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# The Impact of Obesity 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 on LTC disability and mortality above age 65 using the 2004 NLTCS with LTC disability based on the HIPAA ADL and CI Triggers. **Methods**: Self-reported height and weight yielded three measures of BMI: current, age 50, and one year prior; with standard cut-points <18.5, 18.5–24.9, 25.0–29.9, 30.0–34.9, and 35+. Relative risks were assessed using odds-ratios and combinations using the Mantel-Haenzel procedure. **Results**: High current BMI is associated with increased current and lifetime disability among elderly persons; but not with increased mortality or a reduction in residual life expectancy among elderly persons. Obesity is associated with an increase in lifetime disability among elderly persons on the order of 50–60%. **Conclusions**: The impact of BMI varies over age in a manner consistent with a complex multistage/multi-path disablement process involving, e.g., diabetes and cardiovascular diseases, as intermediate stages.

## INTRODUCTION

This paper presents estimates of the impact of obesity on LTC disability among the U.S. elderly population based on data from the 2004 National Long Term Care Survey (NLTCS), with the criteria for LTC disability based on the Health Insurance Portability and Accountability Act (HIPAA) of 1996 ADL and CI Triggers which are widely used in determining eligibility for LTC insurance benefits and the tax-treatment of LTC services (IRS, 1997). The resulting estimates are compared with published estimates from the Medicare Current Beneficiary Survey (MCBS; Lakdawalla et al., 2005) and the Asset and Health Dynamics Among the Oldest Old (AHEAD; Reynolds et al., 2005).

## METHODS

The NLTCS is a multi-round panel survey that covered both the community and institutionalized elderly population using nationally representative sampling of the Medicare enrollment files over the period 1982–2004 (with Medicare covering 97% of persons aged 65+; see Manton et al., 2006). Cross-sectional analysis of the NLTCS was enabled through supplemental sampling of newly eligible Medicare enrollees turning age 65 between survey rounds.

This study used the 2004 round of the NLTCS. The HIPAA ADL Trigger was implemented using six ADLs (bathing, continence, dressing, eating, toileting, and transferring); the trigger requires standby or active personal assistance for at least two of the six ADLs (Stallard, 2008).

The disability classification based on the HIPAA ADL Trigger is more stringent than the standard disability classification reported from the NLTCS which typically includes IADLs and equipment-based ADL limitations (Manton et al., 2006). The higher threshold helps to reduce

the rate of "false negatives" resulting from the screening procedures used in the NLTCS to select respondents for the detailed interview (see Wolf et al., 2005).

The HIPAA CI Trigger targets persons who require substantial supervision due to severe cognitive impairment. The trigger was implemented in two parts. First, because the need for substantial supervision was not directly assessed in the NLTCS, this 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), or (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.

Second, the classification of severe cognitive impairment in the detailed interview was based on the Short Portable Mental Status Questionnaire (SPMSQ) with severe cognitive impairment defined as three or more errors on the 10 questions, or affirmation that the respondent had dementia, Alzheimer's disease (AD), or other cognition problems sufficient to prevent completion of the SPMSQ with a passing score of 0–2 errors. The cutoff at three errors is consistent with actuarial practice for LTC insurance models (Stallard and Yee, 2000).

This implementation effectively assumed that respondents who did not need help with any of nine IADLs (e.g., taking medicine, managing money, using a telephone) or seven ADLs (the six listed above, and indoor mobility) would not meet the requirement for substantial supervision. These restrictions are consistent with reports that (1) AD patients with IADL and ADL impairments were classified in levels 2–5 of the 5-level AD Dependency Scale (Stern et al., 1994) and (2) declines in IADL functioning for AD patients typically occur over a 12-year

period beginning about one-third of the way through an 18-year course of the disease with declines in ADL functioning beginning about two years later (Stern et al., 1996).

Obesity was assessed using self-reported height and weight in the NLTCS detailed community interview to construct three measures of BMI: current, age 50, and one year prior. Standard BMI cut-points were used to define underweight (<18.5), normal weight (18.5–24.9), overweight non-obese (25.0–29.9), class I obese (30.0–34.9), and class II–III obese (35+).

Mortality outcomes were based on deaths in linked Medicare vital statistics data occurring within one year after the 2004 NLTCS.

Sample weights were employed as described in Manton et al. (2006); standard errors (s.e.'s) of weighted estimators of age-specific odds ratios were based on rescaled sample weights using procedures described in Potthoff et al. (1992). These procedures yielded an estimated design effect of 1.187 for the full survey and 1.323 for the detailed community interview.

