	5.70	3.39	-2.31	-40.5	2.56%
		Standard Error			
Total	0.19	0.20	0.28		
1984 ASDR	0.19	0.16	0.25		
2004 ASDR	0.26	0.20	0.33		
		t-statistic			
Total	22.56	16.57	-3.27		
1984 ASDR	22.56	15.44	-7.14		
2004 ASDR	22.10	16.57	-7.01		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community female population. The CI trigger used 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.83

Percent of Community Population Meeting HIPAA CI Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	0.75	0.57	-0.18	-24.3	1.38%
70-74	1.29	0.56	-0.72	-56.2	4.05%
75-79	3.18	2.16	-1.02	-32.1	1.92%
80-84	6.77	3.98	-2.80	-41.3	2.63%
85-89	12.27	7.44	-4.83	-39.4	2.47%
90-94	21.66	11.44	-10.22	-47.2	3.14%
95+	23.33	26.21	2.88	12.4	-0.58%
Total	3.47	2.92	-0.56	-16.1	0.87%
1984 ASDR	3.47	2.13	-1.34	-38.6	2.41%
2004 ASDR	4.69	2.92	-1.77	-37.8	2.35%
		Standard Error			
Total	0.17	0.19	0.26		
1984 ASDR	0.17	0.15	0.23		
2004 ASDR	0.24	0.19	0.31		
		t-statistic			
Total	20.15	15.31	-2.17		
1984 ASDR	20.15	14.32	-5.89		
2004 ASDR	19.68	15.31	-5.81		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community female population. The CI trigger used 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.84

Percent of Community Population Meeting Either HIPAA Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.16	2.59	-0.58	-18.3	1.00%
70-74	4.65	3.05	-1.60	-34.5	2.09%
75-79	7.48	5.18	-2.30	-30.8	1.82%
80-84	13.43	8.43	-5.00	-37.2	2.30%
85-89	22.64	15.10	-7.54	-33.3	2.01%
90-94	39.24	22.28	-16.96	-43.2	2.79%
95+	52.51	44.69	-7.82	-14.9	0.80%
Total	8.04	6.79	-1.26	-15.6	0.85%
1984 ASDR	8.04	5.43	-2.61	-32.5	1.95%
2004 ASDR	10.18	6.79	-3.39	-33.3	2.01%
		Standard Error			
Total	0.25	0.28	0.38		
1984 ASDR	0.25	0.25	0.35		
2004 ASDR	0.32	0.28	0.43		
		t-statistic			
Total	31.78	24.04	-3.31		
1984 ASDR	31.78	22.13	-7.42		
2004 ASDR	31.78	24.04	-7.95		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community female population. The HIPAA triggers are based on 2+ ADL Impariments or 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.85

Percent of Community Population Meeting Either HIPAA Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.97	2.46	-0.51	-17.2	0.94%
70-74	4.15	2.91	-1.24	-29.8	1.75%
75-79	6.85	5.02	-1.82	-26.6	1.54%
80-84	12.23	7.98	-4.25	-34.8	2.11%
85-89	21.05	14.61	-6.44	-30.6	1.81%
90-94	37.15	21.16	-15.99	-43.0	2.77%
95+	50.10	42.96	-7.14	-14.3	0.77%
Total	7.40	6.50	-0.90	-12.2	0.65%
1984 ASDR	7.40	5.20	-2.20	-29.8	1.75%
2004 ASDR	9.41	6.50	-2.90	-30.9	1.83%
		Standard Error			
Total	0.24	0.28	0.37		
1984 ASDR	0.24	0.24	0.34		
2004 ASDR	0.31	0.28	0.42		
		t-statistic			
Total	30.32	23.45	-2.45		
1984 ASDR	30.32	21.62	-6.43		
2004 ASDR	30.23	23.45	-6.97		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted community female population. The HIPAA triggers are based on 2+ ADL Impariments or 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.86
Percent of Institutional Population Meeting HIPAA CI Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	70.91	36.37	-34.54	-48.7	3.28%
70-74	60.30	52.04	-8.25	-13.7	0.73%
75-79	63.91	59.37	-4.54	-7.1	0.37%
80-84	70.46	75.23	4.76	6.8	-0.33%
85-89	74.80	68.95	-5.85	-7.8	0.41%
90-94	77.60	70.33	-7.27	-9.4	0.49%
95+	85.79	77.01	-8.78	-10.2	0.54%
Total	71.96	69.13	-2.83	-3.9	0.20%
1984 ASDR	71.96	66.65	-5.31	-7.4	0.38%
2004 ASDR	73.52	69.13	-4.39	-6.0	0.31%
		Standard Error			
Total	1.60	2.29	2.79		
1984 ASDR	1.60	2.99	3.39		
2004 ASDR	1.61	2.29	2.80		
		t-statistic			
Total	45.06	30.15	-1.01		
1984 ASDR	45.06	22.32	-1.57		
2004 ASDR	45.55	30.15	-1.56		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional female population. The CI trigger used 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.87
Percent of Institutional Population Meeting HIPAA CI Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	62.67	36.37	-26.31	-42.0	2.68%
70-74	54.11	52.04	-2.07	-3.8	0.19%
75-79	61.56	56.14	-5.43	-8.8	0.46%
80-84	65.45	75.23	9.78	14.9	-0.70%
85-89	72.15	67.17	-4.98	-6.9	0.36%
90-94	75.03	67.44	-7.59	-10.1	0.53%
95+	77.33	74.49	-2.84	-3.7	0.19%
Total	67.87	67.36	-0.52	-0.8	0.04%
1984 ASDR	67.87	65.08	-2.80	-4.1	0.21%
2004 ASDR	69.63	67.36	-2.28	-3.3	0.17%
		Standard Error			
Total	1.66	2.33	2.86		
1984 ASDR	1.66	3.00	3.43		
2004 ASDR	1.69	2.33	2.88		
		t-statistic			
Total	40.86	28.96	-0.18		
1984 ASDR	40.86	21.66	-0.81		
2004 ASDR	41.12	28.96	-0.79		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional female population. The CI trigger used 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.88
Percent of Institutional Population Meeting Either HIPAA Trigger (4+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	89.58	64.65	-24.93	-27.8	1.62%
70-74	77.13	92.88	15.74	20.4	-0.93%
75-79	85.48	85.67	0.19	0.2	-0.01%
80-84	84.36	93.29	8.93	10.6	-0.50%
85-89	88.51	92.57	4.06	4.6	-0.22%
90-94	91.54	90.05	-1.49	-1.6	0.08%
95+	96.27	97.26	0.99	1.0	-0.05%
Total	87.20	91.71	4.51	5.2	-0.25%
1984 ASDR	87.20	90.29	3.09	3.5	-0.17%
2004 ASDR	88.10	91.71	3.61	4.1	-0.20%
		Standard Error			
Total	1.19	1.38	1.82		
1984 ASDR	1.19	2.35	2.63		
2004 ASDR	1.17	1.38	1.80		
		t-statistic			
Total	73.32	66.61	2.48		
1984 ASDR	73.32	38.42	1.17		
2004 ASDR	75.55	66.61	2.00		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional female population. The HIPAA triggers are based on 2+ ADL Impariments or 4+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.89
Percent of Institutional Population Meeting Either HIPAA Trigger (5+ SPMSQ Errors), United States 1984 and 2004, Females, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	85.46	64.65	-20.81	-24.3	1.39%
70-74	74.81	92.88	18.06	24.1	-1.09%
75-79	85.48	85.67	0.19	0.2	-0.01%
80-84	83.42	93.29	9.87	11.8	-0.56%
85-89	88.24	92.57	4.33	4.9	-0.24%
90-94	91.54	88.82	-2.72	-3.0	0.15%
95+	91.94	97.26	5.32	5.8	-0.28%
Total	86.23	91.45	5.23	6.1	-0.29%
1984 ASDR	86.23	90.09	3.87	4.5	-0.22%
2004 ASDR	87.24	91.45	4.21	4.8	-0.24%
		Standard Error			
Total	1.23	1.40	1.86		
1984 ASDR	1.23	2.36	2.66		
2004 ASDR	1.21	1.40	1.85		
		t-statistic			
Total	70.25	65.55	2.81		
1984 ASDR	70.25	38.22	1.45		
2004 ASDR	72.10	65.55	2.28		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted institutional female population. The HIPAA triggers are based on 2+ ADL Impariments or 5+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

8. Life Expectancies and Disabled Life Expectancies based on 5+ SPMSQ Errors

This subsection presents selected results for the alternative HIPAA CI trigger based on 5+ SPMSQ errors. This was the more extreme of the two alternatives used to ensure that only cases of severe cognitive impairment would be included in our simulations of the HIPAA CI trigger (see Subsection 3 of Introduction).

Tables 2.90–2.92 present the unisex and sex-specific life expectancies (LEs) and disabled life expectancies (DLEs), based on the alternative HIPAA CI trigger, and the decompositions of the DLE changes into the survival increments and morbidity decrements, as described in Subsections 7 and 8 of Introduction. These are directly comparable to Tables 2.24–2.26.

Table 2.90
Components of Change in Unisex Life Expectancy and HIPAA CI (5+ SPMSQ Errors) Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	16.64	18.11	1.48	1.48	–
HIPAA CI Expectancy	1.31	0.90	-0.41	0.20	0.61
Standard Error	0.03	0.03	0.05	0.01	0.05
t-statistic	39.00	27.86	-8.82	35.91	12.14

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.91
Components of Change in Male Life Expectancy and HIPAA CI (5+ SPMSQ Errors) Expectancy (in Years at Age 65), United States 1984 and 2004

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	14.41	16.67	2.26	2.26	–
HIPAA CI Expectancy	0.74	0.55	-0.19	0.22	0.41
Standard Error	0.04	0.04	0.06	0.01	0.07
t-statistic	18.81	14.01	-3.37	15.86	6.23

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.92
Components of Change in Female Life Expectancy and HIPAA CI (5+ SPMSQ Errors) Expectancy (in Years at Age 65), United States 1984 and 2004

At Age 65	Year 1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	18.66	19.50	0.84	0.84	–
HIPAA CI Expectancy	1.79	1.19	-0.60	0.14	0.75
Standard Error	0.05	0.05	0.07	0.00	0.07
t-statistic	34.27	24.23	-8.40	31.38	9.95

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.90 shows that the DLE for CI declined 0.41 years from 1.31 years in 1984 to 0.90 years in 2004. The decline was statistically highly significant and the estimated value of 0.41 years had high precision. The decline was 33% less than the 0.61-year decline in Table 2.24, consistent with the substantial impact of switching from 3+ errors to 5+ errors in the simulated HIPAA CI trigger.

Corresponding reductions in the size of the decline in the DLE for CI were obtained for males and females. For males, the reduction was 37%, from 0.30 years (Table 2.25) to 0.19 years (Table 2.91); for females, 32%, from 0.88 years (Table 2.26) to 0.60 years (Table 2.92).

Tables 2.93–2.95 present the corresponding unisex and sex-specific LEs and DLEs, based on the combined HIPAA ADL and CI triggers. These are directly comparable to Tables 2.27–2.29.

Table 2.93
Components of Change in Unisex Life Expectancy and HIPAA ADL/CI (5+ SPMSQ Errors) Expectancy (in Years at Age 65), United States 1984 and

At Age 65	Year 1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	16.64	18.11	1.48	1.48	–
HIPAA ADL/CI Expectancy	2.16	1.64	-0.52	0.31	0.83
Standard Error	0.04	0.04	0.06	0.01	0.06
t-statistic	54.16	38.99	-9.03	49.14	13.42

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.94
Components of Change in Male Life Expectancy and HIPAA ADL/CI (5+ SPMSQ Errors) Expectancy (in Years at Age 65), United States 1984 and

At Age 65	Year 1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	14.41	16.67	2.26	2.26	–
HIPAA ADL/CI Expectancy	1.41	1.13	-0.28	0.38	0.66
Standard Error	0.05	0.05	0.07	0.02	0.09
t-statistic	27.72	20.64	-3.77	23.11	7.75

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.95
Components of Change in Female Life Expectancy and HIPAA ADL/CI (5+ SPMSQ Errors) Expectancy (in Years at Age 65), United States 1984 and

At Age 65	Year 1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	18.66	19.50	0.84	0.84	–
HIPAA ADL/CI Expectancy	2.82	2.08	-0.74	0.21	0.95
Standard Error	0.06	0.06	0.09	0.00	0.09
t-statistic	46.73	33.31	-8.47	42.37	10.50

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 2.93 shows that the combined DLE declined 0.52 years from 2.16 years in 1984 to 1.64 years in 2004. The decline was statistically highly significant and the estimated value of 0.52 years had high precision. The decline was 26% less than the 0.70-year decline in Table 2.27.

Corresponding reductions in the size of the decline in the combined DLE were obtained for males and females. For males, the reduction was 28%, from 0.39 years (Table 2.28) to 0.28 years (Table 2.94); for females, 24%, from 0.97 years (Table 2.29) to 0.74 years (Table 2.95).

The above results indicate that, even with the more conservative CI trigger, both sexes exhibited substantial and statistically highly significant declines in their expected total lifetime days of chronic disability at and beyond age 65, supporting Fries' (1980, 1983, 1989) morbidity compression hypothesis.

Comments

The most surprising finding of our study was that the improvements for the HIPAA CI prevalence rates were larger than those for the HIPAA ADL prevalence rates. Previous reports from the

NLTCS, which had documented the ADL trends as they developed over time, generally avoided examination of CI trends due to the difficulties with the institutional assessments shown in Table 2.1, necessitating the use of other sources of data for this purpose.[11]

The early analyses of CI trends in the U.S. from the Health and Retirement Study (HRS) produced conflicting results (see Freedman et al., 2001; Rodgers et al., 2003; and Freedman and Martin, 2003). More recent analyses of the HRS mostly resolved the prior conflicts and produced CI trend estimates and standard errors that supported our results (see discussion of Langa et al. (2008) and Sheffield and Peek (2011) in Subsection 2.5). Likewise, concurrent reports on CI trends in the U.K. (Matthews et al., 2013) and Denmark (Christensen et al., 2013) also produced trend estimates and standard errors that were consistent with our results.

The direct evidence that we have presented regarding morbidity improvement and the compression of morbidity was limited to the changes in prevalence rates for elderly persons meeting the simulated HIPAA ADL and/or CI triggers. This is significant because other definitions of morbidity can lead to different conclusions regarding the temporal trends and the absolute number of life-years spent disabled, as indicated in the following paragraphs.

Crimmins and Beltrán-Sánchez (2011) reported large increases in DLE between 1998 and 2006 in the U.S. using data for the non-institutionalized population from the National Health Interview Survey (NHIS) using two alternative definitions of morbidity: (1) based on mobility functioning (i.e., walking one quarter mile, walking up ten steps, standing/sitting for two hours, and standing/bending/kneeling without special equipment); and (2) based on self-reports of heart disease, stroke, cancer, and/or diabetes. Crimmins' mobility-based DLE estimates at age 65 in 2006 were 4.5 years for males and 7.3 years for females, far above the 1.1 and 2.1 year DLE estimates at age 65 in 2004 in Tables 2.94 and 2.95. Crimmins also provided mobility-based DLE estimates at age 20, which in 2006 were 5.8 years for males and 9.8 years for females – 1.3 and 2.5 years larger than at age 65.

Murray et al. (2013) reported large increases in unisex DLE in the U.S. between 1990 and 2010, increasing at birth from 9.4 to 10.1 years, based on 291 diseases and injuries, 1,160 sequelae, and 67 risk factors, from a variety of data sources. Though large, these DLEs were actually smaller than the disease-based DLEs at age 20 in 2006 reported by Crimmins and Beltrán-Sánchez (2011): 12.3 years for males and 13.0 years for females.

Smith et al. (2013) reported that there was no time trend in ADL disability in the last two years of life during 2000–2010 using mortality follow-back data from the HRS, with disability triggered at

[11] This was the case for Manton et al. (2005) who reported age-adjusted prevalence rates of severe cognitive impairment (SCI) of 5.7% in 1982 and 2.9% in 1999 based on data from the NLTCS with supplemental calculations for the institutional population based on the NNHS, where SCI was defined as the inability to answer any SPMSQ or MMSE questions. Manton estimated a rapid drop in prevalence from 5.7% in 1982 to 4.8% in 1984, implying that the annualized relative rate of decline was 3.3% per year for the 15-year period 1984–1999, just below Sheffield and Peek's (2011) estimate of 3.4% per year for the 10-year period 1993–2004 based on data from the HRS (see Subsection 2.5). Our most conservative definition of severe CI in this report, which was based on 5+ errors on the SPMSQ, produced a highly statistically significant, highly precise, annualized relative rate of decline of 2.6% per year for the 20-year period 1984–2004 (Table 2.55), using data from only the NLTCS with consistent treatment of community and institutional respondents at both ends of the 20-year study period.

1+ ADLs (with continence replaced by inside mobility). Although Smith et al. (2013, p. E5) commented that they did not directly address the morbidity compression hypothesis, the absence of a time trend in the 2-year DLE among decedents suggests that the survival increment and the morbidity decrement were approximately equal in their data. They controlled for age at death, sex, race/ethnicity, education, and household net worth at enrollment, but did not control for the exclusion of institutionalized persons at the time of enrollment. In contrast, we controlled for attained age, stratified by sex, and included institutionalized persons in our sample. Thus, our ADL trend estimates (Tables 1.11–1.13) differed from those of Smith due to differences in the definitions of the ADL triggers and the methods of analysis. This contrasts with the CI trend estimates, for which the HRS results were consistent with ours.

