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Obesity and Mortality in Elderly Nursing Home Residents

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Background. The increasing prevalence of obese Americans over the last several decades has been well documented. A number of studies have analyzed the relationship of obesity and mortality in community-dwelling elderly persons, but little work has analyzed this issue within the institutionalized elderly population.

Methods. In an analysis of the 1996 Medical Expenditures Panel Study, we used logistic regression methods to examine the excess mortality associated with obesity, as defined by body mass index (BMI), over calendar year 1996 for existing and new nursing home residents.

Results. Across the total sample of existing and new residents, there was not a statistically significant difference in mortality for "obese" (BMI $>$ 28 kg/m^2) nursing home residents (odds ratio [OR] 0.89; 95% confidence interval [CI], 0.67–1.17) compared to the "normal" group, but obesity was associated with significantly less mortality among existing residents (OR 0.75; 95% CI, 0.57–0.98). For "thin" (BMI $<$ 19 kg/m^2) nursing home residents, there was significantly higher mortality among both current residents (OR 1.40; 95% CI, 1.11–1.77) and new admissions (OR 1.63; 95% CI, 1.17–2.28). For "very obese" (BMI $>$ 35 kg/m^2) individuals, there was a significantly higher mortality among new admissions (OR 1.75; 95% CI, 1.10–2.80), but not existing residents (OR 0.67; 95% CI, 0.38–1.15). These effects persisted for "very obese" individuals (BMI $>$ 40 kg/m^2).

Conclusions. Very obese nursing home residents experience higher mortality early in their stay, but this association diminishes over time with some evidence suggesting that a higher BMI may be protective among long-stay residents.

THE increasing prevalence of obese Americans over the last several decades has been well documented (1,2). Obesity is associated with a higher incidence of multiple medical conditions and may be associated with approximately 300,000 excess deaths annually in the United States (3). However, the relationship between obesity and mortality in older individuals is not straightforward. Controversy has persisted as to whether the relationship of obesity to increased mortality at younger ages persists into later life. Some studies (4–6) have observed higher mortality for obese elderly individuals, other studies (7,8) have observed a mitigated effect relative to younger obese individuals, still others (9,10) have observed no significant relationship in the elderly population, and a final set of studies (11,12) has observed a negative (or protective) effect of obesity on mortality for elderly individuals. A potential limitation of all of these studies is the general focus on the community-dwelling elderly population. Approximately 1.6 million individuals age 65 or older (constituting roughly 5% of all elderly individuals in the United States) reside in nursing homes (13). Yet, there is only limited research examining the relationship between obesity and mortality in the institutionalized elderly population (14). The elderly nursing home population is typically more disabled than are community-dwelling elderly persons, and requires a greater intensity of services. Thus, it may stand to reason that there is a strong positive relationship between obesity and mortality for institutionalized elderly persons.

Using national data from the Medical Expenditure Panels Study (MEPS) Nursing Home Component for both existing and newly admitted nursing home residents, we test the hypothesis that obese individuals are associated with excess mortality relative to individuals classified as normal with regard to body mass index (BMI).

Methods

Data Source

The MEPS is a national survey conducted by the Agency for Healthcare Research and Quality (AHRQ) on health service utilization and costs in the United States. Our data come from the Nursing Home Component of the MEPS, which details patient characteristics, health care utilization, and costs in nursing homes. The MEPS Nursing Home Component was a survey of nursing homes and persons residing in or admitted to nursing homes at any time during calendar year 1996. Due to patient confidentiality concerns, access to the MEPS was available only within AHRQ's restricted Data Center in Rockville, Maryland.

