# The Impact of Obesity and Diabetes on LTC Disability and Mortality: Population Estimates from the National Long Term Care Survey

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## Abstract

**Purpose:** To estimate the impact of obesity and diabetes on disability and mortality for those older than 65 using the 2004 National Long Term Care Survey (NLTCS) with disability based on the Health Insurance Accountability and Portability Act (HIPAA) Activities of Daily Living and Cognitive Impairment triggers.

**Methods:** Obesity and diabetes were assessed using self-reported medical conditions and health care-provider reported medical diagnoses from Medicare files linked to the NLTCS. Obesity was also assessed using self-reported height and weight in the NLTCS detailed community interview to construct measures of body mass index (BMI) at three time points: currently, at age 50 and one year prior to the NLTCS interview. Standard BMI cut-points were used to define obesity (BMI of 30 or more) and nonobesity (BMI of less than 30) for use in comparisons with self-reported and health care-provider reported obesity.

**Results:** Current obesity was associated with large increases in diabetes, nonsignificant increases in disability and substantial decreases in mortality among the elderly. Obesity at age 50 was associated with large increases in diabetes and disability and nonsignificant increases in mortality among the elderly. Diabetes was associated with large increases in disability and mortality among the elderly. Obesity at age 50 and diabetes were both associated with large increases in disability among the elderly; tests of the interaction between these risk factors did not rule out either additive or multiplicative models.

**Conclusions: The effects of obesity and diabetes were consistent with a complex multistage/multipath disablement process involving separate and joint effects of obesity and diabetes as initial or intermediate stages in a multistage process leading to disability and death.**

## Abbreviations

| | |
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| ADL | Activity of Daily Living |
| A/E | Actual/Expected (Ratio) |
| AHEAD | Asset and Health Dynamics Among the Oldest Old (Survey) |
| BMI | Body Mass Index |
| CI | Cognitive Impairment |
| FFS | Fee for Service |
| HIPAA | Health Insurance Portability and Accountability Act of 1996 |
| HMO | Health Maintenance Organization |
| IADL | Instrumental Activity of Daily Living |
| LTC | Long-Term Care |
| NHANES | National Health and Nutrition Examination Survey |
| NHIS | National Health Interview Survey |
| NLTCS | National Long Term Care Survey |
| SPMSQ | Short Portable Mental Status Questionnaire |

## Introduction

The public health significance of obesity and diabetes among U.S. adults has been increasing in importance due to the marked escalation in the diseases' prevalence rates from 1980–2000 and the continuing but slower growth over the following decade. For example, between 1976–80 and 1999-2000, the age-adjusted prevalence of obesity in the U.S. population age 20–74 increased from 15 to 31 percent, and continued up to 35 percent in 2005–06, based on the National Health and Nutrition Examination Survey (NHANES) (National Center for Health Statistics 2010, 116). Also between 1976–80 and 1999–2000, the corresponding age-adjusted prevalence of diabetes increased from 5.3 to 8.1 percent (Gregg et al. 2005, Table 2). Between 1999–2002 and 2003–06, the age-adjusted prevalence of diabetes in the U.S. population age 20 and older increased from 9.4 to 10.2 percent; among those 60 and older, the prevalence increased from 21 to 23 percent (NCHS 2010, Table 51).

The increases in the prevalence of diabetes occurred for all body mass index (BMI) classes, but the increases were larger for obese than nonobese people and, among the latter, the increases were larger for overweight (BMI between 25 and 30) than nonoverweight (BMI less than 25) people (Gregg et al. 2005, Table 2). Biggs et al. (2010) used the 1989–2007 Cardiovascular Health Study to clarify the relationship between the incidence of diabetes beyond age 65 and BMI at age 50, BMI at the baseline examination (average age 72.6), and weight changes before and after the baseline examination. All four measures were positively associated with the incidence of diabetes; however, the BMI associations were larger prior to age 75 than afterwards.

Obesity and diabetes are chronic metabolic condition linked to each other and to excess disability and mortality. These linkages are part of the conceptual model of the disablement process first described by Verbrugge and Jette (1994) in which diabetes serves both as a pathological precursor to disability and as a source of feedback effects for the disabled due to new pathologies (e.g., cardiovascular disease, renal failure and diabetic retinopathy). Lawrence and Jette (1996) further clarified the role of obesity as a risk factor for multiple pathologies/impairments, including diabetes, jointly associated with increased risks of developing limitations in physical and mental functioning, and, as a consequence, disabilities in activities of daily living (ADL) and instrumental activities of daily living (IADL).

Recent reports are mixed with respect to the directions of change in the deleterious effects of obesity and diabetes on disability. For example, the Centers for Disease Control and Prevention (2010) reported that the percentage of diabetics 75 and older unable to perform their usual activities for at least one of the previous 30 days increased slightly from 26.2 percent in 1997 to 26.9 percent in 2004, while fluctuating between 26.6 and 29.6 percent during the intervening years; the corresponding percentages of noninstitutionalized diabetics with any mobility limitations were 83.5 percent in 1997 and 80.3 percent in 2004, with a low of 77.2 percent in 2001, based on the National Health Interview Survey (NHIS).

Freedman et al. (2007, Table 2) reported relative increases of 4.0 percent and 5.6 percent in the prevalence rates for diabetes and obesity, respectively, among noninstitutionalized people 65 and older in the United States during 1997–2004 (based on the NHIS and consistent with other evidence from the NHANES cited above). However, they also reported relative decreases of 4.1 percent and 2.8 percent in the corresponding conditional disability prevalence rates (i.e., given diabetes or obesity, with disability based on personal assistance with at least one ADL or IADL, from among four ADLs and four IADLs), decreases that substantially offset the increased prevalences of the underlying conditions.

Thus, Freedman's results indicated that the joint prevalence rate for diabetes and disability increased only modestly, from 2.9 to 3.1 percent, during 1997–2004, while fluctuating between 2.5 and 3.2 percent during the intervening years; the joint prevalence rate for obesity and disability also increased only modestly, from 2.5 to 2.7 percent, while fluctuating between 2.6 and 3.1 percent during the intervening years. The large size of the annual fluctuations suggests caution in extrapolating trends based solely on the endpoint values.

Using related measures, Freedman et al. (2007, Table 4) reported that the prevalence of disability caused by obesity increased during 1997–2004 by an absolute 0.22 percent, but this was almost exactly offset by an absolute decrease of 0.21 percent in disability caused by diabetes. Changing the reference period from 1997–2004 to 1998–2003, however, reduced the obesity change from 0.22 to 0.09 percent but increased the absolute value of the diabetes decrease from 0.21 to 0.47 percent. Again, the fluctuations in the underlying rates were large enough to warrant caution in extrapolating trends based solely on the endpoint values.

Reynolds, Saito and Crimmins (2005) used a multistate life table model to estimate the impact of obesity on future lifetime years of disability for those reaching age 70 in the United States during 1993–98, based on the Asset and Health Dynamics Among the Oldest Old (AHEAD) Survey with disability defined as difficulty with one or more of six ADLs. Total life expectancy estimates for males at age 70 were 12.3 and 12.4 years for the nonobese and obese, respectively, with 20.7 percent and 32.0 percent of those years spent disabled. Corresponding estimates for females at age 70 were 15.3 and 15.5 years for the nonobese and obese, respectively, with 31.4 percent and 47.7 percent spent disabled. The total number of years lived was not reduced by obesity but the fraction spent disabled was 52 to 55 percent higher for the obese.