SECTION 3: SENSITIVITIES TO ALTERNATIVE SURVEY WEIGHTING PROTOCOLS

The tertiary focus of the study was on the sensitivity of the results to alternative protocols for developing survey weights. This was important because the design of the NLTCS as a complex longitudinal survey with multiple sets of sample entrants, deletions, and restorations meant that multiple sets of survey weights were necessary to facilitate a broad range of analyses; this also meant that the weights used in Sections 1 and 2 were but one of several possible sets of weights that could have been used (Stallard, 2004, 2008).

The survey weights used in Sections 1 and 2 represented minor modifications to the main set of survey weights developed at Duke University, which have been used extensively by Manton and colleagues in peer-reviewed scientific publications (e.g., Manton et al., 1993, 1998, 2001, 2006). The last of these publications introduced a new set of weights for the 2004 NLTCS which are commonly referred to as the PNAS weights due their first use in the journal *Proceedings of the National Academy of Sciences*.

The most significant alternative set of survey weights was developed by Brenda Cox, at Battelle, Inc., under contract to the U.S. Department of Health and Human Services (Cox and Wolters, 2008). These weights are widely accepted as alternatives to the Duke/PNAS weights (e.g., see Freedman et al., 2013); of greatest relevance, results derived from the Cox weights have been used to challenge the accuracy of Manton et al.'s (2006) estimates for the 2004 NLTCS, leading to uncertainty about the accuracy of trend estimates using the PNAS weights to form the terminal endpoint.

Given this background, we considered it highly beneficial to this study to evaluate the impact of substituting the Cox weights for the Duke/PNAS weights in our assessment of morbidity improvement. We selected the main results from Sections 1 and 2 for this replication.

This section presents the first comprehensive assessment of the impact of using the Cox weights on the disability trend estimates from the NLTCS. The detailed results can be summarized as follows:

1. Use of the Cox weights increased the age-standardized HIPAA ADL/CI unisex disability prevalence rate from 10.09% (Table 2.21) to 11.01% (Table 3.8) in 2004, a relative increase of 9.1%. Adjustment for design differences between the 1984 and 2004 NLTCS reduced the Cox-weighted estimate to 10.72% (Table 3.9) and the relative increase to 6.2%. The adjustment accounted for one-third of the 9.1% Cox-PNAS discrepancy.
2. The overall rate of decline of 2.29% (Table 2.21) per year in the age-standardized HIPAA ADL/CI unisex rates using the Duke/PNAS weighting protocol decreased to 2.01% per year (Table 3.9) using the adjusted Cox weighting protocol, and to 1.88% per year (Table 3.8) using the unadjusted Cox weighting protocol.
3. Considering the rates of decline in the age-standardized HIPAA ADL and CI unisex rates separately, the adjusted and unadjusted Cox weighting protocols generated relative reductions of 18% and 22% for the ADL trigger (Tables 3.15) and 9% and 13% for the CI trigger (Table 3.18).

4. Assessment of the impact of the adjusted Cox weighting protocols on the accuracy of the trend estimates generated using the Duke/PNAS weighting protocol was done by considering the extent to which the Cox-weighted trend estimates were outside the 95% confidence intervals of the Duke/PNAS-weighted trend estimates, using the associated *t*-statistics for the respective comparisons.
    - The adjusted Cox-weighted trend estimates were outside the 95% confidence intervals for the unisex trends for the combined ADL and CI triggers (HIPAA ADL/CI), where, with $t = 2.06$ and 1.97 for the 1984 and 2004 ASDRs, they were close to the $t = 1.96$ cutoff value (Table 3.10).
    - The adjusted Cox-weighted trend estimates were inside the 95% confidence intervals for the unisex trends for the separate ADL and CI triggers (Tables 3.15 and 3.18); and for the sex-specific trends for the combined and separate ADL and CI triggers (Tables 3.23, 3.24, 3.29, 3.30, 3.35, and 3.36).
5. Assessment of the impact of the unadjusted Cox weighting protocols was done similarly.
    - The unadjusted Cox-weighted trend estimates were outside the 95% confidence intervals of the Duke/PNAS-weighted trend estimates for the unisex trends for the combined and separate ADL and CI triggers (Tables 3.10, 3.15, and 3.18); and for the female trends for the combined ADL and CI triggers, where, with $t = 2.38$ and 2.25 for the 1984 and 2004 ASDRs, they were not close to the $t = 1.96$ cutoff value (Table 3.24).
    - The unadjusted Cox-weighted trend estimates were inside the 95% confidence intervals for all other sex-specific trends considered (Tables 3.23, 3.29, 3.30, 3.35, and 3.36).
6. In addition, use of the Cox weights increased the traditional NLTCS unisex disability prevalence rate from 19.00% (Table 1.1) to 22.21% (Table 3.2, 2004 ASDR) in 2004, a relative increase of 16.9%. Adjustment for design differences between the 1984 and 2004 NLTCS reduced the Cox-weighted 2004 ASDR estimate to 20.06% and the relative increase to 5.6%. The adjustment accounted for two-thirds of the 16.9% Cox-PNAS discrepancy.

Thus, the fact of the morbidity decline and its very large size persisted. A reduction in the rate of morbidity decline was expected, but its size was unknown. The main findings in Sections 1 and 2 were confirmed; the main conclusions were found to be robust with respect to the choice of survey weights.

The quantitative results in Sections 1 and 2 were shown to be subject to additional degrees of uncertainty beyond their statistical variability.

The adjusted Cox weighting protocol, which explicitly accounted for the design differences between the 1984 and 2004 NLTCS, was shown to constitute a reasonable alternative to the PNAS weighting protocol, which implicitly accounted for those same design differences. The estimates from the alternative protocol can be used to define ranges of outcomes and to generate expanded confidence intervals for use in further applications.

In contrast, the unadjusted Cox weighting protocol which ignores the design differences between the 1984 and 2004 NLTCS was shown to constitute a biased alternative to the PNAS weighting protocol. The size of the bias was substantially larger for the traditional NLTCS disability trigger than for the HIPAA ADL and CI triggers. Use of this protocol without the proposed adjustment for the design differences between the 1984 and 2004 NLTCS is not recommended.

This section has three parts. *First*, we present tabulations of the 1984 and 2004 NLTCS using the traditional NLTCS disability trigger with alternative sets of survey weights designed to clarify the differences between the Cox and the Duke/PNAS weights, and to motivate the proposed adjustment to the Cox weighting protocol. *Second*, we present select comparisons of the unisex results in Sections 1 and 2 using the HIPAA ADL and CI triggers, tabulated with the Cox and the Duke/PNAS weights, both with and without the proposed adjustment to the Cox weighting protocol. *Third*, we present the corresponding sex-specific comparisons using the HIPAA ADL and CI triggers and the adjusted and unadjusted Cox weighting protocols.

1. ALTERNATIVE SETS OF SURVEY WEIGHTS

Subsection 5 of Introduction presented the basic mathematics associated with the use of survey weights. Briefly, a survey weight is a positive value assigned to each member of a surveyed population that is numerically equal to the inverse of that member's probability of inclusion in the surveyed sample. The sum of the survey weights over the members of the surveyed sample is equal to the size of the surveyed population. The sum of the survey weights over a subset of the surveyed sample is an estimator of the size of the corresponding subset in the surveyed population. The subsets of interest in this study were defined using ADL, IADL, and CI measures.

The above description represents an ideal case. In practice, survey weights are almost always manipulated beyond the initial base case, for example, to account for various types of nonparticipation and nonresponse of selected subjects and to constrain the final weighted sums to match externally determined totals obtained from other data sources.

This was certainly true of the NLTCS for which extensive sets of documentation describing the construction of the various sets of weights were provided with the publicly available data files.[2] These documents covered all of the weights considered in this section, including the Cox and the Duke/PNAS weights.

Our purpose here is not to review the construction of these weights. Instead, we took the weights as given and asked how and why they differed? To address these questions, we present in Table 3.1 unweighted and weighted tabulations of the number and percent of persons under the traditional NLTCS classification rules for disability based on the 1984 NLTCS. These classification rules are the same as shown in Tables 1.1–1.3 and 1.14–1.15.

The top panel of the table shows the results for the initial sample of 21,493 persons, of whom 94 were deleted for various reasons to form the final sample of 21,399 persons shown in the second panel, with their age-breakout shown in Table 1.4. The third panel provides the percentages in the respective disability groups in the first or second panels, as indicated in the panel headings. The fourth panel presents the product-moment correlation coefficients for select pairs of weights.

Table 3.1

Unweighted and Weighted Number and Percent of Persons Under the Traditional NLTCS Classification Rules Using Alternative Survey Weighting Protocols, 1984 NLTCS, Unisex, Age 65 and Above

Traditional Classification	Unweighted	Alternative Survey Weighting Protocol[1]: Base Weight	Duke Weight	Cox Weight	Revised Duke Weight[2]	Revised Cox Weight[2]	*t*-statistic
		Initial Sample Selection					
Nondisabled	14,766	19,317,155	21,406,134	20,818,332	21,390,119	20,802,488	
at Screener Interview	13,786	18,452,451	20,448,382	19,854,591	20,432,367	19,838,747	
at Detailed Interview	980	864,704	957,752	963,741	957,752	963,741	
Disabled	6,727	5,912,639	6,654,461	6,532,916	6,644,796	6,529,834	
IADL Only	1,479	1,424,636	1,637,437	1,592,020	1,637,437	1,592,020	
1-2 ADL	1,753	1,582,576	1,809,987	1,765,032	1,809,987	1,765,032	
3-4 ADL	821	699,258	800,438	779,311	800,438	779,311	
5-6 ADL	901	749,785	863,784	837,342	862,943	836,520	
Institutional	1,773	1,456,383	1,542,815	1,559,211	1,533,991	1,556,951	
Total	21,493	25,229,793	28,060,595	27,351,247	28,034,914	27,332,322	
		Final Sample Selection[2]					
Nondisabled	14,757	19,302,659	21,390,119	20,802,488	21,390,119	20,802,488	
at Screener Interview	13,777	18,437,955	20,432,367	19,838,747	20,432,367	19,838,747	
at Detailed Interview	980	864,704	957,752	963,741	957,752	963,741	
Disabled	6,642	5,842,618	6,580,242	6,524,521	6,644,796	6,529,834	
IADL Only	1,479	1,424,636	1,637,437	1,592,020	1,637,437	1,592,020	
1-2 ADL	1,753	1,582,576	1,809,987	1,765,032	1,809,987	1,765,032	
3-4 ADL	821	699,258	800,438	779,311	800,438	779,311	
5-6 ADL	900	749,055	862,943	836,520	862,943	836,520	
Institutional	1,689	1,387,093	1,469,437	1,551,638	1,533,991	1,556,951	
Total	21,399	25,145,277	27,970,360	27,327,009	28,034,914	27,332,322	
	Percent of Initial Sample				**Percent of Final Sample**		***t*-statistic**
Nondisabled	68.70	76.56	76.29	76.11	76.30	76.11	-0.61
at Screener Interview	64.14	73.14	72.87	72.59	72.88	72.58	-0.92
at Detailed Interview	4.56	3.43	3.41	3.52	3.42	3.53	0.83
Disabled	31.30	23.44	23.71	23.89	23.70	23.89	0.61
IADL Only	6.88	5.65	5.84	5.82	5.84	5.82	-0.09
1-2 ADL	8.16	6.27	6.45	6.45	6.46	6.46	0.01
3-4 ADL	3.82	2.77	2.85	2.85	2.86	2.85	-0.03
5-6 ADL	4.19	2.97	3.08	3.06	3.08	3.06	-0.14
Institutional	8.25	5.77	5.50	5.70	5.47	5.70	1.36
Total	100.00	100.00	100.00	100.00	100.00	100.00	-
		Correlation (Percent)					
Base Weight		100.00	99.90	99.74	99.94	99.73	
Revised Duke Weight[2]		99.94	99.97	99.77	100.00	99.76	
Revised Cox Weight[2]		99.73	99.68	100.00	99.76	100.00	
		Angle (Degrees)					
Base Weight		0.00	2.51	4.14	1.94	4.18	
Revised Duke Weight[2]		1.94	1.41	3.88	0.00	3.93	
Revised Cox Weight[2]		4.18	4.57	0.11	3.93	0.00	

Note 1: The NLTCS variable names for the weights are as follows: Base Weight = "BASEWGT84"; Duke Weight = "CDS_ScreenCrossSectionWGT_SY84"; and Cox Weight = "fincswt84".

Note 2: The final sample selection deleted 18 persons determined to have died prior to the NLTCS screening operation, one person with inconsistent age reporting, and 75 persons who were identified as institutional residents but did not complete the institutional interview. The weighting components in the Duke Weight for the 75 deleted institutional residents were reallocated to the 1,689 institutional residents in the final sample using the Revised Duke Weight. The weighting components in the Cox Weight for the 75 deleted institutional residents (only 7 of which were positive) were reallocated to the 1,689 institutional residents in the final sample using the Revised Cox Weight.

Source: Authors' calculations based on the 1984 NLTCS.

The columns of the table present the results for the various sets of weights:

1. The first column provides the unweighted sample counts.
2. The second column provides the weighted sums for the base case (Base Weight), where the base weights were the inverse of each member's probability of inclusion in the NLTCS. The base weights were designed to be constant over time, making them longitudinally consistent, and allowing them to serve as the starting point for all other weighting protocols.[12]
3. The third column provides the weighted sums for the Duke weights (Duke Weight) which were developed at Duke University by Manton and colleagues to address shortcomings of corresponding weights developed by the U.S. Census Bureau; the target population for both sets of weights was the total U.S. elderly population.
4. The fourth column provides the weighted sums for the Cox weights (Cox Weight) which were developed at Battelle, Inc., by Cox and colleagues as an alternative protocol to address shortcomings of the corresponding weights developed by the U.S. Census Bureau, and revised by Duke, but with the target population redefined to be the Medicare enrollee population rather than the total U.S. elderly population.
5. The fifth column provides the weighted sums for our revision to the Duke weights (Revised Duke Weight) which was necessitated by our need for complete institutional interviews (vs. knowing that a respondent was institutionalized, without any additional information) to implement our simulated HIPAA ADL and CI triggers.
6. The sixth column provides the weighted sums for our revision to the Cox weights (Revised Cox Weight) which was also necessitated by our need for complete institutional interviews. Comparisons of the corresponding percentages between the original and revised weights (cols. 3 vs. 5 and 4 vs. 6) show that the revisions were relatively minor.
7. The seventh column (third panel only) transforms the percentages based on the Revised Cox Weights to normal deviates (t-statistics) based on the sampling distribution of the corresponding percentages based on the Revised Duke Weights. We used a single-population transformation because the two sets of weights were derived from the same population; hence $|t| \le 1.96$ would imply that the Cox-weighted estimate fell within the 95% confidence interval of the Duke-weighted estimate.

The largest differences in the percentages in Table 3.1 were between the unweighted counts in the first column and the base-weighted counts in the second column. These differences reflected the substantial subsampling of the nondisabled population in 1984, at a fractional rate of 44/97. Once these effects were reflected in the base weights, the additional refinements provided by the revised Duke and revised Cox weights were similar.

The t-statistics for their differences (col. 7) were in the range (−0.92)–1.36, and, hence, were not statistically significant, implying that the disability rates based on the Cox weights were consistent with those based on the Duke weights.

The bottom panel of the table displays the product-moment correlations and associated angles for selected pairs of weighting protocols, indicated by the corresponding combinations of the row and

[12] Note, however, that supplemental sampling made it infeasible to maintain constant base weights at age 95 above for the 1994, 1999, and 2004 NLTCS.

column headings. The rows of this panel were defined to focus on the three main weighting protocols: Base Weight, Revised Duke Weight, and Revised Cox Weight; the columns continued to include all five alternative weighting protocols used in the upper part of the table.

The product-moment correlation between a pair of variables, say, X and Y, is defined as the ratio of the covariance between X and Y to the square root of the product of their variances, or:

$$r_{X,Y} = \frac{\text{cov}(X,Y)}{\sqrt{\text{var}(X)\,\text{var}(Y)}} .$$

The correlation coefficient r (subscripts X and Y suppressed for simplicity) is a dimensionless index of the linear association between two variables; r is invariant with respect to a linear transformation of either variable and it ranges from −1 to 1, with the value 1 indicating perfect agreement, 0 indicating no linear association, and −1 indicating perfect disagreement. The value of the correlation coefficient can also be expressed as a percentage, ranging from −100% to 100%.

For a sample of size n, the estimator $\hat{r}$ of the correlation coefficient r is generated using the estimated covariance and variances of the associated n-element variable vectors, $\mathbf{x}$ and $\mathbf{y}$, in place of the population covariance and variances in the above formula.

For large values of $\hat{r}$, it is also informative to consider a supplementary, but less well-known, measure of association: the trigonometric angle between the two *centered* (i.e., with the sample means, $\bar{\mathbf{x}}$ and $\bar{\mathbf{y}}$, subtracted out) n-element vectors, $\mathbf{x}-\bar{\mathbf{x}}$ and $\mathbf{y}-\bar{\mathbf{y}}$, defined using the inverse cosine function as (Rodgers and Nicewander, 1988):

$$\hat{\theta}_{\mathbf{x},\mathbf{y}} = \cos^{-1}(\hat{r}_{\mathbf{x},\mathbf{y}}) ,$$

which converges to $\theta = \cos^{-1}(r)$, as n increases in size.