The nationally representative sample was selected using a two-stage stratified probability design (15). In the first stage, 815 facilities were selected via a stratified sample by nursing home size and in the second stage, 5899 facility residents were sampled from both existing residents as of December 31, 1995 and those residents admitted during calendar year 1996. Round 1 of the survey consisted of residents of nursing homes as of December 31, 1995. Rounds 2 and 3 consisted of residents admitted from the first and second halves of 1996, respectively, who had not

Table 1. Characteristics of Nursing Home Residents Across Weight Categories

Characteristic	Total Sample ($N = 5899$)	Thin (BMI < 19) ($N = 1131$)	Normal Weight ($N = 3503$)	Obese (BMI > 28) ($N = 1265$)
Outcome				
Died (%)	27.06	35.19*	24.75	26.17
Patient demographics				
Age, y	79.79	81.80*	80.33	76.49*
Female, %	67.47	72.50*	65.49	68.46
Less than high school, %	51.68	48.10*	52.50	52.65
High school graduate, %	39.10	41.52*	38.16	39.57
College graduate, %	9.22	10.38	9.34	7.78
Family income, $	14,312	16,096	13,557	14,805
White, %	89.08	88.68	89.35	88.70
Black, %	8.65	8.49	8.45	9.33
Other race, %	2.27	2.83	2.20	1.98
Hispanic, %	3.12	2.73	3.32	2.91
No family contact, %	2.28	1.88	2.56	1.85
Length of stay, d	459.19	443.07	496.62	369.93*
Medicaid dominant payer, first bill paid, %	47.09	46.77	48.96	42.21*
Medicare dominant payer, first bill paid, %	19.65	20.34	17.93	23.79*
Admitted from other nursing home, %	6.20	6.28	6.79	4.51*
Admitted from hospital, %	59.64	59.50	59.43	60.32
Do-not-resuscitate order, %	42.57	47.35*	42.99	36.68*
Do-not-hospitalize order, %	3.33	3.59	3.42	2.79
Patients' health characteristics				
Activities of daily living impairments	4.48	4.80*	4.49	4.14*
Alzheimer's disease, %	12.10	12.64	13.25	8.43*
Arteriosclerotic heart disease, %	16.11	16.36	17.16	12.96*
Arthritis, %	21.03	19.19	21.64	20.99
Bladder incontinence, %	55.58	58.13	57.08	49.12*
Bowel incontinence, %	47.23	53.84*	48.24	38.42*
Cancer, %	9.67	12.20	8.62	10.33
Cardiovascular disease, %	14.83	14.59	15.96	11.92*
Delusional, %	3.41	2.17*	3.69	3.74
Dementia, %	28.46	30.15	30.66	20.83*
Depression, %	17.84	18.57	17.70	17.57
Diabetes, %	18.04	9.02*	18.24	25.60*
Hallucinations, %	3.08	1.72*	3.38	3.49
Hearing impaired, %	10.93	12.14	11.86	7.23*
Heart failure, %	21.83	20.78	22.41	21.14
Hip fracture, %	7.16	7.78	7.96	4.37*
Hypertension, %	36.78	30.59*	38.02	38.87
Manic depression, %	1.12	0.88	1.08	1.43
Mental retardation, %	8.91	6.76*	9.00	10.62
Paraplegia, %	0.56	0.53	0.43	0.95*
Parkinson's disease, %	5.79	5.84	6.54	3.66*
Schizophrenia, %	3.12	1.95*	3.34	3.58
Severely impaired vision, %	12.42	15.98*	12.35	9.41*
Stroke, %	20.18	18.21*	21.38	18.60*
Understands others in communication, %	77.51	76.52	75.59	83.76*
Understood by others in communication, %	78.47	76.34	77.17	84.00*

Notes: *Statistically different from normal weight category at $p < .05$ level. BMI = body mass index.

previously been admitted to a nursing home in 1996. A resident was defined as an individual who spent at least one night in the nursing home.

The two key variables of interest in this study were mortality and BMI. Mortality was measured within the MEPS as whether the individual died by December 31, 1996. Given the inherent design of the study, we observed longer follow-up for round 1 sample persons residing in nursing homes on December 31, 1995 relative to round 3 sample persons admitted late in 1996. However, the sicker, more disabled nature of nursing home residents makes it possible to draw inferences with only limited follow-up for certain residents. Indeed, 27% of our overall nursing home sample died during 1996, and 18.7% of round 3 sample persons died.