Sands et al. (2008) used the 2004 National Long Term Care Survey (NLTCS) to assess the relative risks of ADL disability (based on equipment or personal assistance with one or more of four ADLs) and use of long-term care (LTC) services for two classes of obesity, and found that the class II–III obese (BMI of 35 or more) had ADL and LTC-service risks substantially higher than those of the class I obese (BMI between 30 and 35) which, in turn, were not significantly higher than those of the nonobese.

Stallard (2010) used the 2004 NLTCS to further characterize the impact of obesity on LTC disability for those age 65 and older in the United States, using the Health Insurance Portability and Accountability Act of 1996 (HIPAA) ADL and cognitive impairment (CI) triggers (Internal Revenue Service 1997), and found the greatest risks were for people who were obese at age 50, with substantially lower risks for current obesity and obesity one-year prior to the current assessment. Relative to those with normal weight at age 50 (BMI between 18.5 and 25), the risk of death was significantly higher for the class II–III obese (BMI of 35 and above) but not the class I obese (BMI between 30 and 35). Relative to those with normal weight at the time of the NLTCS interview, the relative risk of death was lower for both classes of obesity, consistent with Kulminski et al. (2007).

Stallard (2009) used cross-sectional life table methods to estimate the impact of diabetes on expected future lifetime years of LTC disability for those reaching age 65 in the United States in 2004, using the NLTCS with the HIPAA ADL and CI triggers. Total disabled life expectancy at age 65 was 1.45 years for males and 2.53 years for females with 0.51 and 0.79 years, respectively, for the joint status of diabetes and disability. The latter values dropped to 0.26 and 0.43 years, respectively, under a simulated intervention with the diabetic component of disabled life expectancy recomputed using nondiabetic disability rates. Thus, 46 to 49 percent of the lifetime years of disability for diabetics was associated with the diabetes; conversely, the fraction disabled was 84 to 96 percent higher for diabetics.

What was missing from the above analyses were quantitative assessments of the separate and joint effects of obesity and diabetes using common definitions of disability applied to a common dataset. This paper attempts to fill that gap by presenting new estimates of the effects of obesity and diabetes on LTC disability and mortality, based on data from the 2004 NLTCS, with the criteria for LTC disability based on the HIPAA ADL and CI triggers. Such estimates could be used to improve current projections of disability and mortality risks, to develop more accurate assessments of the benefits of intervention programs designed to slow down or reverse the increasing rates of obesity and diabetes, and to improve the accuracy of actuarial models used for LTC insurance pricing and reserving. Moreover, the reweighting methods used to generate these estimates from the NLTCS have applicability beyond the current analysis; they may be used to expand the range of applications of the NLTCS detailed interviews to include estimates for all elderly people, not just those who meet the disability screening criteria.

## Methods

The NLTCS was a six-round panel survey that covered both the community and institutionalized elderly population using nationally representative sampling of the Medicare enrollment files from 1982 to 2004 (with Medicare covering 97 percent of people 65 and older; see Manton, Gu and Lamb 2006). Cross-sectional analysis of the NLTCS was enabled through supplemental sampling of newly eligible Medicare enrollees turning age 65 between survey rounds.

The analysis in this paper used the 2004 round of the NLTCS, which, like the prior rounds, was conducted in two stages: (1) a screening stage beginning on Nov. 1, 2004, using a short telephone screening instrument focusing on ADL and IADL disabilities and institutionalization in a nursing home or similar LTC facility, and (2) a detailed in-person interview stage conducted as soon as feasible thereafter, using an assessment instrument with two forms, one for community residents and the second for institutionalized people. All survey operations were completed by April 8, 2005. The overall achieved sample size of 15,993 completed interviews represented a very credible 91 percent response rate (Manton, Gu and Lamb 2006).

Among the sample of 15,993 people, 9,822 screened out, 5,201 were interviewed using the detailed community instrument, and 970 were interviewed using the detailed institutional instrument. All tabulations of these data employed the NLTCS survey sample weights recommended by the survey investigators (Manton, Gu and Lamb 2006), or used these weights as inputs to the reweighting procedures specifically designed for the current analysis (see below).

### Demographic Variables

Sex, race, date of birth and date of death (when applicable) were obtained from the Medicare vital statistics files linked to the NLTCS; the first three were verified during the interviews. Age was computed as the age on the last birthday on or prior to the date of completion of the 2004 NLTCS detailed interview, or in the case of screen-outs, the date of completion of the screener interview (the “interview date”). Mortality status was based on death reports (as of Sept. 30, 2006) in the linked Medicare vital statistics data for deaths occurring on or prior to the one-year anniversary of the interview date.

### HIPAA Disability Trigger

The HIPAA classification rules have two component disability triggers, one based on ADLs and the second on CI. At least one of the component triggers must be satisfied to qualify as being disabled under HIPAA.

The HIPAA ADL trigger uses six ADLs (bathing, continence, dressing, eating, toileting and transferring); to satisfy the trigger, one must need standby or active personal assistance for at least two of the six ADLs (Stallard and Yee 2000; Stallard 2008).

The disability classification based on the HIPAA ADL trigger is more stringent than the standard disability classifications reported from the NLTCS, which typically consider limitations on nine IADLs (housework, laundry, cooking, grocery shopping, outside mobility, travel, money management, taking medications and telephoning) and equipment-based limitations on six ADLs (substituting indoor mobility for continence; Manton, Gu and Lamb 2006). Use of the higher threshold in the HIPAA ADL trigger in the current analysis helped to reduce the rate of "false negatives" resulting from the screening procedures used in the NLTCS to select respondents for the detailed interview (Wolf, Hunt and Knickman 2005).

The HIPAA CI trigger was designed to target people who require substantial supervision due to severe cognitive impairment. The trigger has two parts, which were implemented in the current analysis as follows. First, the identification of respondents with severe cognitive impairment was based on the Short Portable Mental Status Questionnaire (SPMSQ, part of the detailed interview) with severe cognitive impairment defined as three or more errors on the 10 questions, or affirmation that the respondent had dementia, Alzheimer's disease or other cognition problems sufficient to prevent completion of the SPMSQ with a passing score of two or fewer errors. The cutoff at three errors was consistent with, but at the low end of, the range of three to five errors used in actuarial practice for LTC insurance models (Stallard and Yee 2000).

Second, because the need for substantial supervision was not directly assessed in the NLTCS, the substantial supervision requirement was implemented indirectly by restricting the trigger to respondents who met (1) the NLTCS criteria for any ADL or IADL disability at the screener interview (which then qualified them for the detailed interview, including the SPMSQ), (2) the NLTCS criteria for IADL disability or indoor mobility impairment at the detailed interview, or (3) the HIPAA criteria for at least one ADL disability at the detailed interview.

This implementation effectively assumed that respondents who did not need help with any of nine IADLs or seven ADLs (the six HIPAA activities and indoor mobility) would not meet the requirement for substantial supervision. These restrictions were consistent with reports that most Alzheimer's disease patients (87 percent) at relatively mild stages of dementia needed reminders or advice concerning IADL activities (i.e., chores, cooking, shopping or handling money; Stern et al. 1994, Table 4), with the declines in IADL functioning for such patients typically occurring over a 12-year period as the disease progresses, and with declines in ADL functioning beginning about two years later (Stern et al. 1996).