Here, the n elements of $\mathbf{x}-\bar{\mathbf{x}}$ are treated as the coordinates of a point x in an n-dimensional space; the n elements of $\mathbf{y}-\bar{\mathbf{y}}$ are similarly treated as the coordinates of a point y in the same n-dimensional space. It follows that the points x, y, and the centered origin o of the n-dimensional space form a triangle with sides $\overrightarrow{ox}$, $\overrightarrow{oy}$, and $\overrightarrow{xy}$. The angle between $\overrightarrow{ox}$ and $\overrightarrow{oy}$ is given by $\hat{\theta}$, which converges to zero as $x \to y$. The range of $\hat{\theta}$ (and θ) is from 0 to 180 degrees (°): 0° indicates that $\mathbf{x}-\bar{\mathbf{x}}$ and $\mathbf{y}-\bar{\mathbf{y}}$ are collinear (perfect agreement), 90° indicate that $\mathbf{x}-\bar{\mathbf{x}}$ and $\mathbf{y}-\bar{\mathbf{y}}$ are perpendicular (no linear association), and 180° indicates perfect disagreement.

The angle transformation permits one to better visualize the level of association when the association is very high. For example, r = 99.9% is equivalent to θ = 2.6°; r = 99.0 % is equivalent to θ = 8.1°; and r = 95.0% is equivalent to θ = 18.2°. All of these correlations are large, but the computed angles indicate that the levels of association of the corresponding pairs of vectors are very different.

The correlation between the 21,399-element vectors of weights under the revised Duke and revised Cox protocols was 99.76% (Table 3.1), equivalent to an angle of 3.9° between the two sets of centered weights—a scale-invariant visualization of the closeness of the two sets of weights.

The correlation of the weights under the revised Duke protocol with the original Duke protocol was 99.97%, equivalent to a between-weights angle of 1.4°, much closer than with the revised Cox protocol, and confirming that the revision to the Duke weights was indeed minor.

Table 3.2 presents the corresponding results for the 2004 NLTCS.

The structure is similar to Table 3.1 except that the sample composition remained unchanged for the 15,993 sample members; only one panel was needed for the tabulated counts.

The protocol used for the PNAS weights in column 5 was substantially different from the protocol used for the original Duke weights, as can be seen from the correlation structure of the various weights:

- The correlation of the PNAS weights with the original Duke weights was 95.78%, equivalent to a between-weights angle of 16.7° – much larger than any angle in Table 3.1.
- The correlations of (1) the PNAS weights, and (2) the original Duke weights, with the base weights were 84.24% and 87.72%, respectively, equivalent to between-weights angles of 32.6 and 28.7° – indicating substantial differences with the base weights.

The protocol used for the PNAS weights was also substantially different from the protocol used for the revised Cox weights:

- The correlation of the PNAS weights with the revised Cox weights was 83.33%, equivalent to a between-weights angle of 33.6°.
- The correlation of the revised Cox weights with the base weights was 98.43%, equivalent to a between-weights angle of 10.2° – closer than for the PNAS and original Duke weights, but still substantially different from the base weights.

Manton argued that the structure of the 2004 NLTCS was such that the assumptions underlying the original Duke weights were not satisfied and that the PNAS weights should be used instead, as we have done herein.[13]

Comparisons of the percentages in columns 3, 4, and 6 show that the Duke and Cox (original and revised) weights were in closer agreement with each other than with the PNAS weights, as expected, given that Cox and Wolters (2008) cited discrepancies between the Duke and PNAS weights as the primary impetus for developing their weights. Nonetheless, notable differences between the Duke and Cox weights emerged when the results were age-standardized to the 2004 NLTCS weighted unisex population using the PNAS weights to form the population tabulation (last row of the second panel). Comparison of the *Disabled* and *2004 ASDR* rows indicates that the age-standardization increased the Cox-weighted and revised Cox-weighted disability rates by 0.52% and 0.57%, respectively; there was no increase for the Duke-weighted disability rate.

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[13] See Memorandum from Kenneth G. Manton to Brenda Spillman, dated June 15, 2007, distributed with the public use release of the 2004 NLTCS.

Table 3.2

Unweighted and Weighted Number and Percent of Persons Under the Traditional NLTCS Classification Rules Using Alternative Survey Weighting Protocols, 2004 NLTCS, Unisex, Age 65 and Above

Traditional Classification	Unweighted	Base Weight	Duke Weight	Cox Weight	PNAS Weight[2]	Revised Cox Weight[2]	
		Alternative Survey Weighting Protocol[1]					
	Number						
Nondisabled	11,795	21,889,510	28,446,830	27,364,741	29,358,192	27,533,818	
at Screener Interview	9,822	18,628,669	24,197,050	23,144,513	24,209,702	23,144,513	
at Detailed Interview	1,973	3,260,840	4,249,780	4,220,228	5,148,490	4,389,306	
Disabled	4,198	5,594,532	7,798,503	7,602,048	6,887,133	7,602,048	
IADL Only	492	781,188	1,059,353	1,046,338	863,719	1,046,338	
1-2 ADL	1,257	1,853,176	2,529,164	2,478,351	2,016,880	2,478,351	
3-4 ADL	779	1,052,336	1,475,143	1,422,254	1,379,923	1,422,254	
5-6 ADL	700	891,659	1,254,067	1,224,255	1,168,546	1,224,255	
Institutional	970	1,016,173	1,480,776	1,430,849	1,458,065	1,430,849	
Total	15,993	27,484,041	36,245,333	34,966,789	36,245,325	35,135,866	
	Percent						*t*-statistic
Nondisabled	73.75	79.64	78.48	78.26	81.00	78.36	-7.79
at Screener Interview	61.41	67.78	66.76	66.19	66.79	65.87	-2.27
at Detailed Interview	12.34	11.86	11.73	12.07	14.20	12.49	-5.69
Disabled	26.25	20.36	21.52	21.74	19.00	21.64	7.79
IADL Only	3.08	2.84	2.92	2.99	2.38	2.98	4.53
1-2 ADL	7.86	6.74	6.98	7.09	5.56	7.05	7.54
3-4 ADL	4.87	3.83	4.07	4.07	3.81	4.05	1.46
5-6 ADL	4.38	3.24	3.46	3.50	3.22	3.48	1.71
Institutional	6.07	3.70	4.09	4.09	4.02	4.07	0.29
Total	100.00	100.00	100.00	100.00	100.00	100.00	-
2004 ASDR[3]	-	21.35	21.50	22.26	19.00	22.21	9.50
		Correlation (Percent)					
Base Weight		100.00	87.72	98.53	84.24	98.43	
PNAS Weight[2]		84.24	95.78	83.27	100.00	83.33	
Revised Cox Weight[2]		98.43	86.92	99.84	83.33	100.00	
		Angle (Degrees)					
Base Weight		0.00	28.69	9.84	32.61	10.17	
PNAS Weight[2]		32.61	16.71	33.62	0.00	33.56	
Revised Cox Weight[2]		10.17	29.64	3.28	33.56	0.00	

Note 1: The NLTCS variable names for the weights are as follows: Base Weight = "BASEWGT"; Duke Weight = "CDS_ScreenCrossSectionWGT_SY04"; Cox Weight = "fincswt04"; and PNAS Weight = "PNAS_SCR_WGT" (March 2007 version).

Note 2: The PNAS Weight is the alternative to the original Duke Weight recommended for use by Manton et al. (2006). The weighting components in the Cox Weights for 87 nondisabled persons who were coded as nonrespondents to the detailed interview were reallocated to a subset of 729 nondisabled respondents to the detailed interview using the Revised Cox Weight.

Note 3: Each 2004 ASDR is an age-standardized disability rate for the indicated weighting protocol; the standard population is the 2004 NLTCS weighted unisex population tabulated using the PNAS weights.

Source: Authors' calculations based on the 2004 NLTCS.

The *t*-statistics for the differences between the PNAS and Cox weights in column 7 indicated several significant differences, i.e., with $|t| > 1.96$; these were largest for the nondisabled group, the aggregate disabled category, the IADL Only group, and the 1–2 ADL group.

The PNAS weights indicated that 81.0% of the elderly were nondisabled, with 19.0% disabled. Alternatively, the revised Cox weights indicated that 78.4% of the elderly were nondisabled, with

21.6% disabled; with age-standardization, the latter rate increased to 22.2%. The differences were statistically highly significant (t = 7.79 and 9.50, without and with age-standardization).

The differences were primarily concentrated at the lower levels of disability (IADL Only and 1–2 ADLs), with substantially smaller and statistically nonsignificant differences at the higher levels (3–4 ADLs, 5–6 ADLs, and Institutional).

These results also informed our expectations about the impact of the weighting differences on the HIPAA ADL triggers. Specifically, Table 1.14 showed that the HIPAA ADL trigger excluded all persons classified as IADL Only and most persons classified as 1–2 ADLs under the traditional classification—the categories with the largest differences between the PNAS and Cox weights. Hence, with these exclusions, we expected the relative impact on the HIPAA triggers of substituting the revised Cox weights for the revised Duke/PNAS weights to be substantially less than the impact seen in Table 3.2. This expectation was confirmed (see Table 3.13).

In the remainder of this subsection we consider how and why the weights differ. Understanding the differences is essential to making an informed assessment of the credibility of the results based on the Cox weights.

The Role of Disability Assessment on the Screener Interview

Table 3.3 provides a breakout of the results in Table 3.2 according to the disability status at the time of the screener interview. A critical consideration in our review was that the screener disability status was fully known for all respondents to the 1982 and 2004 NLTCS, but was not fully known for all respondents to the 1984, 1989, 1994, and 1999 NLTCS. In addition, beginning with the 1994 NLTCS, select subgroups of screen-outs (i.e., persons determined to be nondisabled using the screener interview disability assessment) were designated to receive the detailed interview, despite having been classified as nondisabled on the screener interview. The changes during 1989–1999 were not relevant to our analysis since we did not use results from those data years. The changes to the 1984 NLTCS were relevant and are considered below.

Manton argued that the screener interview was the "gold standard" for determining national chronic disability prevalence.[13] The screener interview was the only place in the NLTCS instruments where it could be determined that the ADL or IADL disability was *expected* to last three months or more – a chronicity requirement replicated in the HIPAA ADL trigger.

According to the logic of the 1982 NLTCS, once a respondent was determined to be nondisabled at the screener interview, he/she should be dropped from further consideration at that wave of the survey. For the revised Cox weights in Table 3.3, application of this logic to the 2004 NLTCS would result in the reclassification of 724,156 disabled persons (2.06% of the total population) in the second panel of that table as nondisabled. The residual count of 6,877,892 disabled persons in the third panel (19.58% of the total population – replacing the 21.64% estimate shown in Table 3.2) would then become the *adjusted* Cox disability estimate.

Table 3.3

Unweighted and Weighted Number of Persons Under the Traditional NLTCS Classification Rules Using Alternative Survey Weighting Protocols, 2004 NLTCS, Unisex, Age 65 and Above, by Screener Interview Disability Status

	Alternative Survey Weighting Protocol[1]				Ratio of Alternative to Base Weight		Percent of Total	
Traditional Classification	Unweighted	Base Weight	PNAS Weight[2]	Revised Cox Weight[2]	PNAS/ Base	Cox/ Base	PNAS Weight	Revised Cox Weight
	Total Screener Interview							
Nondisabled	11,795	21,889,510	29,358,192	27,533,818	1.341	1.258	81.00	78.36
at Screener Interview	9,822	18,628,669	24,209,702	23,144,513	1.300	1.242	66.79	65.87
at Detailed Interview	1,973	3,260,840	5,148,490	4,389,306	1.579	1.346	14.20	12.49
Disabled	4,198	5,594,532	6,887,133	7,602,048	1.231	1.359	19.00	21.64
IADL Only	492	781,188	863,719	1,046,338	1.106	1.339	2.38	2.98
1-2 ADL	1,257	1,853,176	2,016,880	2,478,351	1.088	1.337	5.56	7.05
3-4 ADL	779	1,052,336	1,379,923	1,422,254	1.311	1.352	3.81	4.05
5-6 ADL	700	891,659	1,168,546	1,224,255	1.311	1.373	3.22	3.48
Institutional	970	1,016,173	1,458,065	1,430,849	1.435	1.408	4.02	4.07
Total	15,993	27,484,041	36,245,325	35,135,866	1.319	1.278	100.00	100.00
	Nondisabled at Screener Interview (Screen-Outs)							
Nondisabled	11,516	21,390,860	28,556,876	26,879,511	1.335	1.257	78.79	76.50
at Screener Interview	9,822	18,628,669	24,209,702	23,144,513	1.300	1.242	66.79	65.87
at Detailed Interview	1,694	2,762,190	4,347,174	3,734,999	1.574	1.352	11.99	10.63
Disabled	368	550,014	592,223	724,156	1.077	1.317	1.63	2.06
IADL Only	94	137,072	144,841	179,620	1.057	1.310	0.40	0.51
1-2 ADL	220	338,767	353,927	446,063	1.045	1.317	0.98	1.27
3-4 ADL	34	46,080	56,282	61,254	1.221	1.329	0.16	0.17
5-6 ADL	14	21,227	27,450	28,038	1.293	1.321	0.08	0.08
Institutional	6	6,868	9,723	9,181	1.416	1.337	0.03	0.03
Total	11,884	21,940,874	29,149,099	27,603,667	1.329	1.258	80.42	78.56
	Disabled at Screener Interview (Screen-Ins)							
Nondisabled	279	498,650	801,316	654,307	1.607	1.312	2.21	1.86
at Screener Interview	0	0	0	0	-	-	0.00	0.00
at Detailed Interview	279	498,650	801,316	654,307	1.607	1.312	2.21	1.86
Disabled	3,830	5,044,518	6,294,911	6,877,892	1.248	1.363	17.37	19.58
IADL Only	398	644,115	718,878	866,719	1.116	1.346	1.98	2.47
1-2 ADL	1,037	1,514,409	1,662,954	2,032,288	1.098	1.342	4.59	5.78
3-4 ADL	745	1,006,256	1,323,642	1,361,000	1.315	1.353	3.65	3.87
5-6 ADL	686	870,432	1,141,096	1,196,217	1.311	1.374	3.15	3.40
Institutional	964	1,009,305	1,448,341	1,421,668	1.435	1.409	4.00	4.05
Total	4,109	5,543,168	7,096,226	7,532,199	1.280	1.359	19.58	21.44

Note 1: The NLTCS variable names for the weights are as follows: Base Weight = "BASEWGT"; Duke Weight = "CDS_ScreenCrossSectionWGT_SY04"; Cox Weight = "fincswt04"; and PNAS Weight = "PNAS_SCR_WGT" (March 2007 version).

Note 2: The PNAS Weight is the alternative to the original Duke Weight recommended for use by Manton et al. (2006). The weighting components in the Cox Weights for 87 nondisabled persons who were coded as nonrespondents to the detailed interview were reallocated to a subset of 729 nondisabled respondents to the detailed interview using the Revised Cox Weight.

Source: Authors' calculations based on the 2004 NLTCS.

Thus, the retention of the additional 2.06% disabled screen-outs reflects the impact of design changes to the 2004 NLTCS under which certain screen-outs were designated to receive the detailed interview, despite screening out for disability, rather than being dropped from further consideration as required under the original logic of the 1982 NLTCS. Manton argued that such cases should be reclassified as nondisabled, based on the use of the screener disability assessment as the gold standard. Manton reported that 92.4% of the screen-out cases with ADL disabilities on the detailed interview had an attained disability duration less than three months at the time of the detailed interview; moreover, he argued that these persons would have failed to satisfy the chronicity requirement at that later time.[13] In making this argument, he implicitly assumed that none of these persons had a disability that was *expected* to last at least three months—an assumption that could not be verified because the detailed interview did not contain the necessary questions to make that determination.

The main challenge in formulating the PNAS weights was to construct them in a manner that would be longitudinally consistent over all waves of the NLTCS, despite the fact that the screener disability status was fully known only for respondents to the 1982 and 2004 NLTCS, and was only partially known for respondents to the 1984, 1989, 1994, and 1999 NLTCS.

The key to understanding the PNAS weights is that they were designed to approximate the disability prevalence estimate that would have been obtained had the above reclassification been strictly enforced for persons in the 2004 NLTCS who were nondisabled at the screener interview.

This was done by differentially reweighting the base weights for the respondents to the detailed interview according to their disability status, as shown in columns 5 and 6 of Table 3.3. The entries in column 5 are the ratios of the corresponding counts in columns 3 and 2; the entries in column 6 are the ratios of the corresponding counts in columns 4 and 2.

The overall Cox/Base ratio was 1.278 (col. 6, last entry, first panel) but the Cox/Base ratio was higher for disabled persons (1.359) and for each disability subgroup. In contrast, the overall PNAS/Base ratio was 1.319 (col. 5, last entry, first panel) but the PNAS/Base ratio was lower for disabled persons (1.231). Moreover, neither value was representative of the PNAS/Base ratios for the no- or low-level disability groups, such as the 1.574 and 1.607 values, respectively, for nondisabled screen-outs and screen-ins vs. the 1.045 value for 1–2 ADL screen-outs.

The PNAS/Base ratios were the consequences of Manton's analysis of Medicare Part A expenditure differentials between disabled and nondisabled persons, for which Manton assumed that the Medicare Part A expenditures for survey nonrespondents could be used to reallocate their base weights to survey respondents (see Manton et al., 2006). Thus the PNAS weighting procedure yielded weights that were roughly consistent with the exclusion of screen-out respondents based on the disability criteria in the 2004 NLTCS screener interview but the PNAS weighting procedure did not directly use the screener results in its calculations.

The PNAS weighting procedure had two goals: (1) to provide survey weights for the 2004 NLTCS detailed interview; and (2) to remove biases associated with retention of screen-out respondents in the 2004 NLTCS detailed interview. The second goal was achieved using the differential reweighting of the base weights indicated above.

The Cox weighting procedure did not address the second goal. The *adjusted* Cox disability estimate, as described above, was constructed to represent what would have occurred had Cox addressed the second goal and to provide an improved basis for comparison of the Cox-weighted estimates with the PNAS-weighted estimates.