We calculated BMI (kg/m^2), a proxy for obesity, by using height and weight from the individuals' medical charts at the time of entry into the study. Based on BMI, individuals were classified into one of three weight categories using thresholds established by earlier studies (4,7,12). Of the 5899 sample persons, 1131 (or 19.2%) had a BMI < 19 and were thus classified as thin. Of the 5899 sample persons, 1265 (or 21.4%) had a BMI > 28 and met our initial definition of obesity. The remaining 3503 (or 59.4%) of the sample who were not classified as either thin (BMI < 19) or obese (BMI > 28) were classified as normal with regard to weight. In recognition of the heterogeneity that may exist within the very obese population, we also classified 520 (or 8.8%) of the sample with a BMI > 35 and 384 (or 6.5%) of the sample with a BMI > 40 as obese in alternate model specifications.

In an effort to get a more precise measure of the effect of BMI on mortality, we also used a second classification scheme that divided the cohort into 7 BMI groups to calculate mortality rates for individuals outside of the extremes of the population. Following recent work (7,12), we divided these groups as follows: group 1 (BMI < 19.0); group 2 (BMI 19.0–21.9); group 3 (BMI 22.0–24.9); group 4 (BMI 25.0–26.9); group 5 (BMI 27.0–28.9); group 6 (BMI 29.0–31.9); and group 7 (BMI ≥ 32.0).

Risk Factors

A number of individual level variables were used as covariates within the analyses. Specifically, we included demographics, familial resources, source of nursing home admission, presence of a do-not-resuscitate order, presence of do-not-hospitalize order, length of stay at the time of the survey, and individual health and well-being (see Table 1 for a full list of covariates and descriptive statistics). All of the covariates used in the study were obtained from survey questionnaires except for payer status, which was obtained from nursing home billing data.

Statistical Analyses

We performed statistical analyses using Stata software (16). In the bivariate analyses, we used a one-way analysis of variance to assess associations between the BMI categories and the other variables included in our study. In the multivariate model, we used a logistic regression analysis to assess associations between BMI and mortality. Statistical significance was assessed at the $p = .05$ level. Facility and resident level MEPS survey weights were used in the logistic

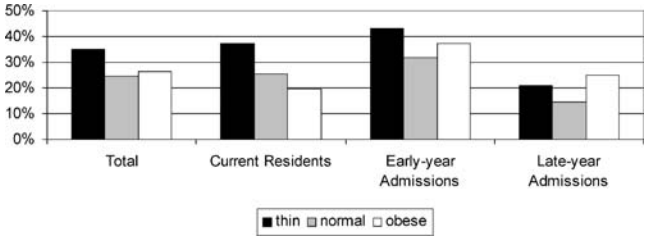

Figure 1. Unadjusted 1-year mortality by weight category. Thin is defined as a body mass index less than 19 and obese is defined as a body mass index greater than 28.

regression analyses to address any over- or under-selection of facility or resident characteristics within the sampling process (15). The weighted regressions generated results for the universe of nursing home residents in 1996. We estimated five alternate specifications of the model: (1) total sample (MEPS rounds 1–3), (2) current (as of January 1, 1996) residents (round 1), (3) early-year admissions in 1996 (round 2), (4) late-year admissions in 1996 (round 3), and (5) all new admissions in 1996 (rounds 2 and 3). We present multivariate results based on three alternate definitions of the obese group: BMI $>$ 28, BMI $>$ 35, and BMI $>$ 40.

Importantly, we also experimented with an unweighted Cox proportional hazards model to take into account time to death within the population. Although we do not report these estimates, we obtained similar results to the logistic regression results presented in the tables.

Results

Descriptive survival and demographic characteristics at the time of the initial assessment for the three separate weight categories are summarized in Table 1. There were a number of statistically significant differences across the obese and normal groups. The obese group was less likely to be Medicaid-funded, admitted from another nursing home, and to have a do-not-resuscitate order, and was more likely to be younger, Medicare-funded, and to have a relatively shorter length of stay. In terms of health characteristics, the obese group had fewer cases of functional impairment, Alzheimer's disease, atherosclerotic heart disease, bladder or bowel incontinence, cardiovascular disease, dementia, hearing impairment, hip fracture, Parkinson's disease, severely impaired vision, stroke, and communication problems, and more cases of diabetes.