Age-adjusted odds ratios (AAOR's) were estimated using weighted averages of age-specific odds ratios based on the Mantel-Haenzel procedure (Fleiss, 1981) with the normal weight group serving as the reference group for all other weight groups. The variances of the age-adjusted odds ratios were approximated using sums of products of (1) the variances of the age-specific odds ratios times (2) the squares of the weights used in the weighted averages. The age-adjusted odds ratios were computed separately for males and females and also for both sexes combined (designated as unisex).

Odds ratios are widely used in retrospective epidemiological studies, which matches the conditions for two of the three BMI measures. A useful property is that the application of odds ratios in retrospective epidemiological studies is valid if the number of persons in the control group represents a different fraction of the eligible control population than the corresponding

fraction for the target group. This property can help to partially resolve an issue in the current analysis that the assessment of BMI in the NLTCS was restricted to respondents to the detailed community interview (DCI).

The DCI had a complex set of rules determining who received it. In 2004, the DCI covered a sample representing 30.4% of the U.S. elderly community population, of whom 53.4% met the NLTCS screen-in criteria and 46.6% did not. The complementary 69.6% of the NLTCS sample that did not receive the DCI consisted solely of persons who did not meet the NLTCS screen-in criteria at any time up to and including 2004. However, among those persons who did not meet the NLTCS screen-in criteria in 2004, 16.9% were given the DCI anyway either because they met the screen-in criteria earlier or because they were part of a special group of "healthy" respondents. The result was that the respondents to the 2004 DCI included persons who did not meet the NLTCS screen-in criteria, but this group was an incomplete sample that excluded 83.1% of such persons.

The exclusion of such a large fraction of persons opens the possibility that the control groups in the 2004 DCI sample may be biased, thereby limiting the applicability of the results to the general U.S. community population. In this case, the proportion of the healthiest BMI classes in the excluded sample who, except for such exclusion, would be eligible for inclusion in the control group would be higher than the corresponding proportion in the included sample, implying that the effects detected in this study would be attenuated.

This effect can be evaluated by reweighting the 16.9% of persons who did not meet the NLTCS screen-in criteria in 2004 but did receive the DCI to represent the entire sample of persons who did not meet the NLTCS screen-in criteria in 2004. This reweighting was done

separately by sex and age (65–74, 75–84, 85+) using reweighting factors that ranged from 3.73 to 6.82.

These factors raised the DCI design effect from 1.323 to 1.945, with corresponding increases in the reweighted standard errors. The actual sample in the DCI for the analyses reported in Tables 1–6 consisted of 5,201 respondents; using the procedures in Potthoff et al. (1992), the computations of the standard errors assumed "effective sample sizes" of 3,931 prior to the reweighting and 2,674 persons after the reweighting.

Disabled life expectancies (DLE) based on the HIPAA criteria can be estimated by applying Sullivan's (1971) method to the 2004 period life tables used by the Social Security Administration (SSA, 2008).

**RESULTS**

Tables 1–3 present the age-adjusted odds ratios (AAOR) for the disability classification defined by the HIPAA ADL and CI Triggers. This is a severe level of disability making the individual eligible for LTC benefits under most LTC insurance policies and for tax benefits with respect to the ability to deduct expenditures for LTC services incurred while meeting these criteria.

Each table presents the sex-specific and unisex AAOR's for five standard BMI groupings based on one of the three measures of BMI: current BMI level (Table 1), BMI level one year prior to the 2004 NLTCS (Table 2), and BMI level at age 50 (Table 3). The reference group for the AAOR is the normal weight group (18.5–24.9).

The lowest AAOR's for current BMI were for the overweight non-obese groups (25.0–29.9), one level higher than normal. The AAOR's exhibited a U–shaped pattern with increasing values for BMI groups with BMI levels both above and below those of the minimum overweight non-

obese group. These results were replicated for the unisex and female AAOR's using the reweighted data; the minimum reweighted AAOR for males was for the class I obese group (30.0–34.9).

The lowest AAOR's for BMI levels one year prior to the 2004 NLTCS were for the unisex and female overweight non-obese groups and the male class I obese group.

The most notable difference between the results in Tables 1 and 2 was the higher AAOR's for the underweight groups (<18.5) for current BMI.

The lowest AAOR's for BMI levels at age 50 were for the normal weight groups. The increases in AAOR's for the overweight non-obese groups were small and generally close in size to their estimated standard errors. The increases in the AAOR's for the class I and class II–III obese groups were large but the class II–III obese groups consistently exhibited the highest values.

As in Tables 1 and 2, the underweight groups (<18.5) also exhibited high AAOR's for BMI at age 50.

The most notable differences between Tables 1–2 and Table 3 were the reversals in relative risk for the overweight non-obese and class I obese groups based on the timing of the BMI assessment. High BMI at age 50 was predictive of higher than normal disability at older ages whereas high BMI at older ages was predictive of lower than normal disability, where "normal disability" was the level of disability in the normal weight group.