The 0.58% difference between the adjusted Cox disability estimate (19.58%) and the corresponding PNAS estimate (19.00%) corresponded to a statistically nonsignificant *t*-statistic of 1.70, suggesting that the adjusted Cox disability estimate was consistent with the PNAS estimate.

With age-standardization, however, the adjusted Cox disability estimate increased to 20.06%, which was statistically significantly higher (t = 3.12) than the 19.00% PNAS estimate. Nonetheless, the adjusted age-standardized Cox disability estimate of 20.06% was markedly lower than the unadjusted age-standardized Cox disability estimate of 22.21% (Table 3.2).

The latter constituted an upwardly biased estimate of the true disability prevalence under the traditional NLTCS classification rules for disability, with screen-outs treated as nondisabled on the detailed interview.

We used the revised Cox weights, both adjusted and unadjusted for screen-outs, to generate upper bound prevalence estimates for the HIPAA triggers in the 2004 NLTCS. The unadjusted estimates appeared to be biased; we provided them for completeness. For consistency, we also used the revised Cox weights to generate prevalence estimates for the HIPAA triggers in the 1984 NLTCS. The results in Table 3.1 indicated that these latter estimates were consistent with those previously generated using the revised Duke weights.

Incomplete Screener Disability Assessment in the 1984 NLTCS

Application of the logic of the 1982 NLTCS screener disability assessment to the 1984 NLTCS was complicated because the 1984 assessment was incomplete, by design. We discuss the potential impact of that design in the following paragraphs.

The 1984 NLTCS attempted full disability screening for 83% of the base-weighted sample (72% unweighted; the revised Duke and revised Cox weights each yielded the same 83% value). The remaining 17% were assigned to the detailed interview without a screener disability assessment; all such respondents had met the screener disability criteria, including the 3-month chronicity test for ADL and IADL impairments, during the 1982 NLTCS making it highly likely that they would continue to be classified as disabled on the 1984 screener and 1984 detailed interviews.

Among this 17% subsample, however, some fraction classified as disabled on the 1984 detailed interview would have screened-out if the 1984 screener disability assessment had been performed; this would have reduced the 1984 disability rate by some amount. The designers of the 1984 NLTCS did not consider this reduction to be material; hence, they chose to bypass the screener disability assessment for this specific subsample. They intended the NLTCS disability estimates to be based on the detailed interview with the screener primarily serving a gatekeeper role for the in-person detailed interview with approximately 80% of the screener interviews completed by phone.

The potential for bias due to bypassing the screener disability assessment for specific subsamples received increasing attention as the NLTCS design was later modified to include and accumulate increasing numbers of “healthy” persons (i.e., screen-outs – persons who had been classified as nondisabled on the disability assessment at the screener interview) among those who received the detailed interview. Following the 1999 NLTCS, the design team concluded that the entire sample needed to be re-screened to ensure valid cross-temporal comparisons. This change was implemented in the 2004 NLTCS, with the results discussed above.

Table 3.4 displays the conditional disability distributions for respondents who completed the detailed interview in 1984 and 2004, based on data in Tables 3.1 and 3.3 and supplemental tabulations for 1982 and 1984.

Table 3.4

Unweighted and Weighted Conditional Disability Distribution for Detailed Interview Completers, Under the Traditional NLTCS Classification Rules, 1982, 1984, and 2004 NLTCS, Unisex, Age 65 and Above,

			Alternative Survey Weighting Protocol[1]		
Year	Subgroup Characteristics	Unweighted	Base Weight	Revised Duke/PNAS Weight[2]	Revised Cox Weight[2]
		Percent Nondisabled at Detailed Interview			
1982	All Completed Detailed Interviews	6.67	6.67	-	-
1984	All Completed Detailed Interviews	12.86	12.89	12.60	12.86
	Not Screened for Disability	12.93	12.93	12.65	12.91
	Disabled at Screener Interview	12.63	12.83	12.50	12.78
	In 1982 NLTCS	13.06	13.06	12.72	13.00
	Not in 1982 NLTCS (Aged-in)	11.48	11.48	11.20	11.45
2004	All Completed Detailed Interviews	31.97	36.82	42.78	36.60
	Nondisabled at Screener Interview	82.15	83.39	88.01	83.76
	Disabled at Screener Interview	6.79	9.00	11.29	8.69
		Percent Disabled at Detailed Interview			
1982	All Completed Detailed Interviews	93.33	93.33	-	-
1984	All Completed Detailed Interviews	87.14	87.11	87.40	87.14
	Not Screened for Disability	87.07	87.07	87.35	87.09
	Disabled at Screener Interview	87.37	87.17	87.50	87.22
	In 1982 NLTCS	86.94	86.94	87.28	87.00
	Not in 1982 NLTCS (Aged-in)	88.52	88.52	88.80	88.55
2004	All Completed Detailed Interviews	68.03	63.18	57.22	63.40
	Nondisabled at Screener Interview	17.85	16.61	11.99	16.24
	Disabled at Screener Interview	93.21	91.00	88.71	91.31

Note 1: The NLTCS variable names for the weights are as follows: Base Weight = "BASEWGT"; Duke Weight = "CDS_ScreenCrossSectionWGT_SY04"; Cox Weight = "fincswt04"; and PNAS Weight = "PNAS_SCR_WGT" (March 2007 version).

Note 2: The PNAS Weight is the alternative to the original Duke Weight recommended for use by Manton et al. (2006). The weighting components in the Cox Weights for 87 nondisabled persons who were coded as nonrespondents to the detailed interview were reallocated to a subset of 729 nondisabled respondents to the detailed interview using the Revised Cox Weight.

Source: Authors' calculations based on the 1982, 1984, and 2004 NLTCS.

The table shows that the overall base-weighted fraction nondisabled at the detailed interview increased from 6.67% in 1982 to 12.89% in 1984, and to 36.82% in 2004.

Among those classified as disabled at the 1984 screener interview, the base-weighted fraction reclassified as nondisabled at the 1984 detailed interview was 12.83%, not statistically significantly different from the 12.93% for the group not screened for disability (t = 0.10). Stratification of the screened group into those who were and were not participants in the 1982 NLTCS produced base-weighted nondisabled fractions of 13.06% and 11.48%, respectively, which also were not statistically significantly different (t = 0.91).

The overall base-weighted fraction that was nondisabled on the 1984 detailed interview was substantially higher than the corresponding 1982 fraction (12.89% vs. 6.67%). Nonetheless, the 1984 subgroup that screened-in for the detailed interview (i.e., those disabled at the screener interview) had nondisabled fractions similar to the 1984 subgroup not screened for disability (12.83% vs. 12.93%), indicating that the decision to bypass the screening disability assessment for the latter group did not introduce detectible bias.

Among those screened for disability in 2004 (i.e., all completed detailed interviews), the base-weighted fraction nondisabled at the detailed interview was 36.82%, 2.9 times the corresponding fraction in 1984 and 5.5 times the corresponding fraction in 2004. Stratification of this group into those who were and were not disabled at the 2004 NLTCS screener interview (i.e., screen-ins vs. screen-outs) produced base-weighted nondisabled fractions of 9.00% and 83.39%, respectively.

The 9.00% fraction of screen-ins classified as nondisabled at the 2004 detailed interview was between the 6.67% fraction for the 1982 screen-ins (representing 100% of detailed interviews) and the 12.83% fraction for the 1984 screen-ins (representing 83.01% of detailed interviews). The 3.83% excess of the 1984 fraction over the 2004 fraction was statistically highly significant (t = 3.95), suggesting that the screening operation in 2004 may have been "tighter" than in 1984.

Comments

Among the 2004 NLTCS screen-outs, complementing the 83.39% nondisabled was a subgroup of 16.61% disabled at the detailed interview, representing 2.00% of the total base-weighted population. This same subgroup generated the 2.06% difference between the adjusted and unadjusted Cox disability estimates of 19.58% and 21.64%, discussed above; and it generated the 2.15% difference between the corresponding age-standardized estimates of 20.06% and 22.21%. The question arises: Should disability at the detailed interview among this screen-out group be treated as equivalent to disability among the screen-in group? Use of the unadjusted Cox weights implicitly answers in the affirmative; use of the PNAS weights implicitly answers in the negative; and use of the adjusted Cox weights explicitly answers in the negative.

Our preference was to use the PNAS weights for the 2004 NLTCS. As discussed, these weights were designed to approximate the disability prevalence estimates that would have been obtained by reclassifying all screen-outs as nondisabled, including the subset that met the disability criteria on the detailed interview. The screener interview was assumed to be the gold standard for determining disability prevalence; the determination of disability on the detailed interview was conditioned on having first met the screener disability criteria. Cross-temporal comparability between the 1984 and 2004 NLTCS was achieved using protocols that were consistent with these assumptions.

One alternative would have been to use the unadjusted (for screen-outs; revised as indicated in Table 3.2) Cox weights for the 2004 NLTCS. As discussed, these weights were also designed to address shortcomings of the weights developed by the U.S. Census Bureau and by Duke, with the goal of improving the accuracy of cross-temporal comparisons. The Cox weights were not designed to take account of the results of the full screening of the 2004 NLTCS sample. As a result, the unadjusted age-standardized Cox disability estimate (22.21%) was shown to be inconsistent with the PNAS estimate (19.00%) whereas the adjusted age-standardized Cox disability estimate (20.06%) was more consistent.

The unadjusted Cox estimate would be preferred if it were more accurate than the adjusted Cox estimate. However, the unadjusted Cox estimate ignores the increase in disability that would occur if the 9,822 screen-outs (Table 3.3) who were not given the detailed interview had in fact been given that interview. That is, if the disability of the first 2,062 (= 1,694 + 368; Table 3.3) screen-outs who were given the detailed interview were accepted as valid for estimation purposes, logic dictates that any comparable disability of the remaining 9,822 screen-outs be similarly accepted, and this could induce a sizeable increase in the unadjusted Cox estimate.[14]

The unadjusted Cox estimate would also be preferred if it could more accurately describe the longitudinal changes in disability, even if no claim were made that it was more accurate in any given year. This position appears to be more reasonable and forms the basis under which we conducted the sensitivity analyses in the next two subsections, using the unadjusted Cox weights to compare the HIPAA-based disability estimates from the 1984 and 2004 NLTCS.

2. COX VS. DUKE/PNAS WEIGHTS – UNISEX RESULTS

This subsection assesses the impact of using the Cox vs. the Duke/PNAS weights on the unisex disability estimates, recalculating select results from Sections 1 and 2 using the Cox weights and comparing the new and prior results.

Differences between the Cox and the Duke/PNAS weighting protocols were described in the prior subsection. Minor revisions were required for each set of weights to match the structure of the NLTCS analytic samples, comprising 21,399 respondents in 1984 and 15,993 respondents in 2004. Unless specifically indicated otherwise, henceforth, our references to the *Cox* and *Duke* weights refer to the revisions to those weights.

We also present and compare "adjusted" Cox-weighted estimates for the 2004 NLTCS under which the 368 screen-outs classified as disabled using the traditional NLTCS disability classification rules were reclassified as nondisabled, in effect, ignoring the disability information in the detailed interview; 50 of the 368 screen-outs had their HIPAA triggers deactivated as a result. The reclassification allowed us to assess the implications of strict adherence to Manton's

[14] In practice, such similar acceptance would not be feasible because the detailed interview was not given to the 9,822 screen-outs. Nonetheless, the results of such a procedure could be approximated using the reweighting procedure described in Stallard (2011a, pp. 9–10), but this would represent a substantial revision to the Cox weights. For further discussion, see Erosheva and White (2010, pp. 334–335).

position that the screener interview should be the "gold standard" for determining national chronic disability prevalence;[13] hence, all screen-outs were considered nondisabled in making these adjusted estimates. No corresponding change was required for the 1984 NLTCS because no screen-outs were given the detailed interview.

Table 3.5 presents the Cox-weighted tabulation of the number and percent of persons meeting either of the HIPAA ADL and CI triggers for the 1984 unisex data, using the format in Table 2.19. The overall combined ADL and CI prevalence rate was 13.23% with a 0.23% SE, compared to the Duke-weighted prevalence rate of 13.05% in Table 2.19, also with a 0.23% SE.

Table 3.5

Number and Percent of Persons Meeting Either HIPAA Trigger, United States 1984, Unisex, Age 65 and Above, by Age – Tabulated Using Cox Weights

	Meets Either HIPAA Trigger				
Age	No	Yes	Total	Percent	Std Error (Pct)
65-69	8,059,580	369,097	8,428,676	4.38%	0.27%
70-74	6,778,176	574,439	7,352,614	7.81%	0.38%
75-79	4,737,843	680,853	5,418,696	12.56%	0.54%
80-84	2,621,067	756,383	3,377,450	22.40%	0.86%
85-89	1,192,969	714,959	1,907,928	37.47%	1.34%
90-94	282,502	388,186	670,688	57.88%	2.30%
95+	45,076	131,194	176,270	74.43%	3.98%
Total	23,717,212	3,615,110	27,332,322	13.23%	0.23%

Note: The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 NLTCS.

Table 3.6 presents the corresponding unadjusted Cox-weighted tabulation for 2004. The overall combined ADL and CI prevalence rate was 10.71% with a 0.25% SE – substantially larger than the PNAS-weighted prevalence rate of 10.09% in Table 2.20, also with a 0.25% SE.

Table 3.6

Number and Percent of Persons Meeting Either HIPAA Trigger, United States 2004, Unisex, Age 65 and Above, by Age – Tabulated Using Cox Weights

	Meets Either HIPAA Trigger				
Age	No	Yes	Total	Percent	Std Error (Pct)
65-69	8,199,509	286,690	8,486,200	3.38%	0.31%
70-74	8,374,530	435,633	8,810,163	4.94%	0.37%
75-79	6,824,696	628,553	7,453,249	8.43%	0.51%
80-84	4,852,292	815,644	5,667,936	14.39%	0.74%
85-89	2,129,514	785,485	2,915,000	26.95%	1.31%
90-94	778,350	480,654	1,259,004	38.18%	2.18%
95+	212,801	331,512	544,314	60.90%	3.33%
Total	31,371,694	3,764,172	35,135,866	10.71%	0.25%

Note: The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 3.7 presents the corresponding adjusted Cox-weighted tabulation for 2004. The overall combined ADL and CI prevalence rate was 10.44% with a 0.24% SE – also larger than the PNAS-weighted prevalence rate of 10.09% in Table 2.20.

Table 3.7

Number and Percent of Persons Meeting Either HIPAA Trigger, United States 2004, Unisex, Age 65 and Above, by Age – Tabulated Using Cox Weights, Adjusted for Screen-Outs

	Meets Either HIPAA Trigger				
Age	No	Yes	Total	Percent	Std Error (Pct)
65-69	8,199,509	286,690	8,486,200	3.38%	0.31%
70-74	8,385,631	424,532	8,810,163	4.82%	0.36%
75-79	6,848,182	605,068	7,453,249	8.12%	0.50%
80-84	4,882,146	785,790	5,667,936	13.86%	0.73%
85-89	2,153,998	761,002	2,915,000	26.11%	1.29%
90-94	782,621	476,384	1,259,004	37.84%	2.18%
95+	215,307	329,006	544,314	60.44%	3.34%
Total	31,467,395	3,668,471	35,135,866	10.44%	0.24%

Note: The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 2004 NLTCS.

Table 3.8 compares the Cox-weighted age-specific and total prevalence rates for 1984 with the corresponding unadjusted Cox rates for 2004, shown in Tables 3.5 and 3.6, using the format shown in Table 2.21.

The overall relative rate of decline (in Total) was 19.0%; the age-specific relative rates of decline ranged from 18.2% to 36.7%. The two sets of age-standardized prevalence rates yielded comparable relative rates of decline: 31.7% vs. 31.6%. For comparability, the standard populations were unchanged from those used in Table 2.21, i.e., the 1984 and 2004 NLTCS Duke/PNAS weighted populations.

The Cox-weighted total prevalence rate for 1984 decreased 0.10%, from 13.23% to 13.13%, when standardized to the Duke-weighted 1984 NLTCS population; in contrast, the Cox-weighted total prevalence rate for 2004 increased 0.40%, from 10.71% to 11.01%, when standardized to the PNAS-weighted 2004 NLTCS population. The different sizes and directions of these changes underscore the importance of age-standardization when comparing results using different weighting protocols, even for comparisons using the same calendar years.

The standard errors of the unstandardized totals and ASDRs ranged from 0.22% to 0.27%; the standard errors of the differences ranged from 0.32% to 0.37%.

All of the *t*-statistics in Table 3.8 were statistically significant at the 0.1% level of significance. As in Table 2.21, the *t*-statistics for the changes in the ASDRs ($|t|$ = 13.09 and 13.71; 1984 and 2004) were substantially larger than for the change in the unstandardized totals ($|t|$ = 7.46). The ASDR changes had high precision; the unstandardized changes had medium precision.

Table 3.8

Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization – Tabulated Using Cox Weights

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	4.38	3.38	-1.00	-22.9	1.29%
70-74	7.81	4.94	-2.87	-36.7	2.26%
75-79	12.56	8.43	-4.13	-32.9	1.97%
80-84	22.40	14.39	-8.00	-35.7	2.19%
85-89	37.47	26.95	-10.53	-28.1	1.64%
90-94	57.88	38.18	-19.70	-34.0	2.06%
95+	74.43	60.90	-13.52	-18.2	1.00%
Total	13.23	10.71	-2.51	-19.0	1.05%
1984 ASDR	13.13	8.96	-4.16	-31.7	1.89%
2004 ASDR	16.10	11.01	-5.10	-31.6	1.88%
		Standard Error			
Total	0.23	0.25	0.34		
1984 ASDR	0.23	0.22	0.32		
2004 ASDR	0.27	0.25	0.37		
		t-statistic			
Total	57.63	43.45	-7.46		
1984 ASDR	57.50	40.52	-13.09		
2004 ASDR	59.51	43.16	-13.71		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.9 substitutes the adjusted Cox-weighted age-specific and total prevalence rates for 2004 for the corresponding unadjusted rates shown in Table 3.8, with all of the other computations done using the same formulas.