The thin group had the highest mortality (35.19%), followed by the obese (BMI $>$ 28) group (26.17%) and the normal weight group (24.75%) for the overall sample (see Figure 1). The thin group was statistically different from the normal group, but the obese group was not. The findings changed when we divided the sample across the existing and new admissions. Unless otherwise noted below, the obese and thin groups were statistically different from the normal weight group. For the existing residents, the thin group still had the highest mortality (37.38%), but the obese group (19.75%) was associated with lower mortality relative to the normal group (25.62%). For the early year 1996 admissions, the thin group had the highest mortality (43.32%) and the obese group (37.43%) had higher mortality relative to the normal weight group (31.83%), although the difference between the normal weight and obese groups was not statistically significant ($p = .067$). For the late year 1996 admissions, the obese group (25.21%) had the highest mortality, followed by the thin (21.03%) and normal weight (14.63%) groups.

Table 2. Relationship of Obesity (BMI $>$ 28) and Thinness to Mortality: Logistic Regression Results

Survey Group[†]	Thin Group OR (95% CI)	Obese Group OR (95% CI)
Total of residents and admissions ($N = 4882$)	1.47 (1.22–1.77)[†]	0.89 (0.67–1.17)
Group 1: Current residents ($N = 2782$)	1.40 (1.11–1.77)[†]	0.75 (0.57–0.98)*
Group 2. Early-year admissions ($N = 1072$)[‡]	1.97 (1.27–3.06)[†]	0.89 (0.50–1.60)
Group 3: Late-year admissions ($N = 1001$)[§]	1.38 (0.71–2.68)	1.68 (0.87–3.25)
Groups 2 and 3: Admitted residents ($N = 2090$)[‖]	1.63 (1.17–2.28)[†]	1.06 (0.66–1.71)

Notes: Survey group variables included: Continuous (age, family income, number of functional limitations, and length of stay) and Categorical/binary (sex, education, race, ethnicity, payer source, admission from hospital, admission from other nursing home, lack of family contact, do-not-resuscitate order, do-not-hospitalize order, Alzheimer's disease, arteriosclerotic heart disease, arthritis, bladder incontinence, bowel incontinence, cancer, cardiovascular disease, delusional, dementia, depression, diabetes, hallucinations, hearing impaired, heart failure, hip fracture, hypertension, manic depression, mental retardation, paraplegia, Parkinson's disease, schizophrenia, severely impaired vision, stroke, understands others, and understood by others).

*Significant at $p < .05$ level.

[†]Significant at $p < .01$ level.

[‡]Four observations were dropped because they predicted mortality perfectly.

[§]Twenty-three observations were dropped because they predicted mortality perfectly.

[‖]Ten observations were dropped because they predicted mortality perfectly.

BMI = body mass index; OR = odds ratio; CI = confidence interval.

The results of the logistic regression analysis examining the relationship between obesity (BMI $>$ 28) and mortality are displayed in Table 2. Across all five model specifications, the obese group was not associated with a higher, statistically significant likelihood of mortality relative to the normal weight group. For the existing residents on January 1, 1996, the obese group was associated with a lower likelihood of mortality (odds ratio [OR] 0.75; 95% confidence interval [CI], 0.57–0.98). The thin group was significantly associated with higher mortality for every specification except the late-year admissions. For instance, the thin group was associated with a 47% greater likelihood of death relative to the normal weight group in the specification containing data from the entire sample.

There may exist some heterogeneity among very obese institutionalized individuals. To address this concern, we estimated the same five model specifications using BMI $>$ 35 (see Table 3) and BMI $>$ 40 (see Table 4) as the cutoffs for obese individuals. The results support the contention that the "very obese" institutionalized population experienced a different pattern of mortality. For individuals with a BMI $>$ 35, there was not a statistically significant association between obesity and mortality within the overall, current

Table 3. Relationship of Obesity (BMI > 35) and Thinness to Mortality: Logistic Regression Results

Survey Group	Thin Group OR (95% CI)	Obese Group OR (95% CI)
Total of residents and admissions ($N = 4882$)	1.53 (1.27–1.83)*	1.16 (0.78–1.72)
Group 1: Current residents ($N = 2782$)	1.45 (1.15–1.82)*	0.67 (0.38–1.15)
Group 2: Early-year admissions ($N = 1072$)†	2.11 (1.35–3.31)*	1.41 (0.74–2.66)
Group 3: Late-year admissions ($N = 1001$)‡	1.42 (0.74–2.75)	2.88 (1.34–6.20)*
Groups 2 and 3: Admitted residents ($N = 2090$)§	1.74 (1.23–2.47)*	1.75 (1.10–2.80)*

Notes: *Significant at $p < .01$ level.