Tables 4–6 present the AAOR's for dying within one year after the 2004 NLTCS. The formats of the tables parallel those of Tables 1–3, with the results for current BMI level shown in Table 4, BMI level one year prior to the 2004 NLTCS in Table 5, and BMI level at age 50 in Table 6.

Tables 4 and 5 indicate that the AAOR's for death for the overweight non-obese, class I obese, and class II–III obese groups were lower than for the normal weight groups. Thus the excess disability for the class II–III obese groups (Tables 1 and 2) was not associated with excess deaths.

Table 6 indicates that the AAOR's for death for the overweight non-obese, class I obese, and class II–III obese groups were higher than for the normal weight groups, although the excess risk was at least twice the size of the standard errors only for the unisex and female class II–III obese groups.

Table 7 abstracts related results from Reynolds et al. (2005) that imply that the relative risk of disability for obese vs. non-obese elderly persons aged 70 or above was 59% for males and 52% for females, using data from the 1993–1998 AHEAD Study, with disability defined as 1+ ADL limitations or institutionalization, and the absolute risks representing the expected fractions of the remaining lifetime at age 70 spent disabled.

Table 8 abstracts related results from Lakdawalla et al. (2005) that show that the risks of disability across BMI groups exhibited a U-shaped pattern for two thresholds of disability (1+ ADLs; 3+ ADLs), using BMI categories that are closer to those in the current study, using data from the 1992–1998 MCBS.

**DISCUSSION**

High current BMI is not associated with increased mortality or a reduction in residual life expectancy among elderly persons. High current BMI is associated with increased current and lifetime disability among elderly persons. Obesity is associated with an increase in lifetime disability among elderly persons on the order of 50–60% above that which would occur if normal weight were maintained.

The impact of BMI varies over age in a manner consistent with a complex multistage/multi-path disablement process involving, e.g., diabetes and cardiovascular diseases, as intermediate stages (Verbrugge and Jette, 1994). Interventions in diet, exercise, and other behaviors to prevent or reverse obesity may yield significant reductions in lifetime LTC disability. The efficacy of such interventions will likely depend on the ages at which the interventions are implemented. Interventions to prevent the development of obesity at middle ages could be especially effective.

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**Table 1. Number and Percent of Persons Meeting Either HIPAA Trigger, United States 2004 Detailed Community Interview, Age 65 and Above, by Sex and Current BMI, with Age-Adjusted Odds Ratios for BMI Groups**

| | Meets Either HIPAA Trigger | | | | | | | Reweighted | |
|---|---|---|---|---|---|---|---|---|---|
| Current BMI | No | Yes | Total | Percent Yes | Std Error (Pct) | Age-Adjusted Odds Ratio | Std Error (AAOR) | Age-Adjusted Odds Ratio | Std Error (AAOR) |
| | | | **Unisex** | | | | | | |
| <18.5 | 192,020 | 172,374 | 364,394 | 47.3% | 4.3% | 2.56 | 0.47 | 2.53 | 0.74 |
| 18.5–24.9 | 3,014,852 | 957,141 | 3,971,994 | 24.1% | 1.1% | 1.00 | 0.09 | 1.00 | 0.15 |
| 25.0–29.9 | 2,984,653 | 555,621 | 3,540,275 | 15.7% | 1.0% | 0.67 | 0.07 | 0.76 | 0.13 |
| 30.0–34.9 | 1,166,473 | 280,057 | 1,446,530 | 19.4% | 1.7% | 0.94 | 0.12 | 1.05 | 0.26 |
| 35.0+ | 583,016 | 157,483 | 740,499 | 21.3% | 2.5% | 1.18 | 0.20 | 1.52 | 0.49 |
| Weighted Total | 7,941,014 | 2,122,678 | 10,063,692 | 21.1% | 0.7% | | | | |
| Unweighted Total | 3,671 | 1,264 | 4,935 | 25.6% | 0.6% | | | | |
| | | | **Male** | | | | | | |
| <18.5 | 39,295 | 39,039 | 78,334 | 49.8% | 9.3% | 3.07 | 1.34 | 4.30 | 3.05 |
| 18.5–24.9 | 1,119,696 | 350,096 | 1,469,792 | 23.8% | 1.8% | 1.00 | 0.14 | 1.00 | 0.26 |
| 25.0–29.9 | 1,409,880 | 254,064 | 1,663,944 | 15.3% | 1.4% | 0.64 | 0.10 | 0.82 | 0.24 |
| 30.0–34.9 | 408,837 | 85,913 | 494,750 | 17.4% | 2.8% | 0.75 | 0.17 | 0.75 | 0.34 |
| 35.0+ | 151,277 | 39,398 | 190,675 | 20.7% | 4.8% | 1.01 | 0.32 | 1.01 | 0.66 |
| Weighted Total | 3,128,985 | 768,510 | 3,897,495 | 19.7% | 1.0% | | | | |
| Unweighted Total | 1,398 | 400 | 1,798 | 22.2% | 1.0% | | | | |
| | | | **Female** | | | | | | |
| <18.5 | 152,725 | 133,335 | 286,060 | 46.6% | 4.8% | 2.38 | 0.51 | 2.14 | 0.71 |
| 18.5–24.9 | 1,895,156 | 607,046 | 2,502,202 | 24.3% | 1.4% | 1.00 | 0.11 | 1.00 | 0.18 |
| 25.0–29.9 | 1,574,774 | 301,557 | 1,876,331 | 16.1% | 1.4% | 0.68 | 0.09 | 0.72 | 0.16 |
| 30.0–34.9 | 757,636 | 194,144 | 951,780 | 20.4% | 2.1% | 1.07 | 0.17 | 1.20 | 0.35 |
| 35.0+ | 431,739 | 118,085 | 549,824 | 21.5% | 2.9% | 1.33 | 0.28 | 1.78 | 0.70 |
| Weighted Total | 4,812,030 | 1,354,167 | 6,166,197 | 22.0% | 0.9% | | | | |
| Unweighted Total | 2,273 | 864 | 3,137 | 27.5% | 0.8% | | | | |