The overall relative rate of decline (in Total) was 21.1%; the age-specific relative rates of decline ranged from 18.8% to 38.3%. The two sets of age-standardized prevalence rates yielded comparable relative rates of decline: 33.5% vs. 33.4%.

As in Table 3.8, the standard errors of the unstandardized totals and ASDRs ranged from 0.22% to 0.27%; the standard errors of the differences also ranged from 0.32% to 0.37%.

Also as in Table 3.8, all of the *t*-statistics in Table 3.9 were statistically significant at the 0.1% level of significance. The *t*-statistics for the changes in the ASDRs ($|t|$ = 13.88 and 14.54; 1984 and 2004) were substantially larger than for the change in the unstandardized totals ($|t|$ = 8.32). All three estimates had high precision.

Table 3.10 summarizes and compares the results in Tables 2.21, 3.8, and 3.9. The table shows that the annual rates of decline in the ASDRs were highly statistically significant for all three weighting protocols. The annual rates of decline for the unadjusted Cox-weighted ASDRs were smaller than for the adjusted Cox-weighted ASDRs which, in turn, were smaller than for the Duke/PNAS-weighted ASDRs; e.g., the unadjusted Cox-weighted 2004 ASDR was 82.3% of the Duke/PNAS estimate; the adjusted Cox-weighted estimate was 87.9%.

Table 3.9

Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization – Tabulated Using Cox Weights, Adjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	4.38	3.38	-1.00	-22.9	1.29%
70-74	7.81	4.82	-2.99	-38.3	2.39%
75-79	12.56	8.12	-4.45	-35.4	2.16%
80-84	22.40	13.86	-8.53	-38.1	2.37%
85-89	37.47	26.11	-11.37	-30.3	1.79%
90-94	57.88	37.84	-20.04	-34.6	2.10%
95+	74.43	60.44	-13.98	-18.8	1.04%
Total	13.23	10.44	-2.79	-21.1	1.18%
1984 ASDR	13.13	8.73	-4.39	-33.5	2.02%
2004 ASDR	16.10	10.72	-5.38	-33.4	2.01%
		Standard Error			
Total	0.23	0.24	0.33		
1984 ASDR	0.23	0.22	0.32		
2004 ASDR	0.27	0.25	0.37		
		t-statistic			
Total	57.63	42.81	-8.32		
1984 ASDR	57.50	39.90	-13.88		
2004 ASDR	59.51	42.51	-14.54		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

The *t*-statistics (cols. 6 and 7) for the deviations of the unadjusted and adjusted Cox-weighted 2004 ASDR declines from the corresponding Duke/PNAS declines were 2.88 and 1.97, respectively, statistically significant at the 1% and 5% levels of significance. The corresponding *t*-statistics for the 1984 ASDR declines were 2.92 and 2.06, with the same levels of significance. Thus, the unadjusted and adjusted Cox-weighted ASDR declines were outside the 95% confidence intervals of the corresponding Duke/PNAS-weighted ASDR declines.

Altogether, the results indicate that the annual rate of decline in the ASDRs was in the range 1.88–2.32% per year. The Duke/PNAS weighting protocol yielded the upper limit of the range; the unadjusted Cox weighting protocol yielded the lower limit. The adjusted Cox-estimate was 2.01–2.02% per year; its deviations from the upper limit Duke/PNAS-estimate were statistically significant, but only at the 5% level of significance.

As noted at the start of this section, results derived using the Cox weights have been used to challenge the accuracy of trend estimates using the PNAS weights to form the terminal endpoint. Table 3.10 answers this challenge directly by displaying three estimates, each highly precise, that yield estimated disability declines in the range 1.88–2.32% per year for the combined HIPAA ADL and CI triggers. The *t*-statistics in column 7 indicate that the adjusted Cox weighting protocol yields trend estimates that fall below the lower 95% confidence limit, but not the 99% confidence limit, of the Duke/PNAS weighting protocol.

Table 3.10

Annual Rate of Decline in the Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization – Tabulated Using Three Alternative Weighting Protocols

	Annual Rate of Decline (%)			Ratio of Cox to Duke/PNAS		*t*-statistic	
Age	Duke/PNAS Weight	Unadjusted Cox Weight	Adjusted Cox Weight	Unadjusted	Adjusted	Unadjusted	Adjusted
65-69	2.09	1.29	1.29	0.618	0.618		
70-74	2.77	2.26	2.39	0.817	0.862		
75-79	2.27	1.97	2.16	0.870	0.952		
80-84	2.57	2.19	2.37	0.851	0.922		
85-89	2.11	1.64	1.79	0.776	0.850		
90-94	2.37	2.06	2.10	0.868	0.886		
95+	1.16	1.00	1.04	0.859	0.891		
Total	1.28	1.05	1.18	0.819	0.919	1.60	0.72
1984 ASDR	2.32	1.89	2.02	0.814	0.869	2.92	2.06
2004 ASDR	2.29	1.88	2.01	0.823	0.879	2.88	1.97
		Standard Error					
Total	0.14	0.14	0.14	0.972	0.978		
1984 ASDR	0.15	0.14	0.15	0.975	0.981		
2004 ASDR	0.14	0.14	0.14	0.977	0.983		
		t-statistic					
Total	8.85	7.46	8.32	0.843	0.940		
1984 ASDR	15.68	13.09	13.88	0.835	0.886		
2004 ASDR	16.27	13.71	14.54	0.843	0.894		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

The conclusion to be drawn from the table is that the evidence for *morbidity improvement* is overwhelming. The *smallest* of the *t*-statistics for the declines in the ASDRs was 13.09 for the unadjusted Cox weighting protocol, which meets the statistical criterion for *high precision* in Subsection 10 of Introduction.

Tables 3.11 and 3.12 present the corresponding results for changes in disabled life expectancy using the unadjusted and adjusted Cox weights.

The results for 1984 in Tables 3.11 and 3.12 were almost the same as the results for 1984 in Table 2.27. The primary differences among weighting protocols involved the HIPAA ADL/CI expectancies for 2004, which were 1.97, 1.92, and 1.81 years, respectively, for the unadjusted Cox, adjusted Cox, and PNAS weights.

The corresponding declines in HIPAA ADL/CI expectancies for 1984–2004 were 0.55, 0.59, and 0.70 years, respectively. The unadjusted Cox-weighted decline (0.55 years) was 21.9% below the Duke/PNAS-weighted decline (0.70 years); the adjusted Cox-weighted decline (0.59 years) was 14.9% lower.

The corresponding morbidity decrements were 0.90, 0.95, and 1.05 years, respectively. The unadjusted Cox-weighted value was 14.5% lower than the Duke/PNAS-weighted value; the adjusted Cox-weighted value was 9.8% lower.

Table 3.11

Components of Change in Unisex Life Expectancy and HIPAA ADL/CI Expectancy (in Years at Age 65), United States 1984 and 2004 – Tabulated Using Cox Weights

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	16.64	18.11	1.48	1.48	–
HIPAA ADL/CI Expectancy	2.52	1.97	-0.55	0.36	0.90
Standard Error	0.04	0.05	0.06	0.01	0.07
t-statistic	60.05	43.48	-8.83	54.89	13.67

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.12

Components of Change in Unisex Life Expectancy and HIPAA ADL/CI Expectancy (in Years at Age 65), United States 1984 and 2004 – Tabulated Using Cox Weights, Adjusted for Screen-Outs

	Year				
At Age 65	1984	2004	Change	Survival Increment	Morbidity Decrement
Life Expectancy	16.64	18.11	1.48	1.48	–
HIPAA ADL/CI Expectancy	2.52	1.92	-0.59	0.36	0.95
Standard Error	0.04	0.04	0.06	0.01	0.07
t-statistic	60.05	42.82	-9.68	54.89	14.48

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

The *t*-statistics indicated that all three estimates of the decline in HIPAA ADL/CI expectancies had high statistical precision. The relative declines, expressed as percentages of the 1984 values, were 21.7%, 23.6%, and 27.9%, respectively.

The conclusion to be drawn from these results is that the evidence for *morbidity compression* was overwhelming and that the size of the effect was huge. The only uncertainty was with respect to where in the range 21.7–27.9% the true value was located.

The results from the unadjusted Cox weighting procedure provided downwardly biased estimates of the rates of morbidity improvement and the associated morbidity compression during 1984–2004.

In contrast, the results from the adjusted Cox-weighted estimation procedure provided plausible alternatives to the Duke/PNAS-weighted estimates of morbidity improvement and morbidity compression.

HIPAA ADL Trigger

This sub-subsection assesses the impact of using the Cox vs. the Duke/PNAS weights on the HIPAA ADL disability estimates.

Table 3.13 compares the Cox-weighted age-specific and total prevalence rates for 1984 with the corresponding unadjusted Cox rates for 2004 using the format shown in Table 1.8. The 2004 ASDR declined from 11.49% to 8.79% between 1984 and 2004. The corresponding decline in Table 1.8 was from 11.42% to 8.16%. The difference between the values for 1984 was minor and will not be discussed further.

The difference between the values for 2004 was more substantial. The HIPAA ADL disability estimate produced by the unadjusted Cox weighting protocol was 7.8% larger than the corresponding PNAS-weighted estimate (8.79% vs. 8.16%). For comparison, the traditional NLTCS disability estimate produced by the unadjusted Cox weighting protocol was 16.9% larger than the corresponding PNAS-weighted estimate (Table 3.2: 22.21% vs. 19.00%).

The impact of the Cox weighting protocol on the HIPAA ADL disability estimate was 46% (7.8% vs. 16.9%) of its impact on the traditional NLTCS disability estimate, confirming our expectation, based on Table 1.14, that the relative impact would be substantially less than in Table 3.2.

Table 3.14 presents the corresponding results using the adjusted Cox-weighted rates for 2004. The terminal value for the 2004 ASDR declined from 8.79% to 8.67%, the excess HIPAA ADL disability declined from 7.8% to 6.2%, and the relative impact of the Cox weighting protocol on the HIPAA ADL disability estimate compared to its impact on the traditional NLTCS disability estimate declined from 46% to 37%.

Table 3.15 summarizes and compares the HIPAA ADL results in Tables 1.8, 3.13, and 3.14. The annual rates of decline in the ASDRs were highly statistically significant for all three weighting protocols. The annual rates of decline for the unadjusted Cox-weighted ASDRs were smaller than for the adjusted Cox-weighted ASDRs which, in turn, were smaller than for the Duke/PNAS-weighted ASDRs.

The annual rate of decline for the unadjusted Cox-weighted 2004 ASDR was 79.8% of the corresponding Duke/PNAS estimate (col. 4); the corresponding percentage for the adjusted Cox-weighted 2004 ASDR was 83.9% (col. 5). Thus, the Cox weighting protocols had greater impacts on the ADL prevalence rates than on the combined ADL and CI prevalence rates (Table 3.10: 82.3% and 87.9%).

The *t*-statistics (cols. 6 and 7) indicate that the adjusted Cox-weighted ASDR declines were within the 95% confidence intervals of the corresponding Duke/PNAS-weighted ASDR declines; the unadjusted Cox declines were outside those intervals.

Table 3.13

Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Unisex, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Unadjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.34	2.67	-0.67	-20.0	1.11%
70-74	5.12	4.30	-0.82	-16.1	0.87%
75-79	8.66	6.63	-2.02	-23.4	1.32%
80-84	15.37	11.32	-4.05	-26.4	1.52%
85-89	26.09	20.95	-5.13	-19.7	1.09%
90-94	45.02	29.97	-15.05	-33.4	2.01%
95+	64.50	52.89	-11.61	-18.0	0.99%
Total	9.37	8.59	-0.78	-8.3	0.43%
1984 ASDR	9.29	7.18	-2.11	-22.7	1.28%
2004 ASDR	11.49	8.79	-2.70	-23.5	1.33%
		Standard Error			
Total	0.20	0.23	0.30		
1984 ASDR	0.20	0.20	0.28		
2004 ASDR	0.24	0.23	0.34		
		t-statistic			
Total	46.66	37.96	-2.57		
1984 ASDR	46.58	35.59	-7.45		
2004 ASDR	47.51	37.64	-8.02		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.14

Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Unisex, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Adjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.34	2.67	-0.67	-20.0	1.11%
70-74	5.12	4.22	-0.90	-17.5	0.96%
75-79	8.66	6.47	-2.18	-25.2	1.44%
80-84	15.37	11.09	-4.28	-27.9	1.62%
85-89	26.09	20.69	-5.40	-20.7	1.15%
90-94	45.02	29.80	-15.22	-33.8	2.04%
95+	64.50	52.89	-11.61	-18.0	0.99%
Total	9.37	8.47	-0.90	-9.6	0.50%
1984 ASDR	9.29	7.08	-2.22	-23.8	1.35%
2004 ASDR	11.49	8.67	-2.82	-24.5	1.40%
		Standard Error			
Total	0.20	0.22	0.30		
1984 ASDR	0.20	0.20	0.28		
2004 ASDR	0.24	0.23	0.34		
		t-statistic			
Total	46.66	37.68	-2.97		
1984 ASDR	46.58	35.31	-7.84		
2004 ASDR	47.51	37.35	-8.41		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.15

Annual Rate of Decline in the Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization – Tabulated Using Three Alternative Weighting Protocols

	Annual Rate of Decline (%)			Ratio of Cox to Duke/PNAS		*t*-statistic	
Age	Duke/PNAS Weight	Unadjusted Cox Weight	Adjusted Cox Weight	Unadjusted	Adjusted	Unadjusted	Adjusted
65-69	1.97	1.11	1.11	0.566	0.566		
70-74	1.38	0.87	0.96	0.631	0.694		
75-79	1.47	1.32	1.44	0.898	0.980		
80-84	1.80	1.52	1.62	0.842	0.898		
85-89	1.50	1.09	1.15	0.727	0.769		
90-94	2.24	2.01	2.04	0.901	0.913		
95+	1.13	0.99	0.99	0.870	0.870		
Total	0.61	0.43	0.50	0.711	0.825	1.02	0.62
1984 ASDR	1.65	1.28	1.35	0.776	0.819	2.10	1.70
2004 ASDR	1.67	1.33	1.40	0.798	0.839	1.99	1.58
		Standard Error					
Total	0.17	0.17	0.17	0.974	0.976		
1984 ASDR	0.18	0.17	0.17	0.977	0.980		
2004 ASDR	0.17	0.17	0.17	0.979	0.982		
		t-statistic					
Total	3.52	2.57	2.97	0.731	0.845		
1984 ASDR	9.38	7.45	7.84	0.794	0.835		
2004 ASDR	9.85	8.02	8.41	0.815	0.855		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

HIPAA CI Trigger

This sub-subsection assesses the impact of using the Cox vs. the Duke/PNAS weights on the HIPAA CI disability estimates.

Table 3.16 compares the Cox-weighted age-specific and total prevalence rates for 1984 with the corresponding unadjusted Cox rates for 2004 using the format shown in Table 2.16.

The 2004 ASDR declined from 11.73% to 7.26% between 1984 and 2004. The corresponding decline in Table 2.16 was from 11.65% to 6.69%. The HIPAA CI disability estimate for the unadjusted Cox weighting protocol was 8.5% larger than the PNAS estimate (7.26% vs. 6.69%).

Table 3.17 presents the corresponding results using the adjusted Cox rates for 2004. The terminal value for the 2004 ASDR declined from 7.26% to 7.08% and the excess HIPAA CI disability (compared to Table 2.16) declined from 8.5% to 5.8%.

Table 3.18 summarizes and compares the HIPAA CI results in Tables 2.16, 3.16, and 3.17. The annual rates of decline in the ASDRs were highly statistically significant for all three weighting protocols. The annual rates of decline for the unadjusted Cox-weighted ASDRs were smaller than for the adjusted Cox-weighted ASDRs which, in turn, were smaller than for the Duke/PNAS-weighted ASDRs.