†Four observations were dropped because they predicted mortality perfectly.

‡Twenty-three observations were dropped because they predicted mortality perfectly.

§Ten observations were dropped because they predicted moritality perfectly.

BMI = body mass index; OR = odds ratio; CI = confidence interval.

resident or early-year admission samples. However, the sample of late-year admissions was associated with statistically significant higher mortality (OR 2.88; 95% CI, 1.34–6.20). When the early- and late-year admission samples were combined, they were also associated with statistically significant higher mortality (OR 1.75; 95% CI, 1.10–2.80). The thin group was associated with statistically significantly higher mortality in every model specification except the late-year admissions.

When we used a BMI of 40 as the threshold for obesity, the magnitude of the estimates increased for the late-year admissions. The results were not statistically significant for the overall or current resident samples. However, very obese individuals within both the early-year (OR 2.10; 95% CI, 1.07–4.13) and late-year (OR 3.28; 95% CI, 1.35–7.98) admission samples were associated with significantly higher mortality. When we examined overall admissions, we also found a statistically significant positive association between obesity and mortality (OR 2.30; 95% CI, 1.28–4.11). The thin group was associated with significantly higher mortality in every model specification except the late-year admissions.

We also calculated mortality rates for individuals outside of the extremes of the population. In Figure 2, we present the

Table 4. Relationship of Obesity (BMI > 40) and Thinness to Mortality: Logistic Regression Results

Survey Group†	Thin Group OR (95% CI)	Obese Group OR (95% CI)
Total of residents and admissions ($N = 4882$)	1.55 (1.29–1.86)**	1.54 (0.93–2.56)
Group 1: Current residents ($N = 2782$)	1.47 (1.17–1.85)**	0.90 (0.44–1.83)
Group 2: Early-year admissions ($N = 1072$)†	2.17 (1.39–3.42)**	2.10 (1.07–4.13)*
Group 3: Late-year admissions ($N = 1001$)‡	1.39 (0.72–2.67)	3.28 (1.35–7.98)**
Groups 2 and 3: Admitted residents ($N = 2090$)§	1.78 (1.25–2.53)	2.30 (1.28–4.11)**

Notes: Survey group variables included: Continuous (age, family income, number of functional limitations, and length of stay) and Categorical/binary (sex, education, race, ethnicity, payer source, admission from hospital, admission from other nursing home, lack of family contact, do-not-resuscitate order, do-not-hospitalize order, Alzheimer's disease, arteriosclerotic heart disease, arthritis, bladder incontinence, bowel incontinence, cancer, cardiovascular disease, delusional, dementia, depression, diabetes, hallucinations, hearing impaired, heart failure, hip fracture, hypertension, manic depression, mental retardation, paraplegia, Parkinson's disease, schizophrenia, severely impaired vision, stroke, understands others, and understood by others).

*Significant at $p < .05$ level

**Significant at $p < .01$ level.

†Four observations were dropped because they predicted mortality perfectly.

‡Twenty-three observations were dropped because they predicted mortality perfectly.

§Ten observations were dropped because they predicted mortality perfectly.

BMI = body mass index; OR = odds ratio; CI = confidence interval.