Source: Author's calculations based on 2004 NLTCS.

**Table 2. Number and Percent of Persons Meeting Either HIPAA Trigger, United States 2004 Detailed Community Interview, Age 65 and Above, by Sex and 1-Year BMI, with Age-Adjusted Odds Ratios for BMI Groups**

| | Meets Either HIPAA Trigger | | | | | | | Reweighted | |
|---|---|---|---|---|---|---|---|---|---|
| 1-Year BMI | No | Yes | Total | Percent Yes | Std Error (Pct) | Age-Adjusted Odds Ratio | Std Error (AAOR) | Age-Adjusted Odds Ratio | Std Error (AAOR) |
| | | | **Unisex** | | | | | | |
| <18.5 | 201,627 | 122,333 | 323,960 | 37.8% | 4.4% | 1.75 | 0.35 | 1.71 | 0.56 |
| 18.5–24.9 | 2,866,084 | 883,056 | 3,749,140 | 23.6% | 1.1% | 1.00 | 0.09 | 1.00 | 0.15 |
| 25.0–29.9 | 2,932,417 | 620,554 | 3,552,971 | 17.5% | 1.0% | 0.78 | 0.08 | 0.86 | 0.15 |
| 30.0–34.9 | 1,222,237 | 253,412 | 1,475,649 | 17.2% | 1.6% | 0.83 | 0.11 | 0.95 | 0.23 |
| 35.0+ | 595,934 | 172,128 | 768,063 | 22.4% | 2.5% | 1.33 | 0.22 | 1.73 | 0.56 |
| Weighted Total | 7,818,300 | 2,051,484 | 9,869,783 | 20.8% | 0.7% | | | | |
| Unweighted Total | 3,609 | 1,212 | 4,821 | 25.1% | 0.6% | | | | |
| | | | **Male** | | | | | | |
| <18.5 | 36,361 | 22,143 | 58,504 | 37.8% | 10.4% | 1.86 | 0.96 | 2.26 | 1.90 |
| 18.5–24.9 | 1,070,298 | 316,589 | 1,386,887 | 22.8% | 1.8% | 1.00 | 0.15 | 1.00 | 0.27 |
| 25.0–29.9 | 1,359,755 | 258,156 | 1,617,911 | 16.0% | 1.5% | 0.71 | 0.11 | 0.92 | 0.27 |
| 30.0–34.9 | 467,614 | 87,002 | 554,616 | 15.7% | 2.5% | 0.68 | 0.15 | 0.66 | 0.30 |
| 35.0+ | 154,328 | 50,156 | 204,484 | 24.5% | 4.9% | 1.33 | 0.41 | 1.50 | 0.95 |
| Weighted Total | 3,088,356 | 734,046 | 3,822,401 | 19.2% | 1.0% | | | | |
| Unweighted Total | 1,378 | 380 | 1,758 | 21.6% | 1.0% | | | | |
| | | | **Female** | | | | | | |
| <18.5 | 165,266 | 100,190 | 265,456 | 37.7% | 4.9% | 1.70 | 0.39 | 1.49 | 0.55 |
| 18.5–24.9 | 1,795,786 | 566,467 | 2,362,254 | 24.0% | 1.4% | 1.00 | 0.12 | 1.00 | 0.19 |
| 25.0–29.9 | 1,572,662 | 362,398 | 1,935,060 | 18.7% | 1.5% | 0.83 | 0.11 | 0.84 | 0.18 |
| 30.0–34.9 | 754,624 | 166,410 | 921,034 | 18.1% | 2.1% | 0.92 | 0.16 | 1.08 | 0.32 |
| 35.0+ | 441,607 | 121,972 | 563,579 | 21.6% | 2.8% | 1.42 | 0.29 | 1.84 | 0.73 |
| Weighted Total | 4,729,944 | 1,317,438 | 6,047,382 | 21.8% | 0.9% | | | | |
| Unweighted Total | 2,231 | 832 | 3,063 | 27.2% | 0.8% | | | | |