Without the implementation of the requirement for substantial supervision, the estimated number of people who met only the HIPAA CI trigger would have been 25.5 percent larger. This implementation did not affect the estimated number of people who met the HIPAA ADL trigger, nor the number who met both triggers simultaneously. Among those who met only the HIPAA CI trigger, 34.1 percent had exactly three errors on the SPMSQ—indicating the estimates for this subpopulation were highly sensitive to the selected cutoff at three errors. However, the three-error group represented only 6.5 percent of the entire HIPAA disabled population, reducing the overall sensitivity substantially.

## Diabetes

The presence of diabetes was established using (1) self-reported medical conditions and (2) health care-provider reported medical diagnoses from Medicare files linked to the NLTCS.

The self-reported conditions were based on affirmative answers to the question: Do you now have diabetes? This question was asked on both the community and the institutional forms of the detailed NTLCS interviewing instruments. This question was not asked on the NLTCS screening instrument, which means that people who screened out of the initial NLTCS disability assessment had unknown status with respect to the presence of self-reported diabetes, except for a subgroup of 17 percent of such people, as discussed below.

The presence of diabetes was separately assessed using billing/diagnosis records in the Standard Analytical Files generated under Parts A and B of the Medicare program, which were linked to the NLTCS. All respondents with ICD-9-CM code 250 appearing at least two times in the 36 months preceding the 2004 NLTCS were classified as diabetic. These reports were complete for respondents enrolled in Medicare's fee-for-service (FFS) program, but not for respondents enrolled in Medicare's prepaid capitated health maintenance organization (HMO) plans. These reports were available for most people who screened out of the initial NLTCS disability assessment, providing a potentially valuable alternative to the missing self-reports noted above.

The 36-month time period was consistent with Taylor, Fillenbaum and Ezell's (2002) analysis of Alzheimer's disease registry data, which concluded that at least 36 months of data were needed to identify Alzheimer's disease using Medicare data. The use of two or more mentions of diabetes as a classification rule for the disease in the Medicare files was consistent with Kinosian et al. (2000), who used it to protect against random coding errors and other reporting anomalies that can occur with a single mention of diabetes using the one-or-more mentions criterion.

## Obesity

The presence of obesity was established using self-reported height and weight in the NLTCS detailed community interview to construct measures of BMI at three time points: currently, at age 50 and one year prior to the NLTCS interview. Standard BMI cut-points were used to define obesity (BMI of 30 or more) and nonobesity (BMI of less than 30) for use in comparisons with self-reported and health care-provider reported obesity. These questions were not asked on the NLTCS screening instrument nor on the institutional form of the detailed NTLCS interviewing instrument.

The self-reported conditions were based on affirmative answers to the question: Do you now have obesity or are you overweight? The obesity/overweight question was asked on both the community and the institutional forms of the detailed NTLCS interviewing instruments, but not on the NLTCS screening instrument.

The presence of obesity was separately assessed using the linked Medicare files. All respondents with ICD-9-CM codes 259.9 or 278.0 appearing at least two times (in any combination) in the 36 months preceding the 2004 NLTCS were classified as obese.

**A/E Ratios**

Comparisons of diabetic and nondiabetic subpopulations were based on ratios of actual to expected counts (A/E ratios) with the expected disability or mortality counts among diabetics generated by application of the age-specific nondiabetic rates to the age-specific diabetic population counts. Similar procedures were employed for comparisons of obese and nonobese subpopulations and for the statuses based on combinations of obesity and diabetes.

**Sample Weighting and Reweighting**

Survey sample weights were employed as described in Manton, Gu and Lamb (2006); standard errors of weighted estimators of binomial proportions were computed using the procedure for weighted survey data described in Potthoff, Woodbury and Manton (1992). This procedure yielded an estimated overall design effect of 1.187, which implied the variances were up to 18.7 percent larger, and the effective sample size as much as 18.7 percent smaller, than under a simple random sampling design with the same sample size, but with equal weights (Kish 1965, 259). Standard errors of A/E ratios of binomial proportions were based on the standard Taylor series approximation for quotients of random variables (Mood, Graybill and Boes 1974, 181).

Reweighting of the survey sample weights was required because the measures of BMI in the NLTCS were restricted to respondents to the detailed community interview, and because the self-reported measures of obesity/overweight and diabetes were restricted to respondents to the detailed community or institutional interviews. Thus, these variables were not available for the 9,822 people who received only the screening interview. This was a large amount of missing data that could neither be ignored nor assumed away.

Complementing the 9,822 people who received only the screening interview was another group of 2,056 people who screened out for ADL and IADL disabilities and institutionalization in 2004 but were given the detailed community interview anyway because (1) they met the corresponding screen-in criteria at an earlier round of the survey, or (2) they were part of a special group of "healthy" respondents. For ease of reference, the group of 9,822 people is designated as the "screener-only" sample, the group of 2,056 people as the "detailed screen-out" sample, and the combined group of 11,878 people as the "total screen-out" sample. The detailed screen-out sample constituted 17.3 percent of the unweighted total screen-out sample and 16.9 percent of the weighted total screen-out sample.

The fact that the detailed screen-out sample actually screened out in 2004 meant that the weights for these respondents could be modified to represent the total screen-out population. Thus the missing data problem for the screener-only sample could be resolved through reweighting the sample weights for the detailed screen-out sample and using the modified weights to tabulate the detailed interview data for these respondents.

The reweighting was done as follows:

- The total and detailed screen-out samples were separately tabulated by sex, age (five-year groups up to 95 and older), HIPAA disability status (disabled or nondisabled) and one-year survival status (alive or dead).
- For each combination of the four tabulated variables, ratios of (1) weighted counts for the total screen-out sample to (2) weighted counts for the detailed screen-out sample, were computed. The ratios for combinations involving HIPAA-disabled people were equal to 1.0, by construction. These combinations included 44 (of 2,056) detailed screen-out respondents who met the HIPAA disability trigger at the time of the detailed interview (but not at the time of the screener interview).
- The ratios were applied as combination-specific multiplicative scale factors to the original sample weights for each person in the detailed screen-out sample to form the modified weights.
- Tabulations of the reweighted counts for the detailed screen-out sample based on the modified weights were compared with the original tabulations of weighed counts for the total screen-out sample to verify they were identical.

Stratification by sex, age, HIPAA disability status and one-year survival status ensured that the reweighting procedure preserved the original weighted estimates of the sex- and age-specific disability and mortality rates; it affected only their standard errors.

The detailed community sample consisted of 5,201 respondents; application of Potthoff, Woodbury and Manton's (1992) procedure indicated that the effective sample size of the detailed community sample was 3,931 respondents prior to reweighting and 2,393 respondents after reweighting. The reweighting raised the detailed community overall sample design effect from 1.323 to 2.173. Stratification of the procedure by age increased the effective sample sizes to 4,448 and 2,739, respectively, with the corresponding design effects reduced to 1.169 and 1.899. Stratification jointly by age and sex produced almost identical effective sample sizes (4,449 and 2,757) and design effects (1.169 and 1.886).