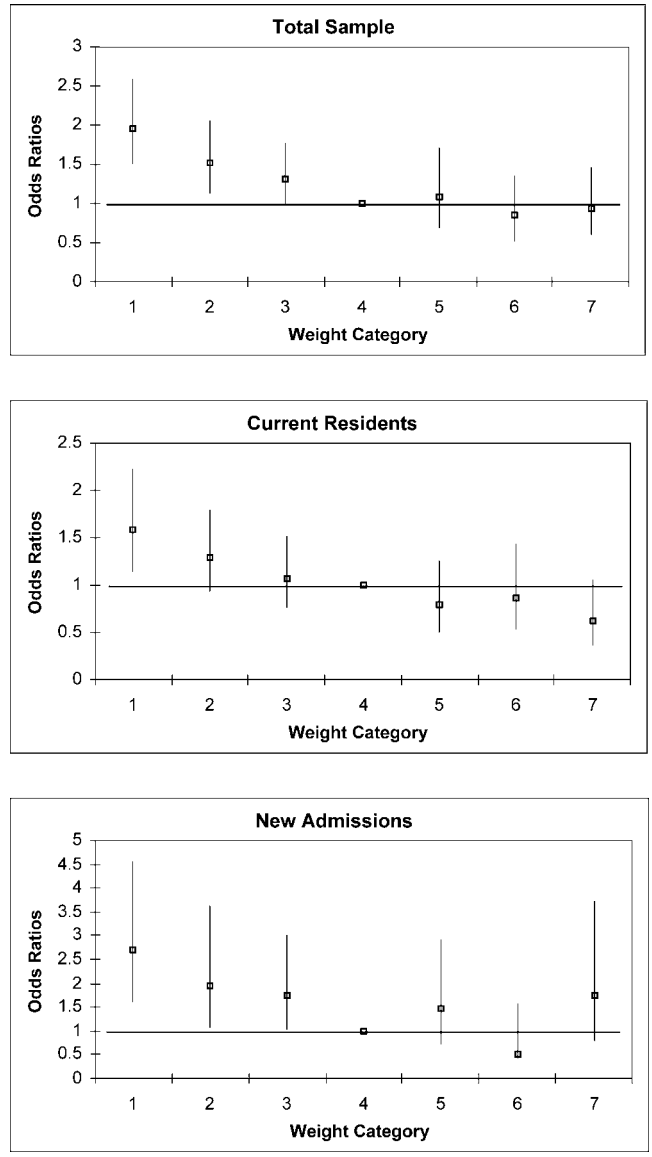

Figure 2. Adjusted odds ratios of death by weight category. Odds ratios with 95% confidence interval of death for all nursing home residents (top panel), current nursing home residents (middle panel), and new nursing home admissions (bottom panel). Category 1 (body mass index [BMI] <19.0); Category 2 (BMI 19.0–21.9); Category 3 (BMI 22.0–24.9); Category 4 (BMI 25.0–26.9); Category 5 (BMI 27.0–28.9); Category 6 (BMI 29.0–31.9); Category 7 (BMI>32.0).

OR values of mortality across 7 BMI categories after adjustment for the same set of variables contained in the regression results above. The reference category was individuals with a BMI of at least 25 but not greater than 27 (Category 4). In this specification, the extreme obesity categories were not statistically different from the reference category. However, the most extreme thin category (Category 1) was significantly different for the entire sample, current residents only and new admissions only. Category 2 was also significantly different for the entire sample, and Categories 2 and 3 were significantly different for the new admissions. Thus, among the thin elderly nursing home population, the BMI threshold for risk of death is lower for existing residents relative to new admissions.

Discussion

We hypothesized that obese elderly nursing home residents would experience higher mortality relative to normal weight individuals. However, we found a more complex relationship in that obese persons residing in the nursing home at the time of the initial survey were less likely to die, whereas obese patients acutely admitted during the period of data collection were more likely to die in the months following admission. Thus, high BMI is associated with increased mortality postadmission for the morbidly obese, but conditional on surviving this initial period, is not associated with increased mortality among long-stay nursing home residents.

The result for long-stay nursing home residents fits into a broader literature showing that obesity is not predictive of greater hospitalization (17) or increased mortality (12) in community-dwelling elderly individuals. The higher mortality observed among new admissions likely reflects the fact that very obese individuals admitted to nursing homes are an acutely ill population, even though the model controlled for a number of health characteristics.

We performed a sensitivity analysis for the relatively small cohort of respondents that were morbidly obese, variously defined as BMI > 35 ($n = 520$) or BMI > 40 ($n = 384$). In these groups, obesity was more often associated with increased death in those persons admitted during the study period. We hypothesize that morbidly obese individuals differ in important ways from those individuals with a BMI > 28. For instance, normal weight individuals and those with a BMI > 28 were admitted to nursing homes from hospitals at similar rates, but individuals with a higher BMI were more frequently admitted from the hospital. From Table 1, 59.43% of normal weight individuals were admitted to the nursing home from a hospital, whereas 60.32% of those individuals with a BMI > 28 were admitted via this pathway. Although unreported in the tables, 66.35% of those with a BMI > 35 and 69.53% of those with a BMI > 40 were admitted to the nursing home from a hospital.