Source: Author's calculations based on 2004 NLTCS.

**Table 3. Number and Percent of Persons Meeting Either HIPAA Trigger, United States 2004 Detailed Community Interview, Age 65 and Above, by Sex and Age 50 BMI, with Age-Adjusted Odds Ratios for BMI Groups**

| | Meets Either HIPAA Trigger | | | | | | | Reweighted | |
|---|---|---|---|---|---|---|---|---|---|
| Age 50 BMI | No | Yes | Total | Percent Yes | Std Error (Pct) | Age-Adjusted Odds Ratio | Std Error (AAOR) | Age-Adjusted Odds Ratio | Std Error (AAOR) |
| | | | **Unisex** | | | | | | |
| <18.5 | 99,939 | 46,036 | 145,976 | 31.5% | 6.3% | 2.18 | 0.67 | 2.59 | 1.32 |
| 18.5–24.9 | 3,534,694 | 745,531 | 4,280,225 | 17.4% | 1.0% | 1.00 | 0.09 | 1.00 | 0.16 |
| 25.0–29.9 | 2,778,085 | 632,292 | 3,410,376 | 18.5% | 1.1% | 1.13 | 0.11 | 1.23 | 0.22 |
| 30.0–34.9 | 723,276 | 236,864 | 960,140 | 24.7% | 2.3% | 1.73 | 0.25 | 2.39 | 0.65 |
| 35.0+ | 298,065 | 144,346 | 442,411 | 32.6% | 3.7% | 2.76 | 0.52 | 3.96 | 1.36 |
| Weighted Total | 7,434,058 | 1,805,069 | 9,239,128 | 19.5% | 0.7% | | | | |
| Unweighted Total | 3,433 | 1,057 | 4,490 | 23.5% | 0.6% | | | | |
| | | | **Male** | | | | | | |
| <18.5 | 18,464 | 9,131 | 27,595 | 33.1% | 14.7% | 2.43 | 1.71 | 2.96 | 3.80 |
| 18.5–24.9 | 1,195,848 | 239,416 | 1,435,264 | 16.7% | 1.6% | 1.00 | 0.17 | 1.00 | 0.30 |
| 25.0–29.9 | 1,367,330 | 274,900 | 1,642,230 | 16.7% | 1.5% | 1.07 | 0.17 | 1.16 | 0.35 |
| 30.0–34.9 | 298,726 | 109,294 | 408,019 | 26.8% | 3.6% | 2.05 | 0.47 | 2.45 | 1.06 |
| 35.0+ | 78,694 | 35,517 | 114,211 | 31.1% | 7.1% | 2.53 | 0.93 | 4.76 | 3.31 |
| Weighted Total | 2,959,062 | 668,259 | 3,627,320 | 18.4% | 1.1% | | | | |
| Unweighted Total | 1,323 | 348 | 1,671 | 20.8% | 1.0% | | | | |
| | | | **Female** | | | | | | |
| <18.5 | 81,475 | 36,905 | 118,380 | 31.2% | 7.0% | 2.12 | 0.72 | 2.43 | 1.36 |
| 18.5–24.9 | 2,338,846 | 506,115 | 2,844,961 | 17.8% | 1.2% | 1.00 | 0.12 | 1.00 | 0.20 |
| 25.0–29.9 | 1,410,755 | 357,391 | 1,768,146 | 20.2% | 1.6% | 1.18 | 0.15 | 1.32 | 0.29 |
| 30.0–34.9 | 424,551 | 127,570 | 552,121 | 23.1% | 2.9% | 1.49 | 0.29 | 2.34 | 0.83 |
| 35.0+ | 219,370 | 108,829 | 328,200 | 33.2% | 4.3% | 2.88 | 0.64 | 3.72 | 1.49 |
| Weighted Total | 4,474,997 | 1,136,810 | 5,611,807 | 20.3% | 0.9% | | | | |
| Unweighted Total | 2,110 | 709 | 2,819 | 25.2% | 0.8% | | | | |

Source: Author's calculations based on 2004 NLTCS.