Although there was a substantial cost for reweighting the detailed screen-out sample, expressible as relative increases of 61.3 to 61.6 percent in the stratified sample design effects, the resulting effective sample sizes of 2,739–57 were still sufficient to support credible analyses.

## Results

### HIPAA Disability and Mortality

Table 1 displays the number and percent of people meeting the HIPAA disability trigger by age in the United States in 2004, based on the full sample of 15,993 respondents (effective N=14,358). The overall prevalence of disability was 10.1 percent with a standard error of 0.24 percent based on the original weighting; the standard error increased to 0.52 percent based on the reweighting of the detailed screen-out sample. There was a strong increase in the disability prevalence rates over age.

Table 2 displays the survival status one year after the HIPAA disability assessment, according to the outcome of that assessment, by age in the United States in 2004, based on the full sample of 15,993 respondents. The overall death rate was 5.0 percent with a standard error of 0.17 percent based on the original weighting and 0.38 percent based on the reweighting of the detailed screen-out sample. Also contained in the table are the A/E ratios for the disabled population, based on the assumption that the nondisabled death rates would apply in the absence of disability. The overall A/E ratio was 4.49 with a standard error of 0.32 (original weighting). There was a strong decrease in the A/E ratios over age. Nonetheless, even at the oldest age group (95 and older), the nondisabled death rate (14.7 percent) had not reached the level of the disabled death rate (15.0 percent) at the youngest age group (65 to 69). The bottom panel of Table 2 shows that the difference between the actual and expected number of deaths in the disabled population was 665,208, representing 36.7 percent of all deaths—the fraction of deaths attributable to disability or to health status differences associated with disability.

### Quality Assessment: Diabetes and Obesity

Table 3 presents selected comparisons of the various measures of diabetes and obesity available from the NLTCS. Two types of comparisons were employed, one based on the kappa statistic (Fleiss 1981, 217–20) for inter-rater agreement and the second on the conditional probability that the disease was reported in the Medicare files, given that it was reported in the NLTCS. All of the statistics were based on the reweighted data with the standard errors adjusted to reflect the effective sample size.

The kappa values for diabetes increased as the threshold for the number of mentions in Medicare increased; all three values were at the upper end of the range for fair to good agreement. The probabilities of Medicare confirmation decreased as the mentions threshold increased, but all three values were close to or above 90 percent indicating that the self-reported diagnoses were substantially confirmed in the Medicare files. The large jump in kappa between one or more and two or more mentions combined with only a small reduction in the probability of Medicare confirmation was consistent with Kinosian et al.'s (2000) use of two or more mentions to protect against random coding errors and other reporting anomalies. The Medicare confirmation probabilities for veterans in Table 3 were lower than for nonveterans, most likely because some veterans received care for diabetes directly from the Veterans Health Administration outside of the Medicare program. Elimination of veterans increased the Medicare confirmation probabilities to 93 to 94 percent, substantially confirming the self-reported diabetes.

The kappa values for obesity/overweight and current obesity (BMI of 30 or more) decreased as the threshold for the number of mentions in Medicare increased; all four values indicated poor agreement, although the agreement was still significantly greater than chance. The probabilities of Medicare confirmation were similarly poor. The kappa value for current obesity nearly doubled, increasing from 20.7 to 41.1 percent, indicating fair agreement, when overweight (BMI of 25 to 30) and class I obese (BMI of 30 to 35) respondents were removed from the calculation. This indicates that class I obesity was generally not reported in the Medicare files, and that class II–III obesity (BMI of 35 or more) was reported at a level substantially below that for diabetes, most likely because reported medical conditions must be actively treated by the health care providers at the time of service. Diabetes requires ongoing medical monitoring and treatment; obesity does not. This might also explain why the kappa values for obesity decreased as the mentions threshold increased. The first mention of obesity, unlike diabetes, did not indicate an initiation of continuing monitoring/treatment.

The bottom panel of Table 3 compares current obesity with obesity/overweight. The kappa value of 52.0 percent indicates fair agreement between the measures; the confirmation probability of 62.3 percent indicates that five of eight people classified as obese using the BMI criteria confirmed that by responding affirmatively to the obesity/overweight question. The kappa value increased to 82.9 percent (excellent agreement) and the confirmation probability increased to 78.8 percent when overweight and class I obese respondents were removed from the calculation. Still, two of nine people with class II–III obesity using the BMI criteria responded negatively to the obesity/overweight question.

**Impact of Health Care-Provider Reported Diabetes on Disability and Mortality**

Table 4 presents the conditional distribution of HIPAA disability by age in the United States in 2004, for people with and without diabetes, based on the Medicare FFS subsample of 13,274 respondents (effective N=11,903). The overall A/E ratio of 1.86 indicates that diabetics were 86 percent more likely than nondiabetics to meet the HIPAA disability trigger. The A/E ratios declined with age. The difference between the actual and expected number of disabled people in the diabetic population was 508,031, representing 16.4 percent of all disability—the fraction of disability attributable to diabetes or to health status differences associated with diabetes.

The overall A/E ratio of 1.86 in Table 4 was consistent with the A/E ratio of 1.90 derived from Wilkin, Hileman and Genuardi (2005, 52) for 271 LTC insurance claims for diabetics age 65 and older after removing the excess risk for diabetics from the expected number in Wilkin's unadjusted A/E ratio of 1.80. The classification of a policyholder as diabetic was made at the time the policy was issued (using ICD9-CM codes 250.0, 250.4 and 250.6; the primary components of code 250 in the current analysis), but the presence of diabetes was not used to reject the application for LTC insurance in this study population. Wilkin, Hileman and Genuardi's (2005, 52) policy-duration table indicated that the underwriting selection effect lasted less than one year, confirming this observation and supporting the comparison of their results with those in Table 4.

Though encouraging, the results were not fully comparable because some fraction of the nondiabetics in Wilkin's database would have developed diabetes between the time the policy was underwritten and the claim filed; such people would be classified as nondiabetic in Wilkin's database but as diabetic in Table 4, possibly lowering the A/E ratio in Wilkin's data to a level below that in Table 4. In addition, the implementation of the HIPAA triggers in the NLTCS is an approximation to the actual benefit eligibility procedures of LTC insurers such as reflected in Wilkin's database. The size and direction of the differences are unknown and they may differ for different LTC insurers.

Table 5 displays the corresponding conditional distribution of survival status one year after the HIPAA disability assessment by age in the United States in 2004, for people with and without diabetes. The overall A/E ratio of 1.64 indicates that diabetics were 64 percent more likely to die than nondiabetics. These A/E ratios also declined with age. The difference between the actual and expected number of deaths in the diabetic population was 193,570, representing 12.7 percent of all deaths.

The overall A/E ratio of 1.64 in Table 5 was consistent with the A/E ratio of 1.60 derived from Wilkin, Hileman and Genuardi (2005, 54) for 327 deaths among diabetics 65 and older after removing the excess risk for diabetics from the expected number in Wilkin's unadjusted A/E ratio of 1.54. Moreover, Wilkin, Hileman and Genuardi's (2005, 54) policy-duration table indicated that there was no underwriting selection effect for mortality. As noted above, the A/E ratios were not fully comparable because of the differences in the treatment of new cases of diabetes in the period between underwriting and claim filing. The finding that the A/E ratios in tables 4 and 5 were very close to Wilkin's ratios indicates that the differences in the classifications of diabetics and implementations of the HIPAA triggers either were very small or, if large, were offsetting.