As in community-dwelling elderly individuals (12), underweight has a far greater association with mortality than does obesity. Institutionalized elderly persons tend to weigh less than those persons living at home (18). Nursing home residents may be underweight and/or lose weight for a variety of reasons (19), including increasing age, depression, medications, psychotropic drug reduction, swallowing disorders, paranoia, dementia (20), gallstones, obsessive-compulsive disorder, dehydration, cancer (21), poor oral intake (22), eating dependency, pressure ulcers, and chewing problems. Sleep disturbances, common in elderly persons, may be associated with increased rates of death and nursing home admission in community-dwelling elderly persons (23). In a cohort of nursing home residents, those who died lost an average of 10% of their body weight from the time of nursing home admission; weight loss was also associated with decreased functional ability and transfer to a higher level of nursing home care (24). Weight loss in nursing home residents of greater than 10% over a 6-month period may well predict mortality in the ensuing 6 months (25,26). Improved oral feeding methods and treatment of depression are potentially important ways to counteract these effects (27).

One recent study by Volpato and colleagues (14) on elderly nursing home residents suggests that BMI may not be the best index of body composition. In this sample of older nursing home residents, body cell mass (BCM) was a strong and independent risk factor for mortality, and performed better than BMI; higher BCM is associated with longer survival. BCM includes the fat-free portion of cells within muscle, viscera, and the immune system and may be considered to be the (functionally) most important compartment in determining energy expenditure, protein needs, and the metabolic response to stress. BCM declines progressively with age, particularly in the thinnest persons, and its decline has been reported as an important predictor of functional decline in older persons (28). Most studies (including ours) that examine the relationship between body composition and mortality do not use this sophisticated measure, but a relative strength of this current study is that our sample size is almost 20 times as large as the sample in the study by Volpato and colleagues.

Another potential limitation of this study is the inability to control for cigarette smoking. Cigarette smoking is a confounder, because it is associated with increased mortality as well as lower body weight. The MEPS did not ask respondents questions about their smoking histories.

A final limitation is the relatively small sample of morbidly obese individuals. Because the MEPS is a nationally representative sample of nursing home residents, this issue relates to the small number of these individuals found in U.S. nursing homes.

Our work suggests that obesity may have dual effects on mortality in nursing home residents, which may assist clinicians to provide prognostic information to patients and family members. Very obese patients may have mortality 2–3 times as great as normal weight individuals during the initial period following admission, and underweight patients continue to suffer excess mortality throughout their stays. Medical and policy implications are unclear. Although encouraging better nutrition for underweight patients would seem worthwhile, the value of weight-loss interventions in obese nursing home residents remains uncertain.

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The results and conclusions in this paper are those of the authors and do not necessarily indicate concurrence by AHRQ or the Department of Health and Human Services.