**Table 4. Number and Percent of Persons who Died within One Year after the NLTCS, United States 2004 Detailed Community Interview, Age 65 and Above, by Sex and Current BMI, with Age-Adjusted Odds Ratios for BMI Groups**

| | Status 1 Year after NLTCS | | | | | | | Reweighted | |
|---|---|---|---|---|---|---|---|---|---|
| Current BMI | Survived | Died | Total | Percent Dead | Std Error (Pct) | Age-Adjusted Odds Ratio | Std Error (AAOR) | Age-Adjusted Odds Ratio | Std Error (AAOR) |
| | | | **Unisex** | | | | | | |
| <18.5 | 281,096 | 83,298 | 364,394 | 22.9% | 3.6% | 2.20 | 0.49 | 2.40 | 0.82 |
| 18.5–24.9 | 3,533,896 | 438,098 | 3,971,994 | 11.0% | 0.8% | 1.00 | 0.12 | 1.00 | 0.17 |
| 25.0–29.9 | 3,356,328 | 183,947 | 3,540,275 | 5.2% | 0.6% | 0.51 | 0.08 | 0.58 | 0.13 |
| 30.0–34.9 | 1,382,492 | 64,039 | 1,446,530 | 4.4% | 0.9% | 0.44 | 0.10 | 0.55 | 0.18 |
| 35.0+ | 712,653 | 27,846 | 740,499 | 3.8% | 1.1% | 0.41 | 0.14 | 0.24 | 0.17 |
| Weighted Total | 9,266,464 | 797,228 | 10,063,692 | 7.9% | 0.4% | | | | |
| Unweighted Total | 4,458 | 477 | 4,935 | 9.7% | 0.4% | | | | |
| | | | **Male** | | | | | | |
| <18.5 | 52,060 | 26,274 | 78,334 | 33.5% | 8.8% | 2.72 | 1.16 | 1.86 | 1.46 |
| 18.5–24.9 | 1,243,723 | 226,069 | 1,469,792 | 15.4% | 1.5% | 1.00 | 0.17 | 1.00 | 0.23 |
| 25.0–29.9 | 1,549,922 | 114,022 | 1,663,944 | 6.9% | 1.0% | 0.47 | 0.10 | 0.55 | 0.17 |
| 30.0–34.9 | 461,237 | 33,513 | 494,750 | 6.8% | 1.9% | 0.46 | 0.15 | 0.61 | 0.27 |
| 35.0+ | 177,812 | 12,863 | 190,675 | 6.7% | 3.0% | 0.47 | 0.24 | 0.21 | 0.22 |
| Weighted Total | 3,484,754 | 412,741 | 3,897,495 | 10.6% | 0.8% | | | | |
| Unweighted Total | 1,585 | 213 | 1,798 | 11.8% | 0.8% | | | | |
| | | | **Female** | | | | | | |
| <18.5 | 229,036 | 57,024 | 286,060 | 19.9% | 3.9% | 2.36 | 0.64 | 3.08 | 1.21 |
| 18.5–24.9 | 2,290,173 | 212,029 | 2,502,202 | 8.5% | 0.9% | 1.00 | 0.17 | 1.00 | 0.25 |
| 25.0–29.9 | 1,806,406 | 69,925 | 1,876,331 | 3.7% | 0.7% | 0.48 | 0.11 | 0.49 | 0.18 |
| 30.0–34.9 | 921,254 | 30,526 | 951,780 | 3.2% | 0.9% | 0.45 | 0.16 | 0.47 | 0.28 |
| 35.0+ | 534,841 | 14,983 | 549,824 | 2.7% | 1.1% | 0.48 | 0.22 | 0.33 | 0.34 |
| Weighted Total | 5,781,710 | 384,487 | 6,166,197 | 6.2% | 0.5% | | | | |
| Unweighted Total | 2,873 | 264 | 3,137 | 8.4% | 0.5% | | | | |

Source: Author's calculations based on 2004 NLTCS.

**Table 5. Number and Percent of Persons who Died within One Year after the NLTCS, United States 2004 Detailed Community Interview, Age 65 and Above, by Sex and 1-Year BMI, with Age-Adjusted Odds Ratios for BMI Groups**