**Impact of Self-Reported Obesity and Diabetes on Disability and Mortality**

Tables 4 and 5 provided templates for generating actual and expected disability and mortality outcomes for people with specified medical conditions. Table 6 displays selected outcomes using these templates for analyses of the impact of self-reported obesity/overweight and diabetes in the NLTCS.

The A/E ratios for diabetes were 1.98 (disability) and 1.78 (death), 0.12 and 0.14 higher, respectively, than the corresponding ratios in tables 4 and 5, but the differences were not statistically significant. Complementing these modest changes, the percentages of disability and deaths attributable to diabetes were smaller (also not statistically significant) than in tables 4 and 5. These shifts were consistent with tabulations that indicated the number of diabetics identified by self-reporting was smaller than the number identified by health care-provider reporting, e.g., for the comparisons in Table 3 using two or more mentions: 4.85 million vs. 6.93 million.

The A/E ratios for obesity/overweight were 2.19, 1.12 and 0.62, respectively, for diabetes, disability and death, indicating that obesity/overweight had a strong unfavorable impact on diabetes, a small (nonsignificant) impact on disability and a favorable impact on mortality. This latter outcome has been termed the "obesity paradox"; the explanation is not that obesity is healthy but instead is that low weight and weight loss among the elderly often results from major chronic disease processes involving the heart, lungs, kidneys and other vital organ systems (Ades and Savage 2010).

The finding that the impact of obesity/overweight on disability was small or neutral was consistent with the explanation of the obesity paradox for mortality, and also with the strong unfavorable impact on diabetes, which provides a pathway for obesity to unfavorably impact disability, counterbalancing the disabling effects of chronic disease processes associated with low weight and weight loss.

Table 7 provides several comparisons based on the various alternative measures of obesity that can be constructed for the noninstitutionalized population from the NLTCS detailed community interview using BMI at age 50, BMI one year prior to the interview, and BMI at the time of the interview ("current obesity"). The A/E ratios for current obesity in the noninstitutionalized population were similar to those for obesity/overweight, which were almost identical to the corresponding values for the total population (in Table 6). Likewise, the A/E ratios for current obesity in the noninstitutionalized population were similar to those for obesity one year prior to the interview.

The A/E ratios for obesity at age 50 in the noninstitutionalized population were 2.64, 2.32 and 1.16, respectively, for diabetes, disability and death, indicating that midlife obesity had a strong unfavorable impact on diabetes and disability and a small (nonsignificant) impact on mortality. Thus, with the introduction of a measure of midlife obesity, the obesity paradox disappeared as did the prior indication that the impact on disability may be small or neutral.

These results are consistent with the finding that the total number of years lived beyond age 70 was not reduced by obesity at age 70 but the fraction spent disabled was 52 to 55 percent higher for the obese (Reynolds, Saito and Crimmins 2005). Indeed, the A/E ratio of 2.32 for the impact of obesity at age 50 on disability was stronger than the A/E ratios of 1.52 to 1.55 implied by Reynolds' results for the impact of obesity at age 70.

**Missing Data**

The maximum effective Ns (2,739) in Table 7 were obtained for obesity/overweight and diabetes, both of which had complete assessments. The effective N for current obesity was 4.8 percent smaller; for one year prior, 6.6 percent smaller; and at age 50, 12.4 percent smaller—indicating that 1.9 percent of respondents who provided their current weight were unable to answer the question regarding their weight one year prior and 10.3 percent were unable to answer the question regarding their weight at age 50.

The A/E ratios comparing respondents who were missing the obesity information at age 50 with those who provided such information were 0.98 (±0.15), 2.16 (±0.35) and 1.34 (±0.36), respectively, for diabetes, disability and death, indicating that the missing-obesity respondents had similar rates of diabetes but substantially higher rates of disability and nonsignificantly higher rates of mortality. The diabetes comparison suggests that the obesity distributions were similar but the disability comparison indicates that there were other, likely nonlethal, factors that distinguished the two groups, consistent with the statistically nonsignificant increase in mortality.

**Potential Interactions Between Obesity and Diabetes Affecting Disability**

The A/E ratios comparing the obese to nonobese at age 50 were 2.64 for diabetes and 2.32 for disability (Table 7); the corresponding diabetes A/E ratio for disability was 2.17. Thus, midlife obesity increased the risk of diabetes and disability and diabetes also increased risk of disability. The joint impact of obesity at age 50 and diabetes on disability was assessed in Table 8 using A/E ratios comparing respondents exhibiting each combination of obesity at age 50 and diabetes with those who had neither condition. The A/E ratios were 1.95 (±0.47) for diabetes without obesity at age 50, 2.14 (±0.53) for obesity at age 50 without diabetes, and 3.68 (±1.11) for both conditions. The 3.68 A/E ratio for both conditions would be consistent with either an additive or multiplicative interaction model, implying A/E ratios of 3.09 and 4.17, respectively; the 3.68 value was close to midway (3.63) between these alternatives but the standard errors were too large to make definite conclusions about the form of the interaction.

## Discussion

The purpose of this paper was to estimate the impact of obesity and diabetes on disability and mortality in those older than 65 using the 2004 NLTCS, with disability defined using the HIPAA ADL and CI triggers. The NLTCS is recognized as the best single source of data on disability covering both the institutionalized and noninstitutionalized populations (Freedman et al. 2002). Nonetheless, the use of the NLTCS for the purpose of this paper required careful consideration of the details of disease and disability reporting and the development of new algorithms for dealing with the coding and completeness of the information provided.

Identification of disabled people in the 2004 NLTCS meeting the HIPAA ADL and CI triggers was based on the responses to the ADL and CI questions in the detailed interview, following the classification procedures introduced by Stallard and Yee (2000). One feature new to the 2004 round of the NLTCS was the full re-screening of all respondents automatically scheduled to receive the detailed interview. This change addressed concerns that had emerged over prior rounds due to the accumulation of people in the "healthy supplement" who had never screened into the detailed interview and the need for assessing the current screener status of the automatic detailed interviewees. The 2004 screener facilitated an indirect implementation of the "substantial supervision" component of the HIPAA CI trigger based on the assumption that a cognitively impaired person who did not meet the screening criteria for IADL and ADL help was not currently in need of supervision.

Identification of diabetics in the 2004 NLTCS was based on self-reports of diabetes among respondents to the community and institutional detailed interviews, but not among respondents who screened out of the detailed interviews. Identification of diabetics in the linked Medicare files was based on diagnoses of diabetes in the various billing records, information that was not complete for respondents who had enrolled in HMOs. Comparisons of the self-reports of diabetes in the detailed interviews with the health care-provider reports for respondents enrolled only in Medicare's FFS program provided confidence that, with the limitations noted, either type of report could be used to classify respondents as diabetic or nondiabetic (Table 3).