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References

1. Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL. Increasing prevalence of overweight among US adults. The National Health and Nutrition Examination Surveys, 1960 to 1991. *JAMA*. 1994;272: 205–211.
2. Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and trends in obesity among US adults, 1999–2000. *JAMA*. 2002;288:1723–1727.
3. Allison DB, Fontaine KR, Manson JE, Stevens J, VanItallie TB. Annual deaths attributable to obesity in the United States. *JAMA*. 1999; 282:1530–1538.
4. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CW Jr. Body-mass index and mortality in a prospective cohort of U.S. adults. *N Engl J Med*. 1999;341:1097–1105.
5. Harris T, Cook EF, Garrison R, Higgins M, Kannel W, Goldman L. Body mass index and mortality among nonsmoking older persons. The Framingham Heart Study. *JAMA*. 1988;259:1520–1524.
6. Cornoni-Huntley JC, Harris TB, Everett DF, et al. An overview of body weight of older persons, including the impact on mortality. The National Health and Nutrition Examination Survey I–Epidemiologic Follow-up Study. *J Clin Epidemiol*. 1991;44:743–753.
7. Stevens J, Cai J, Pamuk ER, Williamson DF, Thun MJ, Wood JL. The effect of age on the association between body-mass index and mortality. *N Engl J Med*. 1998;338:1–7.
8. Bender R, Jockel KH, Trautner C, Spraul M, Berger M. Effect of age on excess mortality in obesity. *JAMA*. 1999;281:1498–1504.
9. Diehr P, Bild DE, Harris TB, Duxbury A, Siscovick D, Rossi M. Body mass index and mortality in nonsmoking older adults: The Cardiovascular Health Study. *Am J Public Health*. 1998;88:623–629.
10. Takala JK, Mattila KJ, Ryynanen OP. Overweight, underweight and mortality among the aged. *Scand J Prim Health Care*. 1994;12:244–248.
11. DeVore PA. Assessment of nutritional status and obesity in elderly patients as seen in general medical practice. *South Med J*. 1993;86: 1008–1010.
12. Grabowski DC, Ellis JE. High body mass index does not predict mortality in older people: analysis of the Longitudinal Study of Aging. *J Am Geriatr Soc*. 2001;49:968–979.
13. Krauss NA, Altman BA. *Characteristics of Nursing Home Residents-1996*. Rockville, MD: Agency for Health Care Policy and Research; 1998. MEPS Research Findings No. 5. AHCPR Pub No. 99-0006.
14. Volpato S, Romagnoni F, Soattin L, et al. Body mass index, body cell mass, and 4-year all-cause mortality risk in older nursing home residents. *J Am Geriatr Soc*. 2004;52:886–891.
15. Sommers J, Bethel J, Broene P. *Construction of Weights for the 1996 Medical Expenditure Panel Survey Nursing Home Component*. Rockville, MD: Agency for Health Care Policy and Research; 1999. MEPS Methodology Report No. 7. AHCPR Pub. No. 99-0045.
16. Stata Corp. Stata Statistical Software, Release 8.0. College Station, TX: Stata Corp., 2003.
17. Luchsinger JA, Lee WN, Carrasquillo O, Rabinowitz D, Shea S. Body mass index and hospitalization in the elderly. *J Am Geriatr Soc*. 2003; 51:1615–1620.
18. Sibai AM, Zard C, Adra N, Baydoun M, Hwalla N. Variations in nutritional status of elderly men and women according to place of residence. *Gerontology*. 2003;49:215–224.
19. Dale MC, Burns A, Panter L, Morris J. Factors affecting survival of elderly nursing home residents. *Int J Geriatr Psychiatry*. 2001;16: 70–76.
20. Wang SY, Fukagawa N, Hossain M, Ooi WL. Longitudinal weight changes, length of survival, and energy requirements of long-term care residents with dementia. *J Am Geriatr Soc*. 1997;45: 1189–1195.
21. Morley JE, Kraenzle D. Causes of weight loss in a community nursing home. *J Am Geriatr Soc*. 1994;42:583–585.
22. Berkhout AM, Cools HJ, van Houwelingen HC. The relationship between difficulties in feeding oneself and loss of weight in nursing-home patients with dementia. *Age Ageing*. 1998;27:637–641.
23. Pollak CP, Perlick D, Linsner JP, Wenston J, Hsieh F. Sleep problems in the community elderly as predictors of death and nursing home placement. *J Community Health*. 1990;15:123–135.
24. Chang JI, Katz PR, Ambrose P. Weight loss in nursing home patients: prognostic implications. *J Fam Pract*. 1990;30:671–674.
25. Murden RA, Ainslie NK. Recent weight loss is related to short-term mortality in nursing homes. *J Gen Intern Med*. 1994;9:648–650.
26. Ryan C, Bryant E, Eleazer P, Rhodes A, Guest K. Unintentional weight loss in long-term care: predictor of mortality in the elderly. *South Med J*. 1995;88:721–724.
27. Blaum CS, Fries BE, Fiatarone MA. Factors associated with low body mass index and weight loss in nursing home residents. *J Gerontol A Biol Sci Med Sci*. 1995;50:M162–M168.
28. Moore FD, Olesen KH, McMurray JD. *The BodyCell Mass and Its Supporting Environment: Body Composition in Health and Disease*. Philadelphia: W.B. Saunders; 1963.

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