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The Impact of Obesity and Diabetes on LTC Disability and Mortality:

POPULATION ESTIMATES FROM THE NATIONAL LONG-TERM CARE SURVEY *

by Eric Stallard

[**Editor's Note:** This is a summary of a paper presented at the Society of Actuaries' Living to 100 Symposium held on Jan. 5–7, 2011 in Orlando, Florida. The full paper was published as part of the 2011 Living to 100 Symposium Monograph and can be found at *http://www.soa.org/livingto100monographs.*]

The primary contribution of the paper was its quantitative assessment of the separate and joint effects of obesity and diabetes using common definitions of disability applied to a common dataset. The paper provided new estimates of the effects of obesity and diabetes on long-term care (LTC) disability and mortality, 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 activities of daily living (ADL) and cognitive impairment (CI) benefit triggers.

Such estimates can 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.

A useful byproduct of the analysis was that the reweighting methods developed 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 persons, not just those who met the disability screening criteria. Such applications can be implemented by LTCI actuaries using publicly available copies of the NLTCS.[1]

METHODOLOGY

The objective of this study was to estimate the impact of obesity and diabetes on LTC disability and mortality above age 65 using the 2004 NLTCS.

The disability classifications were based on the HIPAA ADL and CI triggers. Two types of disability qualify for tax-qualified LTCI benefits under HIPAA: (1) specified limitations in activities of daily living (ADL trigger); and (2) severe cognitive impairment (CI trigger). Nearly half (47 percent) of disabled persons in the 2004 NLTCS met the HIPAA requirements for both the ADL and CI triggers simultaneously.

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Vital status was assessed through the first anniversary of the date of the NLTCS interview using linked vital statistics micro-data files obtained from the Medicare program.

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 $\geq$ 30) and non-obesity (BMI $<$ 30) for use in comparisons with self-reported and health care provider-reported obesity.

HIPAA ADL TRIGGER

The HIPAA ADL trigger requires that the individual be unable to perform at least two out of six basic ADLs (bathing, dressing, toileting, transferring, continence and eating) without "substantial assistance" from another individual, for at least 90 days due to a loss of functional capacity.

To simulate the HIPAA ADL Trigger using the NLTCS, the questionnaire responses for each of the six ADLs were classified according to the highest value indicated in the following hierarchy:

0. Performs ADL
1. Needs help with ADL, but does not receive it
2. Performs ADL with special equipment
3. Performs ADL with standby help or oral cues, with or without special equipment
4. Performs ADL with active or hands-on help, with or without special equipment
5. Unable to perform ADL.

An ADL was coded as "severely impaired" when the selected value for that ADL was 3 or higher. When two or more ADLs were coded as "severely impaired," then the HIPAA ADL trigger was assumed to be met.

HIPAA CI TRIGGER

The HIPAA CI trigger requires that the individual requires "substantial supervision" to protect him/herself from threats to health and safety due to "severe cognitive impairment," defined as "a loss or deterioration in intellectual capacity that is comparable to (and includes) Alzheimer's Disease and similar forms of irreversible dementia" that is "measured by clinical evidence and standardized tests that reliably measure impairment."

To simulate the HIPAA CI trigger using the NLTCS, the responses to the 10-item Short Portable Mental Status Questionnaire (SPMSQ) were coded according to the following hierarchy:

0–2 errors	=	unimpaired
3–10 errors	=	cognitively impaired.

Respondents with a proxy interview due to dementia, Alzheimer's Disease, or other cognition problems sufficient to prevent completion of the SPMSQ with a passing score of 0–2 errors were also coded as cognitively impaired.

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

In addition to the six basic ADLs noted above, nine instrumental ADLs (IADLs) were considered in these assessments: housework, laundry, cooking, grocery shopping, outside mobility, travel, money management, taking medications and telephoning. Each IADL has a cognitive component such that an individual who could successfully complete all nine without any help was assumed to be without need for substantial supervision, even if cognitively impaired according to the SPMSQ.

DIABETES

The presence of diabetes was established using

… Nine instrumental ADLs (IADLs) were considered in these assessments: housework, laundry, cooking, grocery shopping, outside mobility, travel, money management, taking medications and telephoning.

(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 NLTCS interviewing instruments. This question was not asked on the NLTCS screening instrument, which means that persons 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 persons, as discussed below.

SELF-REPORTED OBESITY/ OVERWEIGHT

Self-reported obesity/overweight was 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 NLTCS interviewing instruments, but not on the NLTCS screening instrument.

SELF-REPORTED BMI OBESITY

The NLTCS detailed community interview asked about the respondent's current height (inches), current weight (pounds), weight at age 50, and weight one year prior. Body Mass Index (BMI) was computed for each weight and time as:

$$BMI = Weight/Height^2 \times 703.07,$$

scaled to metric units (kg/m^2). Self-reported BMI obesity was defined as $BMI \geq 30$.