Table 3.16

Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Unisex, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Unadjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.39	1.44	-0.95	-39.7	2.50%
70-74	4.87	2.45	-2.42	-49.7	3.38%
75-79	8.69	5.36	-3.34	-38.4	2.39%
80-84	16.85	9.80	-7.06	-41.9	2.68%
85-89	29.60	19.49	-10.11	-34.1	2.07%
90-94	45.31	28.58	-16.73	-36.9	2.28%
95+	58.01	46.40	-11.61	-20.0	1.11%
Total	9.41	7.04	-2.37	-25.2	1.44%
1984 ASDR	9.32	5.68	-3.64	-39.0	2.44%
2004 ASDR	11.73	7.26	-4.47	-38.1	2.37%
		Standard Error			
Total	0.20	0.21	0.29		
1984 ASDR	0.20	0.18	0.26		
2004 ASDR	0.24	0.21	0.32		
		t-statistic			
Total	47.14	34.26	-8.26		
1984 ASDR	47.06	32.30	-13.74		
2004 ASDR	47.94	33.97	-13.75		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.17

Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Unisex, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Adjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.39	1.44	-0.95	-39.7	2.50%
70-74	4.87	2.40	-2.47	-50.8	3.48%
75-79	8.69	5.17	-3.53	-40.6	2.57%
80-84	16.85	9.46	-7.39	-43.8	2.84%
85-89	29.60	18.82	-10.78	-36.4	2.24%
90-94	45.31	28.41	-16.90	-37.3	2.31%
95+	58.01	45.94	-12.07	-20.8	1.16%
Total	9.41	6.86	-2.54	-27.0	1.56%
1984 ASDR	9.32	5.54	-3.79	-40.6	2.57%
2004 ASDR	11.73	7.08	-4.65	-39.7	2.49%
		Standard Error			
Total	0.20	0.20	0.28		
1984 ASDR	0.20	0.17	0.26		
2004 ASDR	0.24	0.21	0.32		
		t-statistic			
Total	47.14	33.78	-8.93		
1984 ASDR	47.06	31.83	-14.36		
2004 ASDR	47.94	33.49	-14.39		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.18

Annual Rate of Decline in the Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Unisex, Age 65 and Above, by Age and Totaled Over Age, with Two Modes of Age Standardization – Tabulated Using Three Alternative Weighting Protocols

	Annual Rate of Decline (%)			Ratio of Cox to Duke/PNAS		*t*-statistic	
Age	Duke/PNAS Weight	Unadjusted Cox Weight	Adjusted Cox Weight	Unadjusted	Adjusted	Unadjusted	Adjusted
65-69	3.13	2.50	2.50	0.797	0.797		
70-74	3.67	3.38	3.48	0.921	0.948		
75-79	2.74	2.39	2.57	0.872	0.937		
80-84	3.03	2.68	2.84	0.885	0.940		
85-89	2.55	2.07	2.24	0.809	0.877		
90-94	2.60	2.28	2.31	0.877	0.888		
95+	1.25	1.11	1.16	0.886	0.925		
Total	1.61	1.44	1.56	0.896	0.974	0.93	0.24
1984 ASDR	2.82	2.44	2.57	0.866	0.910	2.08	1.39
2004 ASDR	2.74	2.37	2.49	0.865	0.911	2.10	1.38
		Standard Error					
Total	0.18	0.17	0.18	0.973	0.979		
1984 ASDR	0.18	0.18	0.18	0.976	0.982		
2004 ASDR	0.18	0.17	0.17	0.977	0.984		
		t-statistic					
Total	8.98	8.26	8.93	0.920	0.995		
1984 ASDR	15.49	13.74	14.36	0.887	0.927		
2004 ASDR	15.53	13.75	14.39	0.885	0.926		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted unisex population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

The annual rate of decline for the unadjusted Cox-weighted 2004 ASDR was 86.5% of the corresponding Duke/PNAS estimate (col. 4); the corresponding percentage for the adjusted Cox-weighted 2004 ASDR was 91.1% (col. 5). Thus, the Cox weighting protocols had substantially greater impacts on the ADL prevalence rates (Table 3.15: 79.8% and 83.9%) than on the CI prevalence rates; the impacts on the combined ADL and CI prevalence rates were in between the impacts on the separate rates.

The *t*-statistics (cols. 6 and 7) indicate that the adjusted Cox-weighted ASDR declines were within the 95% confidence intervals of the corresponding Duke/PNAS-weighted ASDR declines; the unadjusted Cox declines were outside those intervals.

3. Cox vs. Duke/PNAS weights – Sex-Specific Results

This subsection assesses the impact of using the Cox vs. the Duke/PNAS weights on sex-specific disability estimates.

Tables 3.19–3.22 present age-specific, totaled, and age-standardized disability prevalence rates for 1984 and 2004 for the combined HIPAA ADL and CI triggers, for males and females, separately tabulated using the Cox weights without ("unadjusted") and with ("adjusted") adjustments to reclassify as nondisabled the 50 screen-out respondents classified as disabled in the 2004 NLTCS detailed interview.

Tables 3.23 and 3.24 summarize and compare the results in Tables 3.19–3.22, separately for males and females. The tables show that the annual rates of decline in the ASDRs were highly statistically significant for all three weighting protocols for both sexes. In all cases, the annual rates of decline for the unadjusted Cox-weighted ASDRs were smaller than for the adjusted Cox-weighted ASDRs which, in turn, were smaller than for the Duke/PNAS-weighted ASDRs.

The unadjusted Cox-weighted annual rates of decline in the 2004 ASDR were 83.0% of the Duke/PNAS estimate for males and 82.6% for females, which were close to the corresponding 82.3% unisex value in Table 3.10. The adjusted Cox-weighted annual rates of decline in the 2004 ASDR were 88.4% of the Duke/PNAS estimate for males and 88.6% for females, which were similarly close to the corresponding 87.9% unisex value in Table 3.10. Thus, the relative impacts of the Cox weights on the combined HIPAA ADL and CI triggers were similar for males and females.

The annual rates of decline in the HIPAA ADL/CI ASDRs were in the range 2.07–2.50% per year for males, and 1.75–2.17% per year for females, ranges which overlapped and which jointly contained the 1.88–2.32% unisex range in Table 3.10.

The *t*-statistics (Tables 3.23 and 3.24; cols. 6 and 7) indicate that the adjusted Cox-weighted ASDR declines were within the 95% confidence intervals of the corresponding Duke/PNAS-weighted ASDR declines for both males and females; the unadjusted Cox declines were also inside those intervals for males, but were outside for females.

Tables 3.25–3.28 present the corresponding age-specific, totaled, and age-standardized disability prevalence rates for 1984 and 2004 for the HIPAA ADL trigger. Tables 3.29 and 3.30 summarize and compare the results in Tables 3.25–3.28.

The tables indicate that the relative impacts of the Cox weights on the HIPAA ADL trigger were larger for females than males, except for the 2004 ASDR where they were similar. The annual rates of decline in the HIPAA ADL ASDRs were in the range 1.65–2.11% per year for males, and 1.06–1.39% per year for females, ranges which did not overlap but which jointly contained the 1.28–1.67% unisex range in Table 3.15.

The *t*-statistics (Tables 3.29 and 3.30; cols. 6 and 7) indicate that both the adjusted and unadjusted Cox-weighted ASDR ADL declines were within the 95% confidence intervals of the corresponding Duke/PNAS-weighted ASDR ADL declines for both males and females. This differs from the unisex results in Table 3.15 for which the unadjusted Cox ADL declines were outside those intervals.

Tables 3.31–3.34 present the corresponding age-specific, totaled, and age-standardized disability prevalence rates for 1984 and 2004 for the HIPAA CI trigger. Tables 3.35 and 3.36 summarize and compare the results in Tables 3.31–3.34.

The tables indicate that the relative impacts of the Cox weights on the HIPAA CI trigger were larger for females than males. The annual rates of decline in the HIPAA CI ASDRs were in the range 2.52–2.85% per year for males, and 2.24–2.72% per year for females, ranges which overlapped substantially and which were only moderately wider than the 2.37–2.82% unisex range in Table 3.18.

The *t*-statistics (Tables 3.35 and 3.36; cols. 6 and 7) indicate that both the adjusted and unadjusted Cox-weighted ASDR CI declines were within the 95% confidence intervals of the corresponding Duke/PNAS-weighted ASDR CI declines for both males and females. This differs from the unisex results in Table 3.18 for which the unadjusted Cox CI declines were outside those intervals.

These results indicate that morbidity improvement occurred for both sexes for the combined HIPAA ADL and CI triggers, but was more rapid for males. Separate analyses of the ADL and CI triggers indicated that the male advantage was primarily with respect to improvements in ADL disability rates. This was evidenced by the lack of overlap of the sex-specific ranges for the annual rates of decline in ADL disability and the substantial overlap of the corresponding sex-specific ranges for CI disability.

In contrast to the unisex results, all estimates of the sex-specific adjusted Cox-weighted ASDR declines were inside the 95% confidence intervals of the corresponding Duke/PNAS-weighted ASDR declines. This was due to the reduced sample size of the sex-specific analyses, as evidenced by the stability of the ratios of the Cox- to the Duke/PNAS-weighted annual rates of decline.

Comment: The results support the conclusion that the adjusted Cox weighting protocol constitutes a reasonable alternative to the PNAS weighting protocol. The PNAS protocol used Medicare Part A expenditure data for nonrespondents to the 2004 NLTCS to inform its weighting process, whereas the Cox protocol did not. The differences between the protocols rarely exceeded the limits of the Duke/PNAS 95% confidence intervals, but were frequently more than one standard error unit apart, indicating that it would be prudent to consider expanded confidence intervals in further applications.

Table 3.19

Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Males, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Unadjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	4.10	2.93	-1.17	-28.6	1.67%
70-74	7.97	4.81	-3.16	-39.6	2.49%
75-79	11.28	7.81	-3.47	-30.7	1.82%
80-84	18.40	11.94	-6.46	-35.1	2.14%
85-89	30.07	19.29	-10.77	-35.8	2.19%
90-94	47.59	32.31	-15.28	-32.1	1.92%
95+	64.71	42.98	-21.72	-33.6	2.02%
Total	10.20	7.80	-2.41	-23.6	1.34%
1984 ASDR	10.15	6.68	-3.47	-34.2	2.07%
2004 ASDR	12.43	8.18	-4.25	-34.2	2.07%
		Standard Error			
Total	0.34	0.34	0.48		
1984 ASDR	0.34	0.31	0.46		
2004 ASDR	0.41	0.36	0.55		
		t-statistic			
Total	30.14	22.77	-5.00		
1984 ASDR	30.10	21.65	-7.59		
2004 ASDR	30.30	22.75	-7.80		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.20

Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Females, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Unadjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	4.60	3.78	-0.82	-17.7	0.97%
70-74	7.70	5.06	-2.65	-34.4	2.08%
75-79	13.35	8.89	-4.46	-33.4	2.01%
80-84	24.48	15.89	-8.60	-35.1	2.14%
85-89	40.30	30.43	-9.88	-24.5	1.40%
90-94	60.99	40.27	-20.73	-34.0	2.05%
95+	76.40	65.36	-11.04	-14.5	0.78%
Total	15.18	12.79	-2.39	-15.8	0.85%
1984 ASDR	15.06	10.57	-4.49	-29.8	1.76%
2004 ASDR	18.46	12.96	-5.49	-29.8	1.75%
		Standard Error			
Total	0.31	0.34	0.46		
1984 ASDR	0.31	0.31	0.43		
2004 ASDR	0.36	0.35	0.50		
		t-statistic			
Total	49.40	37.25	-5.19		
1984 ASDR	49.27	34.32	-10.35		
2004 ASDR	51.47	36.87	-10.94		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.21

Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Males, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Adjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	4.10	2.93	-1.17	-28.6	1.67%
70-74	7.97	4.64	-3.33	-41.8	2.67%
75-79	11.28	7.62	-3.66	-32.5	1.94%
80-84	18.40	11.76	-6.65	-36.1	2.22%
85-89	30.07	18.16	-11.91	-39.6	2.49%
90-94	47.59	31.67	-15.92	-33.4	2.02%
95+	64.71	42.98	-21.72	-33.6	2.02%
Total	10.20	7.59	-2.61	-25.6	1.47%
1984 ASDR	10.15	6.51	-3.64	-35.8	2.20%
2004 ASDR	12.43	7.96	-4.48	-36.0	2.21%
		Standard Error			
Total	0.34	0.34	0.48		
1984 ASDR	0.34	0.31	0.45		
2004 ASDR	0.41	0.36	0.54		
		t-statistic			
Total	30.14	22.43	-5.45		
1984 ASDR	30.10	21.32	-8.00		
2004 ASDR	30.30	22.40	-8.25		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.22

Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Females, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Adjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	4.60	3.78	-0.82	-17.7	0.97%
70-74	7.70	4.97	-2.73	-35.5	2.17%
75-79	13.35	8.48	-4.87	-36.4	2.24%
80-84	24.48	15.15	-9.33	-38.1	2.37%
85-89	40.30	29.72	-10.58	-26.3	1.51%
90-94	60.99	40.03	-20.96	-34.4	2.08%
95+	76.40	64.78	-11.62	-15.2	0.82%
Total	15.18	12.47	-2.71	-17.9	0.98%
1984 ASDR	15.06	10.30	-4.76	-31.6	1.88%
2004 ASDR	18.46	12.63	-5.82	-31.5	1.88%
		Standard Error			
Total	0.31	0.34	0.46		
1984 ASDR	0.31	0.30	0.43		
2004 ASDR	0.36	0.35	0.50		
		t-statistic			
Total	49.40	36.70	-5.93		
1984 ASDR	49.27	33.79	-11.03		
2004 ASDR	51.47	36.31	-11.65		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.23

Annual Rate of Decline in the Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Males, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Three Alternative Weighting Protocols

	Annual Rate of Decline (%)			Ratio Cox:Duke/PNAS		*t*-statistic	
Age	Duke/PNAS Weight	Unadjusted Cox Weight	Adjusted Cox Weight	Unadjusted	Adjusted	Unadjusted	Adjusted
65-69	2.34	1.67	1.67	0.715	0.715		
70-74	2.87	2.49	2.67	0.868	0.931		
75-79	1.97	1.82	1.94	0.925	0.988		
80-84	2.51	2.14	2.22	0.851	0.882		
85-89	2.76	2.19	2.49	0.794	0.901		
90-94	2.56	1.92	2.02	0.749	0.787		
95+	2.58	2.02	2.02	0.785	0.785		
Total	1.49	1.34	1.47	0.900	0.987	0.55	0.07
1984 ASDR	2.48	2.07	2.20	0.833	0.884	1.48	1.03
2004 ASDR	2.50	2.07	2.21	0.830	0.884	1.56	1.07
	Standard Error						
Total	0.27	0.27	0.27	0.980	0.986		
1984 ASDR	0.28	0.27	0.27	0.975	0.981		
2004 ASDR	0.27	0.27	0.27	0.980	0.987		
	t-statistic						
Total	5.45	5.00	5.45	0.918	1.000		
1984 ASDR	8.87	7.59	8.00	0.855	0.901		
2004 ASDR	9.21	7.80	8.25	0.847	0.895		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.24

Annual Rate of Decline in the Percent of Population Meeting Either HIPAA Trigger, United States 1984 and 2004, Females, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Three Alternative Weighting Protocols

	Annual Rate of Decline (%)			Ratio Cox:Duke/PNAS		*t*-statistic	
Age	Duke/PNAS Weight	Unadjusted Cox Weight	Adjusted Cox Weight	Unadjusted	Adjusted	Unadjusted	Adjusted
65-69	1.87	0.97	0.97	0.521	0.521		
70-74	2.69	2.08	2.17	0.773	0.805		
75-79	2.41	2.01	2.24	0.835	0.930		
80-84	2.50	2.14	2.37	0.856	0.949		
85-89	1.76	1.40	1.51	0.791	0.856		
90-94	2.23	2.05	2.08	0.921	0.934		
95+	0.87	0.78	0.82	0.891	0.941		
Total	1.11	0.85	0.98	0.767	0.881	1.53	0.78
1984 ASDR	2.17	1.76	1.88	0.809	0.868	2.38	1.64
2004 ASDR	2.12	1.75	1.88	0.826	0.886	2.25	1.48
	Standard Error						
Total	0.17	0.16	0.17	0.969	0.974		
1984 ASDR	0.17	0.17	0.17	0.975	0.982		
2004 ASDR	0.16	0.16	0.16	0.976	0.982		
	t-statistic						
Total	6.55	5.19	5.93	0.792	0.904		
1984 ASDR	12.48	10.35	11.03	0.830	0.884		
2004 ASDR	12.92	10.94	11.65	0.847	0.902		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.25

Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Males, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Unadjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.13	2.52	-0.61	-19.5	1.08%
70-74	5.47	4.01	-1.45	-26.6	1.53%
75-79	8.34	5.96	-2.38	-28.5	1.67%
80-84	13.42	9.37	-4.05	-30.2	1.78%
85-89	20.89	13.28	-7.61	-36.4	2.24%
90-94	35.25	24.03	-11.23	-31.8	1.90%
95+	48.57	35.62	-12.95	-26.7	1.54%
Total	7.38	6.08	-1.30	-17.6	0.96%
1984 ASDR	7.33	5.25	-2.08	-28.4	1.65%
2004 ASDR	8.99	6.33	-2.65	-29.5	1.73%
		Standard Error			
Total	0.30	0.31	0.43		
1984 ASDR	0.29	0.28	0.41		
2004 ASDR	0.36	0.32	0.49		
		t-statistic			
Total	24.92	19.72	-3.04		
1984 ASDR	24.90	18.83	-5.13		
2004 ASDR	24.67	19.66	-5.45		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.26

Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Females, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Unadjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.50	2.81	-0.70	-20.0	1.11%
70-74	4.87	4.53	-0.34	-7.0	0.36%
75-79	8.85	7.13	-1.73	-19.5	1.08%
80-84	16.39	12.51	-3.88	-23.7	1.34%
85-89	28.07	24.44	-3.63	-12.9	0.69%
90-94	47.97	32.09	-15.89	-33.1	1.99%
95+	67.74	57.19	-10.55	-15.6	0.84%
Total	10.65	10.38	-0.28	-2.6	0.13%
1984 ASDR	10.56	8.54	-2.02	-19.1	1.06%
2004 ASDR	13.11	10.49	-2.62	-20.0	1.11%
		Standard Error			
Total	0.27	0.32	0.42		
1984 ASDR	0.27	0.28	0.39		
2004 ASDR	0.32	0.33	0.46		
		t-statistic			
Total	39.60	32.64	-0.66		
1984 ASDR	39.52	30.28	-5.20		
2004 ASDR	40.69	32.26	-5.73		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.27

Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Males, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Adjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.13	2.52	-0.61	-19.5	1.08%
70-74	5.47	3.96	-1.51	-27.7	1.61%
75-79	8.34	5.85	-2.48	-29.8	1.75%
80-84	13.42	9.27	-4.15	-30.9	1.83%
85-89	20.89	12.97	-7.92	-37.9	2.35%
90-94	35.25	24.03	-11.23	-31.8	1.90%
95+	48.57	35.62	-12.95	-26.7	1.54%
Total	7.38	6.00	-1.37	-18.6	1.02%
1984 ASDR	7.33	5.19	-2.14	-29.2	1.71%
2004 ASDR	8.99	6.26	-2.73	-30.4	1.79%
		Standard Error			
Total	0.30	0.31	0.43		
1984 ASDR	0.29	0.28	0.40		
2004 ASDR	0.36	0.32	0.49		
		t-statistic			
Total	24.92	19.59	-3.22		
1984 ASDR	24.90	18.71	-5.30		
2004 ASDR	24.67	19.53	-5.63		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.28

Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Females, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Adjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	3.50	2.81	-0.70	-20.0	1.11%
70-74	4.87	4.44	-0.43	-8.8	0.46%
75-79	8.85	6.93	-1.93	-21.8	1.22%
80-84	16.39	12.20	-4.19	-25.6	1.47%
85-89	28.07	24.19	-3.88	-13.8	0.74%
90-94	47.97	31.85	-16.12	-33.6	2.03%
95+	67.74	57.19	-10.55	-15.6	0.84%
Total	10.65	10.23	-0.43	-4.0	0.20%
1984 ASDR	10.56	8.41	-2.15	-20.4	1.13%
2004 ASDR	13.11	10.33	-2.78	-21.2	1.18%
		Standard Error			
Total	0.27	0.32	0.41		
1984 ASDR	0.27	0.28	0.39		
2004 ASDR	0.32	0.32	0.46		
		t-statistic			
Total	39.60	32.39	-1.03		
1984 ASDR	39.52	30.02	-5.57		
2004 ASDR	40.69	32.00	-6.09		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.29

Annual Rate of Decline in the Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Males, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Three Alternative Weighting Protocols

	Annual Rate of Decline (%)			Ratio Cox:Duke/PNAS		*t*-statistic	
Age	Duke/PNAS Weight	Unadjusted Cox Weight	Adjusted Cox Weight	Unadjusted	Adjusted	Unadjusted	Adjusted
65-69	1.81	1.08	1.08	0.596	0.596		
70-74	1.87	1.53	1.61	0.822	0.862		
75-79	1.65	1.67	1.75	1.012	1.065		
80-84	2.10	1.78	1.83	0.849	0.874		
85-89	2.90	2.24	2.35	0.772	0.812		
90-94	2.40	1.90	1.90	0.790	0.790		
95+	2.18	1.54	1.54	0.705	0.705		
Total	1.10	0.96	1.02	0.878	0.933	0.41	0.23
1984 ASDR	2.03	1.65	1.71	0.816	0.845	1.13	0.95
2004 ASDR	2.11	1.73	1.79	0.820	0.849	1.17	0.99
		Standard Error					
Total	0.32	0.32	0.32	0.981	0.984		
1984 ASDR	0.33	0.32	0.32	0.976	0.979		
2004 ASDR	0.32	0.32	0.32	0.982	0.985		
		t-statistic					
Total	3.40	3.04	3.22	0.895	0.948		
1984 ASDR	6.14	5.13	5.30	0.835	0.863		
2004 ASDR	6.53	5.45	5.63	0.836	0.862		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.30

Annual Rate of Decline in the Percent of Population Meeting HIPAA ADL Trigger, United States 1984 and 2004, Females, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Three Alternative Weighting Protocols

	Annual Rate of Decline (%)			Ratio Cox:Duke/PNAS		*t*-statistic	
Age	Duke/PNAS Weight	Unadjusted Cox Weight	Adjusted Cox Weight	Unadjusted	Adjusted	Unadjusted	Adjusted
65-69	2.06	1.11	1.11	0.537	0.537		
70-74	1.01	0.36	0.46	0.359	0.455		
75-79	1.34	1.08	1.22	0.807	0.913		
80-84	1.59	1.34	1.47	0.846	0.924		
85-89	0.94	0.69	0.74	0.735	0.789		
90-94	2.09	1.99	2.03	0.954	0.971		
95+	0.91	0.84	0.84	0.923	0.923		
Total	0.31	0.13	0.20	0.417	0.649	0.90	0.54
1984 ASDR	1.39	1.06	1.13	0.759	0.815	1.61	1.24
2004 ASDR	1.39	1.11	1.18	0.796	0.849	1.43	1.06
		Standard Error					
Total	0.20	0.20	0.20	0.971	0.974		
1984 ASDR	0.21	0.20	0.20	0.979	0.982		
2004 ASDR	0.20	0.19	0.19	0.978	0.982		
		t-statistic					
Total	1.54	0.66	1.03	0.429	0.667		
1984 ASDR	6.71	5.20	5.57	0.776	0.830		
2004 ASDR	7.04	5.73	6.09	0.814	0.865		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.31

Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Males, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Unadjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.24	1.23	-1.01	-45.1	2.96%
70-74	4.64	2.72	-1.92	-41.4	2.64%
75-79	7.37	4.59	-2.78	-37.7	2.34%
80-84	12.91	7.18	-5.73	-44.4	2.89%
85-89	22.71	13.85	-8.86	-39.0	2.44%
90-94	35.14	23.69	-11.45	-32.6	1.95%
95+	47.67	31.34	-16.32	-34.2	2.07%
Total	6.67	4.75	-1.92	-28.8	1.69%
1984 ASDR	6.63	3.94	-2.68	-40.5	2.56%
2004 ASDR	8.38	5.04	-3.35	-39.9	2.52%
		Standard Error			
Total	0.28	0.27	0.39		
1984 ASDR	0.28	0.24	0.37		
2004 ASDR	0.35	0.29	0.46		
		t-statistic			
Total	23.78	17.42	-4.92		
1984 ASDR	23.75	16.67	-7.34		
2004 ASDR	23.62	17.37	-7.30		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.32

Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Females, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Unadjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.51	1.63	-0.88	-35.0	2.13%
70-74	5.03	2.23	-2.81	-55.8	4.00%
75-79	9.50	5.92	-3.58	-37.7	2.34%
80-84	18.92	11.39	-7.52	-39.8	2.50%
85-89	32.24	22.06	-10.17	-31.6	1.88%
90-94	48.39	30.32	-18.06	-37.3	2.31%
95+	60.11	50.15	-9.96	-16.6	0.90%
Total	11.17	8.67	-2.50	-22.4	1.26%
1984 ASDR	11.07	6.91	-4.16	-37.6	2.33%
2004 ASDR	13.86	8.80	-5.05	-36.5	2.24%
		Standard Error			
Total	0.27	0.29	0.40		
1984 ASDR	0.27	0.25	0.37		
2004 ASDR	0.33	0.30	0.45		
		t-statistic			
Total	40.91	29.65	-6.26		
1984 ASDR	40.83	27.73	-11.31		
2004 ASDR	41.86	29.32	-11.31		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.33

Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Males, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Adjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.24	1.23	-1.01	-45.1	2.96%
70-74	4.64	2.61	-2.04	-43.9	2.85%
75-79	7.37	4.50	-2.87	-38.9	2.44%
80-84	12.91	7.10	-5.82	-45.0	2.95%
85-89	22.71	12.81	-9.90	-43.6	2.82%
90-94	35.14	23.04	-12.10	-34.4	2.09%
95+	47.67	31.34	-16.32	-34.2	2.07%
Total	6.67	4.61	-2.07	-30.9	1.83%
1984 ASDR	6.63	3.83	-2.80	-42.3	2.71%
2004 ASDR	8.38	4.88	-3.51	-41.8	2.67%
		Standard Error			
Total	0.28	0.27	0.39		
1984 ASDR	0.28	0.23	0.36		
2004 ASDR	0.35	0.29	0.46		
		t-statistic			
Total	23.78	17.13	-5.31		
1984 ASDR	23.75	16.38	-7.70		
2004 ASDR	23.62	17.07	-7.70		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.34

Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Females, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Cox Weights, Adjusted for Screen-Outs

Age	1984	2004	Change	% Change	Annual Rate of Decline; 20 yr.
65-69	2.51	1.63	-0.88	-35.0	2.13%
70-74	5.03	2.23	-2.81	-55.8	4.00%
75-79	9.50	5.65	-3.85	-40.5	2.56%
80-84	18.92	10.91	-8.00	-42.3	2.71%
85-89	32.24	21.56	-10.68	-33.1	1.99%
90-94	48.39	30.32	-18.06	-37.3	2.31%
95+	60.11	49.57	-10.54	-17.5	0.96%
Total	11.17	8.47	-2.70	-24.2	1.38%
1984 ASDR	11.07	6.74	-4.33	-39.1	2.45%
2004 ASDR	13.86	8.60	-5.26	-37.9	2.36%
		Standard Error			
Total	0.27	0.29	0.40		
1984 ASDR	0.27	0.25	0.37		
2004 ASDR	0.33	0.30	0.44		
		t-statistic			
Total	40.91	29.26	-6.80		
1984 ASDR	40.83	27.35	-11.81		
2004 ASDR	41.86	28.94	-11.82		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.35

Annual Rate of Decline in the Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Males, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Three Alternative Weighting Protocols

	Annual Rate of Decline (%)			Ratio Cox:Duke/PNAS		*t*-statistic	
Age	Duke/PNAS Weight	Unadjusted Cox Weight	Adjusted Cox Weight	Unadjusted	Adjusted	Unadjusted	Adjusted
65-69	3.38	2.96	2.96	0.876	0.876		
70-74	2.72	2.64	2.85	0.969	1.045		
75-79	2.40	2.34	2.44	0.974	1.014		
80-84	3.16	2.89	2.95	0.913	0.932		
85-89	2.98	2.44	2.82	0.819	0.946		
90-94	2.68	1.95	2.09	0.728	0.778		
95+	2.53	2.07	2.07	0.819	0.819		
Total	1.68	1.69	1.83	1.001	1.089	0.00	-0.43
1984 ASDR	2.85	2.56	2.71	0.899	0.951	0.81	0.39
2004 ASDR	2.85	2.52	2.67	0.883	0.938	0.95	0.50
		Standard Error					
Total	0.35	0.34	0.35	0.985	0.992		
1984 ASDR	0.36	0.35	0.35	0.980	0.987		
2004 ASDR	0.35	0.34	0.35	0.985	0.993		
		t-statistic					
Total	4.84	4.92	5.31	1.016	1.098		
1984 ASDR	7.99	7.34	7.70	0.918	0.963		
2004 ASDR	8.15	7.30	7.70	0.897	0.945		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted male population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

Table 3.36

Annual Rate of Decline in the Percent of Population Meeting HIPAA CI Trigger, United States 1984 and 2004, Females, Age 65+, by Age and Totaled Over Age, with Two Modes of Age Standardization – Using Three Alternative Weighting Protocols

	Annual Rate of Decline (%)			Ratio Cox:Duke/PNAS		*t*-statistic	
Age	Duke/PNAS Weight	Unadjusted Cox Weight	Adjusted Cox Weight	Unadjusted	Adjusted	Unadjusted	Adjusted
65-69	2.92	2.13	2.13	0.729	0.729		
70-74	4.49	4.00	4.00	0.891	0.891		
75-79	2.86	2.34	2.56	0.817	0.896		
80-84	2.84	2.50	2.71	0.880	0.954		
85-89	2.28	1.88	1.99	0.824	0.874		
90-94	2.46	2.31	2.31	0.938	0.938		
95+	0.99	0.90	0.96	0.910	0.968		
Total	1.49	1.26	1.38	0.848	0.926	1.09	0.53
1984 ASDR	2.72	2.33	2.45	0.858	0.901	1.82	1.27
2004 ASDR	2.59	2.24	2.36	0.865	0.909	1.72	1.15
		Standard Error					
Total	0.21	0.20	0.20	0.969	0.974		
1984 ASDR	0.21	0.21	0.21	0.975	0.981		
2004 ASDR	0.20	0.20	0.20	0.975	0.980		
		t-statistic					
Total	7.15	6.26	6.80	0.875	0.950		
1984 ASDR	12.85	11.31	11.81	0.880	0.919		
2004 ASDR	12.75	11.31	11.82	0.887	0.928		

NOTE: ASDR denotes age-standardized disability rate; the 1984 ASDR and 2004 ASDR results were age-standardized, respectively, to the 1984 and 2004 NLTCS weighted female population. The HIPAA triggers are based on 2+ ADL Impariments or 3+ errors on the SPMSQ.

Source: Authors' calculations based on the 1984 and 2004 NLTCS.

SECTION 4: FEASIBILITY OF SIMULATING THE IMPACT OF UNDERWRITING PROTOCOLS

The fourth focus of the study was on the feasibility of simulating the impact of various types of underwriting protocols using the data and insights gained from the analyses described in Sections 1–3. We emphasize that our goal in this task was to *assess the feasibility* of such simulations, not *to actually develop* a full scale implementation of those simulations. We recognized from the outset that the latter would be a major project which would logically follow the completion of the current project. The project would make sense, however, only if we could demonstrate that it were actually feasible. Successful implementation of the simulations would be of obvious interest to LTC actuaries—providing the motivation for consideration here—and we relied on the input and insights of actuaries on the Project Oversight Group in approaching this task. Our assessment concluded that the simulations could not be successfully done using the NLTCS data alone—primarily due to design limitations in the early waves of the survey. However, the simulations could be done using other publicly available data, possibly in conjunction with the NLTCS, and we describe how this could be done. An important limitation in such applications will be the relatively small sample sizes that result once a given set of underwriting protocols is imposed on the sample. We describe how proportional hazards and logistic regression procedures can be used to mitigate the effects of this limitation.

This section has three parts. *First*, we consider the general problem of simulating the impact of various types of underwriting protocols using publicly available data under the assumption that all needed information is available for sufficiently large samples followed longitudinally over time with periodic measures of disability status at the time of each assessment. *Second*, we consider how the simulations could be specified to include the declines in ADL and CI disability during 1984–2004 described in Sections 1–3. *Third*, we match the input requirements of the simulation model with the data actually available in the NLTCS to form our conclusions about the feasibility of such a project.

1. GENERAL PROBLEM

To address the general problem we have to resolve a major analytic challenge: There exist no publicly available datasets that allow for direct estimation of the incidence, continuance, and mortality rates routinely used in actuarial modeling for LTC insurance applications. This restriction is central to the discussion in this section and its resolution is essential to establishing the feasibility of the proposed approach. The existing publicly available datasets allow only for indirect estimation of the incidence, continuance, and mortality rates. These datasets, however, do allow for direct estimation of the disability prevalence rates, from which it is possible to infer the values of the associated pairings of incidence and continuance rates. This inference can be strengthened if the prevalence data contain information on the duration of disability at the time of data collection, but we do not require this information to be available.

In previous work (e.g., Stallard and Yee, 2000), we used a Markov transition matrix approach to the estimation of incidence and continuance functions which works well for longitudinal data when the intervals between the periodic assessments are not too long (e.g. five years as in the NLTCS), and works best when they are short (e.g., 1–2 years) (Cai and Lubitz, 2007; Stallard, 2011b). Our concern here is that the interval between the simulated underwriting and the incidence of significant numbers of disability claims may be from one to several decades which makes it difficult to accurately estimate the required transition matrices for the Markov model. This span of decades makes the problem fundamentally different from standard Markov applications such as Cai and Lubitz (2007) for which only two sequential observations are required for implementation.

As a consequence, we propose to apply Sullivan's (1971) method to the longitudinal data to form the required cohort life table functions having the highly desirable optimality properties of unbiasedness and consistency, as proven by Imai and Soneji (2007). This assumes that the longitudinal follow-up of each sample participant is sufficiently long to observe significant numbers of disability episodes, which precludes use of rotating panel designs such as the Medicare Current Beneficiary Survey used by Cai and Lubitz (2007).

We also need to correct an error in Cai and Lubitz (2007, p. 482) who claim that the Markov approach is superior because it allows both disability onset and recovery. In fact, the Sullivan approach implicitly allows both disability onset and recovery; i.e., the results of the Sullivan approach do not depend on whether a given disabled participant does or does not recover at a later date. The only requirement is that the disability status on the given assessment date is correct and this is the same requirement as for the Markov approach.

Indeed, Imai and Soneji (2007, p. 1206) point out that the homogeneity assumption applied to each cell of the Markov approach is likely to be in error if a prior history of disability is predictive of future disability, which is almost surely true, given that the purpose of underwriting for disability is to take account of such individual differences. Hence, rather than being superior to the Sullivan approach, it follows that the Markov approach is inferior: It can never perform better than the Sullivan approach and will almost always be worse. At best, use of the Markov approach can be justified as an approximation to the Sullivan approach, albeit a very useful one that can yield information not available from the Sullivan approach, e.g., the lifetime probability of ever becoming disabled.

The critique of the Markov approach does not apply to the incidence/continuance approach routinely used in actuarial modeling for LTC insurance applications where all transitions are recorded to the exact date and the incidence and continuance rates are observed directly. Conversely, the insurance data admit to a simple re-tabulation and reformulation using the Sullivan approach which is unbiased and consistent (Imai and Soneji, 2007). This equivalence provides a necessary condition for simulating the impact of various underwriting protocols. The results of the population-based simulation will be directly comparable to the Sullivan-based reformulation of the insurance data.

Under the "period version" of Sullivan's method, the disabled life expectancy (DLE) at age x in year y is given by the following formula (see Section 8 of the Introduction):

$$e_{DLE\ x,y} = \int_0^\infty {}_t p_{x,y}\ \ \pi_{x+t,y}\ \ dt$$

where

${}_t p_{x,y} = l_{x+t,y} / l_{x,y}$

with

$l_{x+t,y} =$ probability of survival from birth to age $x+t$ in year y;

and

$\pi_{x+t,y} =$ disability prevalence at age $x+t,$ in year y.