| | Status 1 Year after NLTCS | | | | | | | Reweighted | |
|---|---|---|---|---|---|---|---|---|---|
| 1-Year BMI | Survived | Died | Total | Percent Dead | Std Error (Pct) | Age-Adjusted Odds Ratio | Std Error (AAOR) | Age-Adjusted Odds Ratio | Std Error (AAOR) |
| | | | **Unisex** | | | | | | |
| <18.5 | 267,634 | 56,326 | 323,960 | 17.4% | 3.5% | 1.70 | 0.44 | 1.56 | 0.65 |
| 18.5–24.9 | 3,371,269 | 377,871 | 3,749,140 | 10.1% | 0.8% | 1.00 | 0.13 | 1.00 | 0.18 |
| 25.0–29.9 | 3,321,943 | 231,028 | 3,552,971 | 6.5% | 0.7% | 0.70 | 0.10 | 0.81 | 0.17 |
| 30.0–34.9 | 1,409,856 | 65,794 | 1,475,649 | 4.5% | 0.9% | 0.50 | 0.12 | 0.53 | 0.19 |
| 35.0+ | 725,502 | 42,561 | 768,063 | 5.5% | 1.4% | 0.70 | 0.20 | 0.58 | 0.30 |
| Weighted Total | 9,096,204 | 773,579 | 9,869,783 | 7.8% | 0.4% | | | | |
| Unweighted Total | 4,365 | 456 | 4,821 | 9.5% | 0.4% | | | | |
| | | | **Male** | | | | | | |
| <18.5 | 45,785 | 12,719 | 58,504 | 21.7% | 8.8% | 1.75 | 1.14 | 1.39 | 1.41 |
| 18.5–24.9 | 1,210,817 | 176,069 | 1,386,887 | 12.7% | 1.5% | 1.00 | 0.19 | 1.00 | 0.26 |
| 25.0–29.9 | 1,463,438 | 154,473 | 1,617,911 | 9.5% | 1.2% | 0.82 | 0.17 | 0.95 | 0.27 |
| 30.0–34.9 | 519,417 | 35,199 | 554,616 | 6.3% | 1.7% | 0.53 | 0.17 | 0.62 | 0.29 |
| 35.0+ | 186,080 | 18,404 | 204,484 | 9.0% | 3.3% | 0.80 | 0.35 | 0.62 | 0.46 |
| Weighted Total | 3,425,537 | 396,865 | 3,822,401 | 10.4% | 0.8% | | | | |
| Unweighted Total | 1,554 | 204 | 1,758 | 11.6% | 0.8% | | | | |
| | | | **Female** | | | | | | |
| <18.5 | 221,850 | 43,606 | 265,456 | 16.4% | 3.7% | 1.86 | 0.56 | 1.71 | 0.83 |
| 18.5–24.9 | 2,160,452 | 201,802 | 2,362,254 | 8.5% | 0.9% | 1.00 | 0.17 | 1.00 | 0.26 |
| 25.0–29.9 | 1,858,506 | 76,555 | 1,935,060 | 4.0% | 0.7% | 0.49 | 0.12 | 0.51 | 0.18 |
| 30.0–34.9 | 890,439 | 30,595 | 921,034 | 3.3% | 1.0% | 0.47 | 0.16 | 0.39 | 0.23 |
| 35.0+ | 539,422 | 24,157 | 563,579 | 4.3% | 1.4% | 0.79 | 0.30 | 0.65 | 0.48 |
| Weighted Total | 5,670,668 | 376,714 | 6,047,382 | 6.2% | 0.5% | | | | |
| Unweighted Total | 2,811 | 252 | 3,063 | 8.2% | 0.5% | | | | |

Source: Author's calculations based on 2004 NLTCS.

**Table 6. Number and Percent of Persons who Died within One Year after the NLTCS, United States 2004 Detailed Community Interview, Age 65 and Above, by Sex and Age 50 BMI, with Age-Adjusted Odds Ratios for BMI Groups**