SURVEY WEIGHTS

Survey weights were employed as described by Manton and colleagues.[2] Standard errors ("s.e.'s") of weighted estimators of binomial proportions were based on rescaled sample weights using procedures described by Potthoff and colleagues.[3]

Application of these procedures within age groups yielded an estimated overall design effect of 1.11, which implied that the variances were 11 percent larger, and the effective sample size 10 percent smaller, than under a simple random sampling design with the same sample size, but with equal weights.[4]

An additional reweighting of the survey weights was done for a subset of the detailed community sample comprising approximately 17 percent of respondents who were rejected by the NLTCS screener protocol used for the initial disability assessment. The complementary 83 percent of screen-out respondents were then dropped from the analysis, reducing the total sample size from 15,993 to 6,171 respondents, of whom 5,201 were community residents at the time of interview.

The second reweighting 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.

The second reweighting raised the detailed community overall sample design effect from 1.11 to 1.90, implying that the effective size of the detailed community sample was reduced from 5,201 to 2,739 respondents.

RESULTS

Comparisons of the self-reported and health care provider-reported medical conditions were presented in the full paper where it was found that diabetes self-reports were confirmed in the Medicare reports but obesity reports were not. Hence, the remainder of the paper analyzed the impact of self-reported obesity and diabetes on disability and death.

Table 1 on page 10 displays actual and expected disability and mortality outcomes for self-reported obesity/overweight and diabetes in the combined population-weighted community and institutionalized NLTCS sample, where the effective sample size was 3,120.

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Comparisons of the self-reported and health care provider-reported medical conditions were presented in the full paper where it was found that diabetes self-reports were confirmed in the Medicare reports but obesity reports were not.

Table 1. 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 weighted 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.

The impact of each condition was quantified by the ratio of the actual to expected outcome counts (A/E ratios), with the expected disability or mortality counts among diabetics generated by application of the age-specific non-diabetic disability or mortality rates to the age-specific diabetic population counts. Similar procedures were employed for comparisons of obese and non-obese subpopulations.

The A/E ratios for diabetes were 1.98 and 1.78, respectively, for disability and death, indicating that diabetics were 98 percent more likely than non-diabetics to meet the HIPAA disability trigger and 78 percent more likely than non-diabetics to die within one year after the NLTCS interview.

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 (non-significant) 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 result from major chronic disease processes involving the heart, lungs, kidney and other vital organ systems.[5]

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.

The relative differences between the actual and expected disability or mortality counts in the diabetic population represent the fractions of disability or mortality attributable to diabetes (or to health status differences associated with diabetes); a similar interpretation applies to relative differences in comparisons of the obese and non-obese subpopulations.

Table 1 shows that 12 percent of disability was attributable to diabetes and 20 percent of diabetes was attributable to current obesity/overweight.

Table 2 displays the A/E ratios for various alternative measures of obesity 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").

Table 2. Actual and Expected Health Outcomes for Non-institutionalized 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

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
				Self-Reported Medical Condition				
				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

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

The A/E ratios for current obesity in the non-institutionalized population were similar to those for obesity/overweight, which were almost identical to the corresponding values for the total population (in Table 1). Likewise, the A/E ratios for current obesity in the non-institutionalized population were similar to those for obesity one year prior to the interview.

The A/E ratios for obesity at age 50 in the non-institutionalized 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 (non-significant) 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.

Obesity at age 50 increased the risk of diabetes and disability, and diabetes also increased the risk of disability. The joint impact of obesity at age 50 and diabetes on disability was assessed in Table 3 using A/E ratios comparing respondents exhibiting each combination of obesity at age 50 and diabetes with those who had neither condition.

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Table 3. Actual and Expected Numbers Meeting the HIPAA Disability Trigger for Non-institutionalized 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 non-institutionalized 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.

The A/E ratios were 1.95 for diabetes without obesity at age 50; 2.14 for obesity at age 50 without diabetes; and 3.68 for both conditions. The 3.68 A/E ratio for both conditions was consistent with both additive and multiplicative interaction models, 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.

Table 3 shows that 21 percent of disability was attributable to obesity at age 50 and/or diabetes, substantially more than due to either condition alone (12 percent and 14 percent, respectively).

CONCLUSIONS

The results showed that current obesity was associated with large increases in diabetes, non-significant increases in disability, and substantial decreases in mortality among elderly persons.

Obesity at age 50 was associated with large increases in diabetes and disability, and non-significant increases in mortality among elderly persons. Diabetes was associated with large increases in disability and mortality among elderly persons.

Obesity at age 50 and diabetes were both associated with large increases in disability among elderly persons; tests of the interaction between these risk factors were consistent with both additive and multiplicative models, with the interaction effects falling roughly midway between these alternatives.

The effects of obesity and diabetes were consistent with a complex multistage/multi-path 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.[6]

LIMITATIONS

The NLTCS is representative of the general U.S. elderly population, for which only a small fraction was covered by private LTCI during the study period. The LTC experience of insured elderly may be substantially different from that of non-insured elderly.

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View Stallard's paper and other papers presented at the Living to 100 Symposium at http://www.soa.org/livingto100monographs. ■

END NOTES

1. *See http://www.icpsr.umich.edu/icpsrweb/NACDA/studies/9681.*
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