Thus, the disabled life expectancy provides a summarization of the age-specific disability prevalence rates in a given population at a given year. The nondisabled (disability-free) life expectancy is similarly defined, but with the prevalence rates replaced by their complements:

$$e_{NDLE\ x,y} = \int_0^\infty {}_t p_{x,y}\ \ (1-\pi_{x+t,y})\ dt.$$

Sullivan's DLE formula can be readily generalized to represent an actuarial present value of LTC insurance benefits by introducing appropriate cost and discounting factors (to reflect the time value of money). Similarly, Sullivan's NDLE formula can be generalized to represent an actuarial present value of LTC insurance net premiums with the two actuarial present values set equal in the simulated pricing calculations, assuming waiver of premium for disabled lives.

The DLE and NDLE formulas shown above define the "period life table" approach to survival analysis for which the calculations refer to the conditions in a specified calendar year, y. This is the approach that was used in Sections 1–3 of this report. It is a common but hypothetical form of survival analysis that differs from the "cohort life table" approach for which the calculations refer to the conditions experienced by a specified group of individuals, all of whom were born during the same 1-year time period, c, where $c = y - x$.

The cohort formulas differ from the period formulas in that the time dimension t is redefined to include calendar year y, i.e., each occurrence of y is replaced by a corresponding occurrence of $y + t$. Thus, the cohort DLE is given by the following formula, where the superscript c is used to distinguish cohort measures from the corresponding period measures:

$$e^{c}_{DLE\ x,y} = \int_0^\infty {}_t p^c_{x,y}\ \pi^c_{x+t,y+t}\ dt$$

where

$${}_t p^c_{x,y} = l^c_{x+t,y+t} \big/ l^c_{x,y}$$

with

$l^c_{x+t,y+t} =$ probability of survival from birth, in year $c = y - x$,

to age $x + t$ in year $y + t$;

and

$\pi^c_{x+t,y+t} =$ disability prevalence at age $x + t$, in year $y + t$.

Because later-born (younger) cohorts have improved survival compared to earlier-born (older) cohorts, it will be useful to introduce birth cohort as a predictor of mortality in the case that the survival functions are modeled using, e.g., proportional hazards regression procedures (Cox, 1972).

The cohort approach can be naturally extended to "underwriting cohorts" by defining each underwriting cohort *r* as the survivors among those born in the same year who were alive at age *x* in year *y* and simultaneously had the same underwriting risk classification. In this case, we use ${}_t p^{c,r}_{x,y}$ to denote the survival function at time *t* (i.e., *t* years after the baseline exam in publicly available data or *t* years after issuance of the LTC insurance policy in insured data) and $\pi^{c,r}_{x+t,y+t}$ to denote the corresponding disability prevalence rate.

Under the above assumptions, attention focuses on the DLEs, $e^{c,r}_{DLE\ x,y}$, as the primary measures of interest. Differences in the DLEs for the underwriting cohorts can be used to answer a range of questions regarding the impacts of the various underwriting protocols. This may require use of a robust method for estimation of the disability prevalence rates: $\pi^{c,r}_{x+t,y+t}$. We propose using logistic regression for this purpose.

Our choice of logistic regression was motivated not only by its robustness but also because its application to disability prevalence rates is consistent with use of the proportional hazards regression model for the corresponding disability incidence rates. In the logistic model, the logarithms of the *odds-ratios* based on the respective prevalence rates are represented as linear functions of the predictor variables; in the proportional hazards regression model, the logarithms of the *direct ratios* of the respective incidence rates are represented as linear functions of the predictor variables. For a static population, Miettinen (1976, eqn. 21) showed that the first ratio is proportional to the second, which means that the linearity of the logistic model implies a corresponding linearity of the proportional hazards model, and vice versa. More generally, for a dynamic population, the proportionality assumption for the respective ratios provides a satisfactory first-order approximation. This means that the logistic model provides an appropriate basis for estimating the disability prevalence rates for input to the Sullivan life tables.

Under the above assumptions, attention will also focus on the differences in net premiums for the different underwriting cohorts. The behavior of the net premiums will reflect several interacting effects whereby a given cohort with substantially longer total and nondisabled life expectancies may exhibit longer disabled life expectancies, but yet have lower net premiums than the comparison cohort. In this case, the additional premium payments during the additional nondisabled life years would compensate for the additional months of disability. It is also possible that the same cohort would have higher net premiums than the comparison cohort, despite having lower disability prevalence rates at every age. This means that it is not sufficient to consider only the age-specific disability prevalence rates in evaluating the impact of various types of underwriting protocols. The net premiums must also be considered for valid inferences.

2. MORBIDITY IMPROVEMENT

We considered how the above simulations could be specified to include declines in ADL and CI disability during the period 1984–2004 and later. A critical insight was the recognition that most of the effects of the declines would already be implicitly represented in the cohort analyses without any specific action being taken to represent these effects. The reason for this implicit representation lies in the temporal relationships between the period and cohort analyses with respect to the meaning of attained age.

To understand this point, consider the ADL disability rate for age 65–69 in 1984 in Table 1.8 with the value 3.27%. Under the period approach, the ADL disability rate twenty years later at age 85–89 was 26.22%—an increase by a factor of 8.02. Under the cohort approach, the ADL disability rate twenty years later at age 85–89 was 19.39%—an increase by a factor of 5.93. The cohort factor is 26.1% lower than the period factor (see % Change column of Table 1.8). This difference, which represents the 20-year decline in ADL disability prevalence, is implicitly represented in the cohort analysis for this age group—i.e., for persons aged 65–69 in 1984— since the data that would be used for modeling their disability would be for persons aged 85–89 in 2004. Each single-year increase in age shifts their calendar year experience one year later and it is this gradual shifting in calendar year experience that captures the disability declines in the cohort analyses without any specific further action being taken.

It is important to emphasize that we have not characterized the 20-year declines as either period or cohort effects, primarily because we did not have sufficient data to do so. As more data are assembled it will become feasible to separate out the components of the decline that are due to period effects from those due to cohort effects using, for example, the innovative methods described by Yang and Land (2013). Such separation could be useful in setting assumptions for projecting model parameters to future years and younger cohorts.

Given that the effects of the ADL and CI declines are implicitly represented in the cohort analyses for the general population cohorts, it follows that the same property applies to the cohort analyses for the underwriting cohorts; this property supports our conclusions regarding their feasibility.

3. DATA REQUIREMENTS

Having specified a feasible model for simulating the impact of various types of underwriting protocols using the data and insights gained from the analyses described in Sections 1–3, we then considered whether the NLTCS could reasonably match the input requirements of that model or whether it would be necessary to seek other sources of data.

The primary reason for considering the NLTCS for the first three aims was its high quality, extensive temporal range, and ready availability. In this fourth aim, the 20-year temporal range would be workable but certainly not long for risks that take many decades to develop. The primary limitations of the NLTCS are due to the design characteristics of the early waves of the survey. Specifically:

- All 1984 survey participants were aged 65 years or older—for the underwriting analyses we would want to see persons as young as 45 years of age. The “missing age group” at ages 45–64 could be critically important for underwriting assessments (Willcox et al., 2006).
- All 1984 survey participants were screened for disability in 1982 and/or 1984 but the screen-out groups were not assessed with respect to characteristics that could be used for the proposed underwriting analyses. Table 3.1 shows that there were 980 participants who were nondisabled at the detailed interview but it is unclear how many of these would meet the simulated underwriting criteria given that all had previously screened-in for disability.
- This differs from the 2004 survey where 1,694 participants (Table 3.3) who screened-out were nondisabled at the detailed interview and could be used for assessing the impact of underwriting protocols in years after 2004. Unfortunately, 2004 was the terminal year of the NLTCS so this option is not feasible.
- The survey records for all NLTCS participants were linked Medicare Part A and B administrative data records containing diagnoses and billing amounts. Unfortunately, Part B diagnostic codes were not included on these records until 1991 which meant that the information that might be most useful for underwriting analyses of the screen-outs was not available for the 1984 survey participants. Indeed, inspection of the Medicare files showed that the Part A information was sporadic for calendar years 1984–1985 so that even the more limited Part A hospitalization codes were not sufficiently complete to be used for underwriting analyses; i.e., the lack of a given diagnostic code could not be taken as a reliable indicator that the participant was free of the specified condition.

The limitations in the early waves of the survey should not dissuade users from related applications of this very significant and powerful data source. For example, Stallard (2011a) used the 2004 NLTCS with linked Medicare data to assess the impact of obesity and diabetes on ADL/CI disability and mortality using indicators of current obesity and diabetes, and obesity at age 50 (retrospectively assessed). Among the findings were the following:

- Current obesity was associated with large increases in diabetes, non-significant increases in disability, and substantial decreases in mortality among elderly persons.
- Obesity at age 50 was associated with large increases in diabetes and disability, and non-significant increases in mortality among elderly persons.

- Diabetes was associated with large increases in disability and mortality among elderly persons.
- Obesity at age 50 and diabetes were both associated with large increases in disability among elderly persons.

It is unfortunate, indeed, that we were unable to replicate such analyses for the 1984 NLTCS for the reasons indicated above.

Given the above assessment, we considered whether the proposed simulations could be done using other publicly available data. Several longitudinal studies were considered suitable for this purpose. All have restrictions on data availability which would have to be addressed if a project were to be considered for implementation:

- The Framingham Heart Study (FHS) has been ongoing since 1948 and has extensive medical information that could be used to simulate various underwriting protocols and a range of disability measures that could be used to simulate the HIPAA ADL and CI triggers. The original cohort had over 5,200 participants followed biennially for over 60 years; see Yashin et al. (2012) for analyses of the primary cardiovascular predictors. The offspring cohort had over 5,100 participants followed quadrennially since 1971–1975 with ongoing follow-up.
- The Honolulu Heart Program (HHP)/Honolulu Asia Aging (HAA) Study has been ongoing since 1965 and has a broad array of medical information and disability measures that are closely matched to the protocols used in the Framingham Heart Study. The sample comprises over 8,000 American males of Japanese ancestry living in Hawaii, aged 45–68 years at the time of the baseline exam (Exam 1) in 1965–1968, among whom 252 were still alive in 2011–2012 (Exam 12) when they were aged 91–106 years.
- The NHANES Epidemiologic Follow-up Study (NHEFS) is a complex longitudinal dataset derived from the first National Health and Nutrition Examination Survey (NHANES I) conducted between 1971 and 1975 with disability assessments conducted over a 10-year period in Exams 2–5 (1982–1984; 1986; 1987; and 1992) with the longest span start-to-end over 20 years. The sample includes over 4,100 participants (1,971 males and 2,163 females) who were aged 45–75 years old at Exam 1. Like the prior two studies, it has extensive medical information that could be used to simulate various underwriting protocols and a range of disability measures that could be used to simulate the HIPAA ADL and CI triggers.
- The Health and Retirement Study (HRS) comprises about 26,000 distinct participants aged 51 years and older with longitudinal follow-up beginning in 1992 and continuing indefinitely with biennial interviews covering all key areas covered by the NLTCS. Medicare data are available for approximately 19,700 distinct participants. Two strengths of the HRS are its relatively large sample size and the linkage to Medicare Parts A and B diagnostic information; a weakness is the absence prior to 2006 of standard cardiovascular risk factors like blood pressure, serum cholesterol, serum glucose, etc. Section 3.5 contains several informative comparisons between the results of the HRS and NLTCS.

The above listing is not intended to be exhaustive; it represents data sources for which we had sufficient familiarity to consider for the proposed simulations. The primary advantage of these sources over the early waves of the NLTCS is the availability of measures needed to credibly simulate a variety of underwriting protocols. A weakness of these sources is that the disability measures are not quite as good as those in the NLTCS (Freedman et al., 2002). This weakness could be mitigated by tailoring the specifications of the disability measures in these sources to most closely match the NLTCS age-sex-residence-specific disability rates using the results in this report.

While the sample sizes indicated above are representative of the ranges likely to occur in publicly available datasets, one should be aware that the many stratifications likely to be considered in simulating various underwriting protocols will yield small numbers of disabled cases in the later waves of each study. When attention is focused on fine-grained modifications to selected underwriting protocols, it is likely that the changes in the number of disabled cases will be small compared to the standard errors of the estimates—leading to inconclusive results. This limitation may be mitigated by pooling the data from two or more of the sources indicated above.

Finally, it needs to be stressed that simulations based on publicly available data will likely yield different results than those actually obtained when the underwriting protocols are applied to insured populations. Insured populations behave differently from non-insured populations and it is a major challenge in the LTC insurance field to specify the size and direction of the resulting differences.

SECTION 5: CONCLUSIONS

The National Long Term Care Survey (NLTCS) is an excellent source of longitudinal data on a national sample of aged persons in the United States. The survey collected a range of information on the social and demographic characteristics of the aged population, but concentrated on health and functional limitations, their correlates, and relation to mortality.

The NLTCS was initiated in 1982 to provide cross-sectional and longitudinal data on changing patterns of health and illness in the aged population in a cost-effective manner. The survey screened a large number of elderly persons, totaling 49,258 distinct persons over the six waves of the survey (1982, 1984, 1989, 1994, 1999, and 2004), for evidence of illness or disability and, once identified, continued to conduct lengthy interviews with these persons until they were no longer available (i.e., died, left the country, or refused follow-up). The NLTCS was fielded using comparable instrumentation in all years, a key requirement for assessing morbidity improvement. Limitations of the 1982 sampling design with respect to institutionalized respondents, however, necessitated that analyses of the changes in the morbidity rates and lifetime disability be most effectively conducted beginning with the 1984 NLTCS. For each survey year, the cross-sectional sample size was in the range 16,000–21,000, with approximately 6,000–7,500 detailed in-person interviews for persons who met various disability screening criteria. Detailed interviews were conducted for both community and institutional residents at all survey years except for 1982, when the fact of institutionalization was noted without further information being collected. The institutional detailed interview was a shortened, modified form of the community detailed interview with sample sizes in the range 970–1,770 for the period 1984–2004.

The public use version of the NLTCS is available free of charge to users who certify that they will comply with the terms of the NLTCS Data Use Agreement. Users who comply with a somewhat more stringent set of terms can obtain copies of linked Medicare and Medicaid data from CMS, currently through 2009, with updates planned as further data become available.

Results from the NLTCS reported in Manton et al. (1997) produced the *first compelling evidence* of significant declines in functional limitations where the entire population was represented (e.g., most surveys do not effectively include the institutional groups). Continuations of the decline in functional limitations were reported in Manton and Gu (2001) and Manton et al. (2006). Preliminary evidence for concurrent declines in severe cognitive impairment was reported in Manton et al. (2005), using NLTCS data supplemented with results from the NNHS.

The analyses reported herein focused on precise estimation of the declines in severe ADL functional limitation and cognitive impairment (CI) using the HIPAA ADL and CI criteria, based on NLTCS changes over the 20-year period 1984–2004. Among the major findings were:

1. The *age-adjusted* ADL prevalence rates declined at an annualized rate of 1.67%/yr. during 1984–2004 (t = 9.85, $p < 0.001$; Table 1.8), which was slightly larger than Manton et al.'s (2006) estimate of 1.50%/yr. during 1982–2004 (Table 1.1).
2. The *unadjusted* ADL prevalence rates among community residents declined at an annualized rate of 0.31%/yr. during 1984–2004 (t = 1.28, n.s.; Table 1.18), which showed the importance of age standardization to the validity of trend estimates, and explained why many studies fail

to find significant disability declines when based on comparisons of unadjusted prevalence rates—even with a time span as long as 20 years.

3. The *age-adjusted* CI prevalence rates declined at an annualized rate of 2.74%/yr. ($t = 15.53$, $p < 0.001$; Table 2.16), which was somewhat smaller than the estimate of 3.3%/yr. during 1984–1999 derived from Manton et al. (2005) (see Section 2.8), but was consistent with recent reports from the U.K during 1991–2011 (Matthews et al., 2013) and Denmark during 1998–2010 (Christensen et al., 2013), and which provided the confirmation sought by Dallas W. Anderson, Program Administrator, NIA Dementias of Aging Branch (as quoted in *The New York Times*, July 16, 2013).
4. The *age-adjusted* joint ADL and/or CI prevalence rates declined at an annualized rate of 2.29%/yr. during 1984–2004 ($t = 16.27$, $p < 0.001$; Table 2.21), which indicated that the decline in severe CI was faster than that of severe ADL disability.

These findings imply joint and separate reductions in ADL and CI disability that more than compensated for the expansion of disability that would have occurred due to increased longevity, in the absence of such trends, a phenomenon that is not currently properly recognized in the field of aging. The findings may seem to be at odds with some reports on ADL (but not CI) trends based on changes in unadjusted prevalence rates over short time periods (e.g., during 2000–2008; Freedman et al., 2013); the differences, however, are fully explained by combining findings 1 and 2 above.

We extensively tested the sensitivity of these findings to alternative specifications of the survey weighting procedures to assure their validity (within the limitations of the NLTCS).

The sensitivity analyses showed that the estimated large declines in ADL and CI disability during 1984–2004 were robust with respect to reasonable alternative survey weighting protocols. They also showed that the adjusted Cox protocol produced estimates near to or within the 95%-confidence intervals for the corresponding Duke/PNAS estimates, indicating that our reconciliation of the differences between the Duke/PNAS and the Cox protocols was successful.

Given the strength of the findings herein, our focus now shifts to questions regarding the extent to which ADL declines can be explained by CI declines and the degree to which the CI declines are attributable to Alzheimer's disease (AD) vs. non-AD changes. Better understanding of the dynamics of these processes has the potential to yield substantially improved forecasts of future changes in ADL and CI morbidity.

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