| | Status 1 Year after NLTCS | | | | | | | Reweighted | |
|---|---|---|---|---|---|---|---|---|---|
| Age 50 BMI | Survived | Died | Total | Percent Dead | Std Error (Pct) | Age-Adjusted Odds Ratio | Std Error (AAOR) | Age-Adjusted Odds Ratio | Std Error (AAOR) |
| | | | **Unisex** | | | | | | |
| <18.5 | 134,863 | 11,113 | 145,976 | 7.6% | 3.6% | 1.09 | 0.58 | 0.67 | 0.68 |
| 18.5–24.9 | 3,984,241 | 295,983 | 4,280,225 | 6.9% | 0.6% | 1.00 | 0.14 | 1.00 | 0.20 |
| 25.0–29.9 | 3,131,086 | 279,290 | 3,410,376 | 8.2% | 0.8% | 1.26 | 0.18 | 1.25 | 0.26 |
| 30.0–34.9 | 887,125 | 73,014 | 960,140 | 7.6% | 1.4% | 1.21 | 0.28 | 1.27 | 0.48 |
| 35.0+ | 389,234 | 53,177 | 442,411 | 12.0% | 2.5% | 2.16 | 0.58 | 1.80 | 0.89 |
| Weighted Total | 8,526,549 | 712,578 | 9,239,128 | 7.7% | 0.5% | | | | |
| Unweighted Total | 4,075 | 415 | 4,490 | 9.2% | 0.4% | | | | |
| | | | **Male** | | | | | | |
| <18.5 | 23,650 | 3,946 | 27,595 | 14.3% | 10.9% | 1.46 | 1.40 | 1.11 | 1.97 |
| 18.5–24.9 | 1,287,448 | 147,816 | 1,435,264 | 10.3% | 1.3% | 1.00 | 0.20 | 1.00 | 0.27 |
| 25.0–29.9 | 1,477,520 | 164,711 | 1,642,230 | 10.0% | 1.2% | 1.05 | 0.21 | 1.12 | 0.32 |
| 30.0–34.9 | 364,729 | 43,290 | 408,019 | 10.6% | 2.5% | 1.14 | 0.35 | 1.12 | 0.56 |
| 35.0+ | 99,027 | 15,185 | 114,211 | 13.3% | 5.2% | 1.54 | 0.76 | 0.97 | 0.97 |
| Weighted Total | 3,252,374 | 374,947 | 3,627,320 | 10.3% | 0.8% | | | | |
| Unweighted Total | 1,480 | 191 | 1,671 | 11.4% | 0.8% | | | | |
| | | | **Female** | | | | | | |
| <18.5 | 111,213 | 7,167 | 118,380 | 6.1% | 3.6% | 1.17 | 0.78 | 0.72 | 0.92 |
| 18.5–24.9 | 2,696,793 | 148,168 | 2,844,961 | 5.2% | 0.7% | 1.00 | 0.20 | 1.00 | 0.29 |
| 25.0–29.9 | 1,653,566 | 114,580 | 1,768,146 | 6.5% | 1.0% | 1.27 | 0.27 | 1.09 | 0.36 |
| 30.0–34.9 | 522,397 | 29,724 | 552,121 | 5.4% | 1.6% | 1.13 | 0.39 | 1.21 | 0.74 |
| 35.0+ | 290,207 | 37,993 | 328,200 | 11.6% | 2.9% | 2.91 | 1.00 | 2.60 | 1.51 |
| Weighted Total | 5,274,176 | 337,632 | 5,611,807 | 6.0% | 0.5% | | | | |
| Unweighted Total | 2,595 | 224 | 2,819 | 7.9% | 0.5% | | | | |

Source: Author's calculations based on 2004 NLTCS.

**Table 7. Alternative Estimates of Components of Life Expectancy at Age 70 (in Years) by Sex and BMI Classification at Age 70**

| | Sex and BMI Classification at Age 70 | | | |
|---|---|---|---|---|
| | Male | | Female | |
| | Not Obese | Obese | Not Obese | Obese |
| **Component** | **<30.0** | **30.0+** | **<30.0** | **30.0+** |
| Disability-free | 9.8 | 8.4 | 10.5 | 8.1 |
| 1+ ADLs/Inst | 2.5 | 4.0 | 4.8 | 7.4 |
| Total | 12.3 | 12.4 | 15.3 | 15.5 |
| 1+ ADLs/Inst (%) | 20.3% | 32.3% | 31.4% | 47.7% |

Source: Table 2 in Reynolds, S.L., Saito, Y., and Crimmins, E.M. The impact of obesity on active life expectancy in older American men and women. *The Gerontologist* 45(4):438–444, 2005.

**Table 8. Components of Life Expectancy at Age 70 (in Years) by Weight Status at Age 70**

| | Weight Status and BMI Classification at Age 70 | | | |
|---|---|---|---|---|
| | Underweight | Normal | Overweight | Obese |
| Component | <20.0 | 20.0–24.9 | 25.0–29.9 | 30.0+ |
| Disability-free | 5.80 | 6.75 | 6.63 | 4.02 |
| 1–2 ADLs | 3.09 | 4.40 | 4.87 | 5.23 |
| 3+ ADLs | 1.66 | 1.42 | 2.02 | 3.80 |
| Institutionalized | 1.55 | 1.19 | 0.96 | 0.83 |
| Total | 12.10 | 13.76 | 14.48 | 13.88 |
| 1+ ADLs/Inst | 6.30 | 7.01 | 7.85 | 9.86 |
| 1+ ADLs/Inst (%) | 52.1% | 50.9% | 54.2% | 71.0% |
| 3+ ADLs/Inst | 3.21 | 2.61 | 2.98 | 4.63 |
| 3+ ADLs/Inst (%) | 26.5% | 19.0% | 20.6% | 33.4% |

Source: Author's calculations based on Exhibit 2 in Lakdawalla, D.N., Goldman, D.P., and Shang, B. The health and cost consequences of obesity among the future elderly. *Health Affairs* 24(Supp. 2):W5-R30–W5-R41, 2005.