Identification of obesity in the 2004 NLTCS was based on self-reports of obesity/overweight among respondents to the community and institutional detailed interviews, but not among respondents who screened out of the detailed interviews, and self-reports of BMI measures at three time points among respondents to the community detailed interview, but not among respondents who screened out of the detailed interviews or who received the institutional detailed interview. Identification of obesity in the linked Medicare files was based on diagnoses of obesity in the various billing records for FFS enrollees. Unfortunately, the levels of agreement between both types of self-reported obesity and health care-provider reported obesity were very poor, providing little confidence that the Medicare reports could be used to classify respondents as obese or nonobese (Table 3). Even here, the two types of self-reported obesity had only fair agreement—three of eight people classified as obese using the BMI measure failed to classify themselves as overweight or obese when directly asked if they were overweight or obese.

The inability to use the Medicare reports to identify obesity greatly constrained the options for analysis, which led to the decision to rely on the self-reported obesity measures available from the detailed interviews, along with the corresponding diabetes measure. This decision required reweighting the sample weights for respondents to the detailed interview who had screened out at the time of the screener interview, in order to generate estimates for the total population as well as for the noninstitutionalized component. The statistical cost of this reweighting was a substantial increase in the standard errors of the estimated parameters.

The effects of obesity and diabetes on LTC disability and mortality were characterized in several ways. Current obesity was associated with large increases in diabetes, nonsignificant increases in disability and substantial decreases in mortality among the elderly—with the latter exemplifying the obesity paradox for mortality. Obesity at age 50 was associated with large increases in diabetes and disability and nonsignificant increases in mortality among the elderly, resolving the obesity paradox for mortality but implying even stronger effects of obesity on disability than reported by Reynolds, Saito and Crimmins (2005) for their analysis of obesity at age 70. Diabetes was associated with large increases in disability and mortality among the elderly.

Obesity at age 50 and diabetes were both associated with large increases in disability among the elderly. Tests of the interaction between these risk factors did not rule out either additive or multiplicative models. The large standard error associated with the interaction effect resulted from the combined effects of (1) the use of the reweighting procedure, (2) the use of effective sample sizes for weighted survey data instead of the much larger actual sample sizes (Potthoff, Woodbury and Manton 1992), and (3) the relatively small number of people who were obese at age 50 and had survived sufficiently long to have had diabetes at the time of the NLTCS interview.

The effects of obesity and diabetes were consistent with a complex multistage/multipath disablement process such as described by Verbrugge and Jette (1994), involving separate and joint effects of obesity and diabetes as initial or intermediate stages in a multistage process leading to disability and death.

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**Table 1. Number and Percent of Persons Meeting the HIPAA Disability Trigger, United States 2004, Unisex, Age 65 and Above, by Age**

| | HIPAA Disability Status[1] | | | | s.e.(Percent Disabled) | |
|---|---|---|---|---|---|---|
| Age | Nondisabled | Disabled | Total | Percent Disabled | Original Weights | Reweighted |
| 65-69 | 8,249,343 | 239,296 | 8,488,639 | 2.82% | 0.26% | 0.64% |
| 70-74 | 8,353,574 | 383,573 | 8,737,147 | 4.39% | 0.40% | 0.91% |
| 75-79 | 7,023,298 | 600,636 | 7,623,934 | 7.88% | 0.55% | 1.32% |
| 80-84 | 5,230,199 | 798,648 | 6,028,847 | 13.25% | 0.69% | 1.58% |
| 85-89 | 2,602,925 | 849,078 | 3,452,003 | 24.60% | 1.01% | 1.85% |
| 90-94 | 951,734 | 530,500 | 1,482,233 | 35.79% | 2.01% | 3.44% |
| 95+ | 178,647 | 253,875 | 432,523 | 58.70% | 2.01% | 2.75% |
| Total | 32,589,719 | 3,655,606 | 36,245,325 | 10.09% | 0.24% | 0.52% |

Note 1: The HIPAA disability trigger requires 2+ ADL disabilities or severe cognitive impairment requiring substantial supervision.

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

**Table 2. Survival Status One Year After Being Assessed for the HIPAA Disability Trigger, and Ratio of Actual to Expected Number of Deaths Assuming that the Nondisabled Death Rates Would Apply in the Absence of Disability, United States 2004, Unisex, Age 65 and Above, by Age**

| | | Status 1 Year After Assessment | | | | s.e.(Percent Dead) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Meets HIPAA Disability Trigger[1] | Age | Alive | Dead | Total | Percent Dead | Original Weights | Reweighted | Expected | A/E Ratio | s.e.(A/E) |
| No | 65-69 | 8,122,821 | 126,522 | 8,249,343 | 1.53% | 0.20% | 0.48% | | | |
| | 70-74 | 8,182,373 | 171,201 | 8,353,574 | 2.05% | 0.28% | 0.64% | | | |
| | 75-79 | 6,820,477 | 202,821 | 7,023,298 | 2.89% | 0.35% | 0.85% | | | |
| | 80-84 | 5,046,042 | 184,157 | 5,230,199 | 3.52% | 0.40% | 0.92% | | | |
| | 85-89 | 2,425,234 | 177,691 | 2,602,925 | 6.83% | 0.68% | 1.24% | | | |
| | 90-94 | 883,445 | 68,289 | 951,734 | 7.18% | 1.35% | 2.31% | | | |
| | 95+ | 152,379 | 26,268 | 178,647 | 14.70% | 2.25% | 3.08% | | | |
| | Total | 31,632,770 | 956,949 | 32,589,719 | 2.94% | 0.15% | 0.34% | | | |
| Yes | 65-69 | 203,427 | 35,869 | 239,296 | 14.99% | 3.39% | 8.19% | 3,670 | 9.77 | 2.54 |
| | 70-74 | 314,968 | 68,605 | 383,573 | 17.89% | 3.59% | 8.11% | 7,861 | 8.73 | 2.13 |
| | 75-79 | 496,634 | 104,002 | 600,636 | 17.32% | 2.73% | 6.61% | 17,345 | 6.00 | 1.20 |
| | 80-84 | 604,920 | 193,728 | 798,648 | 24.26% | 2.41% | 5.48% | 28,121 | 6.89 | 1.05 |
| | 85-89 | 644,989 | 204,089 | 849,078 | 24.04% | 2.01% | 3.69% | 57,963 | 3.52 | 0.46 |
| | 90-94 | 379,489 | 151,011 | 530,500 | 28.47% | 3.17% | 5.41% | 38,064 | 3.97 | 0.87 |
| | 95+ | 155,616 | 98,259 | 253,875 | 38.70% | 2.59% | 3.56% | 37,330 | 2.63 | 0.44 |
| | Total | 2,800,044 | 855,563 | 3,655,606 | 23.40% | 1.06% | 2.24% | 190,354 | 4.49 | 0.32 |
| Total | | 34,432,814 | 1,812,511 | 36,245,325 | 5.00% | 0.17% | 0.38% | | | |
| Actual − Expected | | | 665,208 | | | | | | | |
| Percent of Deaths | | | 36.70% | | | | | | | |
| Std Error (Pct of Deaths) | | | 2.02% | | | | | | | |

Note 1: The HIPAA disability trigger requires 2+ ADL disabilities or severe cognitive impairment requiring substantial supervision.

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

**Table 3. Selected Comparisons of Healthcare-Provider Reported Diabetes and Obesity in Medicare FFS with Self-Reported Diabetes and Obesity in the NLTCS; Reweighted to U.S. 2004 Unisex Population, Age 65 and Above**

| Healthcare-Provider Reported Disease in Medicare | Self-Reported Disease in the NLTCS: Kappa[1] | s.e.(Kappa) | Prob(Medicare Confirmation)[2] | s.e.(Prob[Med. Conf.]) | Effective N |
|---|---|---|---|---|---|
| | Diabetes | | | | |
| 1+ Mentions | 58.92% | 1.85% | 91.85% | 1.46% | 2,599 |
| 2+ Mentions | 68.56% | 1.91% | 90.68% | 1.54% | 2,599 |
| 3+ Mentions | 72.88% | 1.94% | 89.31% | 1.62% | 2,599 |
| | Obesity/Overweight | | | | |
| 1+ Mentions | 11.64% | 1.60% | 13.38% | 1.67% | 2,599 |
| 2+ Mentions | 8.26% | 1.26% | 7.81% | 1.32% | 2,599 |
| | Current Obesity (BMI ≥ 30) | | | | |
| 1+ Mentions | 20.65% | 1.71% | 17.98% | 1.98% | 2,147 |
| 2+ Mentions | 13.87% | 1.34% | 10.55% | 1.58% | 2,147 |

| Self-Reported Disease in the NLTCS | Current Obesity (BMI ≥ 30) | | | | |
|---|---|---|---|---|---|
| Obesity/Overweight | 52.01% | 1.96% | 62.33% | 2.26% | 2,607 |

Note 1: Kappa is a measure of inter-rater agreement for categorical classifications made by two independent raters or rating systems, which is adjusted for chance agreement. The range is 0-100% with 0% indicating chance agreement and 100% indicating complete agreement; values in the range 40-75% are considered "fair to good agreement," with values below 40% considered "poor agreement."

Note 2: Prob(Medicare Confirmation) is the probability that the Medicare files reported the condition at the indicated frequency for those who had self-reported the condition in the NLTCS. The last entry in table refers to the probability that the BMI obesity measure was confirmed with self-reported obesity/overweight.

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

**Table 4. Number and Percent of Persons Meeting the HIPAA Disability Trigger, by Medicare Diabetes Status, and Ratio of Actual to Expected Number of Disabled Persons Assuming that the Non-Diabetic Disability Rates Would Apply in the Absence of Diabetes, United States 2004, Unisex, Age 65 and Above, by Age**

| Medicare Diabetes Status[2] | Age | HIPAA Disability Status[1] Nondisabled | Disabled | Total | Percent Disabled | s.e.(Percent Disabled) | Expected | A/E Ratio | s.e.(A/E) |
|---|---|---|---|---|---|---|---|---|---|
| Non-Diabetic | 65-69 | 5,642,679 | 109,723 | 5,752,402 | 1.91% | 0.26% | | | |
| | 70-74 | 5,010,220 | 169,598 | 5,179,819 | 3.27% | 0.45% | | | |
| | 75-79 | 4,316,505 | 290,258 | 4,606,763 | 6.30% | 0.63% | | | |
| | 80-84 | 3,227,309 | 393,718 | 3,621,027 | 10.87% | 0.82% | | | |
| | 85-89 | 1,650,050 | 533,038 | 2,183,087 | 24.42% | 1.25% | | | |
| | 90-94 | 678,525 | 336,516 | 1,015,041 | 33.15% | 2.39% | | | |
| | 95+ | 130,513 | 173,723 | 304,236 | 57.10% | 2.36% | | | |
| | Total | 20,655,801 | 2,006,574 | 22,662,375 | 8.85% | 0.28% | | | |
| Diabetic | 65-69 | 1,341,712 | 111,408 | 1,453,121 | 7.67% | 1.02% | 27,717 | 4.02 | 0.77 |
| | 70-74 | 1,612,220 | 153,988 | 1,766,208 | 8.72% | 1.22% | 57,829 | 2.66 | 0.52 |
| | 75-79 | 1,370,936 | 225,586 | 1,596,522 | 14.13% | 1.54% | 100,592 | 2.24 | 0.33 |
| | 80-84 | 1,035,773 | 258,663 | 1,294,436 | 19.98% | 1.76% | 140,745 | 1.84 | 0.21 |
| | 85-89 | 430,736 | 191,445 | 622,181 | 30.77% | 2.53% | 151,916 | 1.26 | 0.12 |
| | 90-94 | 108,376 | 109,697 | 218,073 | 50.30% | 5.48% | 72,298 | 1.52 | 0.20 |
| | 95+ | 19,281 | 45,111 | 64,393 | 70.06% | 4.75% | 36,769 | 1.23 | 0.10 |
| | Total | 5,919,035 | 1,095,898 | 7,014,933 | 15.62% | 0.67% | 587,866 | 1.86 | 0.11 |
| Total | | 26,574,836 | 3,102,472 | 29,677,307 | 10.45% | 0.26% | | | |
| Actual − Expected | | | 508,031 | | | | | | |
| Percent of Disability | | | 16.38% | | | | | | |
| Std Error (Pct of Disability) | | | 1.59% | | | | | | |

Note 1: The HIPAA disability trigger requires 2+ ADL disabilities or severe cognitive impairment requiring substantial supervision.
Note 2: "Diabetic" is defined as having 2+ mentions of diabetes in the linked Medicare FFS files during the 36 months ending at the month of the NLTCS interview.

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

**Table 5. Survival Status One Year After Being Assessed, by Medicare Diabetes Status, and Ratio of Actual to Expected Number of Deaths Assuming that the Non-Diabetic Death Rates Would Apply in the Absence of Diabetes, United States 2004, Unisex, Age 65 and Above, by Age**

| Medicare Diabetes Status[1] | Age | Status 1 Year After Assessment: Alive | Dead | Total | Percent Dead | s.e(Percent Dead) | Expected | A/E Ratio | s.e.(A/E) |
|---|---|---|---|---|---|---|---|---|---|
| Non-Diabetic | 65-69 | 5,669,837 | 82,566 | 5,752,402 | 1.44% | 0.23% | | | |
| | 70-74 | 5,077,396 | 102,423 | 5,179,819 | 1.98% | 0.35% | | | |
| | 75-79 | 4,466,645 | 140,118 | 4,606,763 | 3.04% | 0.45% | | | |
| | 80-84 | 3,394,490 | 226,537 | 3,621,027 | 6.26% | 0.64% | | | |
| | 85-89 | 1,930,084 | 253,003 | 2,183,087 | 11.59% | 0.94% | | | |
| | 90-94 | 874,005 | 141,036 | 1,015,041 | 13.89% | 1.76% | | | |
| | 95+ | 226,397 | 77,839 | 304,236 | 25.59% | 2.08% | | | |
| | Total | 21,638,854 | 1,023,521 | 22,662,375 | 4.52% | 0.21% | | | |
| Diabetic | 65-69 | 1,390,231 | 62,890 | 1,453,121 | 4.33% | 0.78% | 20,857 | 3.02 | 0.73 |
| | 70-74 | 1,676,408 | 89,800 | 1,766,208 | 5.08% | 0.95% | 34,924 | 2.57 | 0.67 |
| | 75-79 | 1,479,996 | 116,526 | 1,596,522 | 7.30% | 1.15% | 48,559 | 2.40 | 0.52 |
| | 80-84 | 1,206,725 | 87,710 | 1,294,436 | 6.78% | 1.11% | 80,982 | 1.08 | 0.21 |
| | 85-89 | 549,483 | 72,698 | 622,181 | 11.68% | 1.76% | 72,106 | 1.01 | 0.17 |
| | 90-94 | 175,361 | 42,712 | 218,073 | 19.59% | 4.35% | 30,300 | 1.41 | 0.36 |
| | 95+ | 38,955 | 25,438 | 64,393 | 39.50% | 5.07% | 16,475 | 1.54 | 0.23 |
| | Total | 6,517,160 | 497,773 | 7,014,933 | 7.10% | 0.49% | 304,203 | 1.64 | 0.15 |
| Total | | 28,156,013 | 1,521,294 | 29,677,307 | 5.13% | 0.20% | | | |

| | |
|---|---|
| Actual − Expected | 193,570 |
| Percent of Deaths | 12.72% |
| Std Error (Pct of Deaths) | 2.39% |

Note 1: "Diabetic" is defined as having 2+ mentions of diabetes in linked Medicare FFS files during the 36 months ending at the month of the NLTCS interview.

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

**Table 6. Selected Comparisons of Actual and Expected Health Outcomes for Persons with Self-Reported Obesity/Overweight and Diabetes in the NLTCS; Reweighted to U.S. 2004 Unisex Population, Age 65 and Above**

| | Self-Reported Medical Condition | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Outcome | Actual (A) | Expected (E) | A/E Ratio | s.e.(A/E) | A − E | Percent of Total[1] | s.e.(Pct. of Total) | Effective N |
| | Obesity/Overweight | | | | | | | |
| Diabetes | 2,258,554 | 1,031,473 | 2.19 | 0.20 | 1,227,081 | 19.95% | 2.62% | 3,120 |
| HIPAA Disability | 604,790 | 540,425 | 1.12 | 0.17 | 64,365 | 1.76% | 2.51% | 3,120 |
| Death | 192,011 | 311,628 | 0.62 | 0.17 | -119,617 | -6.60% | 3.22% | 3,120 |
| | Diabetes | | | | | | | |
| HIPAA Disability | 900,089 | 453,785 | 1.98 | 0.26 | 446,305 | 12.21% | 2.71% | 3,120 |
| Death | 422,549 | 236,910 | 1.78 | 0.36 | 185,639 | 10.24% | 4.10% | 3,120 |

Note 1: The referenced total is the sum of the indicated outcomes for persons with and without the indicated self-reported medical condition in the NLTCS.

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

**Table 7. Selected Comparisons of Actual and Expected Health Outcomes for Noninstitutionalized Persons with Self-Reported BMI Obesity, Obesity/Overweight, and Diabetes in the NLTCS; Reweighted to U.S. 2004 Unisex Noninstitutionalized Population, Age 65 and Above**

| | Self-Reported Medical Condition | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Outcome | Actual (A) | Expected (E) | A/E Ratio | s.e.(A/E) | A − E | Percent of Total[1] | s.e.(Pct. of Total) | Effective N |
| | Obesity (BMI ≥ 30) at Age 50 | | | | | | | |
| Diabetes | 1,393,590 | 527,724 | 2.64 | 0.27 | 865,866 | 16.41% | 2.22% | 2,399 |
| HIPAA Disability | 381,210 | 164,023 | 2.32 | 0.46 | 217,187 | 12.03% | 3.63% | 2,399 |
| Death | 141,157 | 121,630 | 1.16 | 0.37 | 19,527 | 1.65% | 3.63% | 2,399 |
| | Obesity (BMI ≥ 30) One Year Prior | | | | | | | |
| Diabetes | 2,119,959 | 972,825 | 2.18 | 0.21 | 1,147,134 | 20.69% | 2.87% | 2,557 |
| HIPAA Disability | 425,541 | 322,883 | 1.32 | 0.27 | 102,657 | 5.00% | 3.92% | 2,557 |
| Death | 166,985 | 247,448 | 0.67 | 0.21 | -80,463 | -6.21% | 4.25% | 2,557 |
| | Current Obesity (BMI ≥ 30) | | | | | | | |
| Diabetes | 2,165,735 | 937,273 | 2.31 | 0.22 | 1,228,462 | 21.51% | 2.75% | 2,607 |
| HIPAA Disability | 437,541 | 307,014 | 1.43 | 0.28 | 130,527 | 6.15% | 3.78% | 2,607 |
| Death | 135,350 | 237,222 | 0.57 | 0.20 | -101,872 | -7.71% | 3.84% | 2,607 |
| | Obesity/Overweight | | | | | | | |
| Diabetes | 2,173,088 | 985,437 | 2.21 | 0.21 | 1,187,651 | 20.33% | 2.74% | 2,739 |
| HIPAA Disability | 407,848 | 359,490 | 1.13 | 0.23 | 48,358 | 2.09% | 3.48% | 2,739 |
| Death | 148,383 | 251,796 | 0.59 | 0.20 | -103,413 | -7.49% | 3.92% | 2,739 |
| | Diabetes | | | | | | | |
| HIPAA Disability | 612,098 | 281,513 | 2.17 | 0.37 | 330,585 | 14.31% | 3.74% | 2,739 |
| Death | 322,499 | 181,950 | 1.77 | 0.43 | 140,549 | 10.18% | 4.91% | 2,739 |

Note 1: The referenced total is the sum of the indicated outcomes for persons with and without the indicated self-reported medical condition in the NLTCS.

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

**Table 8. Actual and Expected Numbers Meeting the HIPAA Disability Trigger for Noninstitutionalized Persons with Self-Reported BMI Obesity at Age 50 and/or Self-Reported Current Diabetes in the NLTCS; Reweighted to U.S. 2004 Unisex Noninstitutionalized Population, Age 65 and Above**

| Self-Reported Medical Condition(s) | Actual (A) | Expected (E) | A/E Ratio | s.e.(A/E) | A − E | Percent of Total[1] | s.e.(Pct. of Total) | Effective N |
|---|---|---|---|---|---|---|---|---|
| | Reference Population: Persons without Self-Reported Current Diabetes | | | | | | | |
| Diabetes | 471,898 | 220,000 | 2.14 | 0.43 | 251,899 | 13.96% | 4.32% | 2,399 |
| | Reference Population: Persons without Self-Reported Obesity at Age 50 | | | | | | | |
| Obesity at Age 50 | 381,210 | 164,023 | 2.32 | 0.46 | 217,187 | 12.03% | 3.63% | 2,399 |
| | Reference Population: Persons with Neither Self-Reported BMI Obesity at Age 50 nor Self-Reported Current Diabetes | | | | | | | |
| Diabetes w/o Obesity | 302,855 | 155,393 | 1.95 | 0.47 | 147,462 | | | |
| Obesity w/o Diabetes | 212,167 | 99,025 | 2.14 | 0.53 | 113,142 | | | |
| Obesity & Diabetes | 169,043 | 45,920 | 3.68 | 1.11 | 123,123 | | | |
| Obesity and/or Diabetes | 684,065 | 300,339 | 2.28 | 0.34 | 383,727 | 21.26% | 5.07% | 2,399 |

Note 1: The referenced total is the weighted total number of noninstitutionalized persons meeting the HIPAA disability trigger in the NLTCS with known status for both medical conditions.

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