The effect of weight change on nursing care facility admission in the NHANES I Epidemiologic Followup Survey

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Abstract

Data from the first National Health and Nutrition Examination Survey Epidemiologic Followup Survey were used to examine whether weight change was associated with an increased relative risk of nursing care facility admission. Hazard ratios were calculated with Cox proportional hazards models and stratified by overweight status at baseline. Moderate and large weight loss was associated with an increased risk of nursing care facility admission in overweight and non-overweight subjects. Large weight gain was associated with an increased relative risk in only overweight subjects. In the process of functional decline that results in nursing care facility admission, weight loss may be a sign of acute illness, starvation, or aging. Preventing weight loss may help delay this process of decline. In overweight subjects, preventing weight gain may also be important in delaying this process of decline.   © 2003 Elsevier Inc. All rights reserved.

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1. Introduction

Large weight loss and large weight gain have been associated with greater morbidity, mortality, functional limitation, and greater health care charges [1–19]. Given that weight gain and weight loss have been strongly associated with aspects of declining functional status, both may be risk factors for earlier nursing home utilization. Previous work has shown that weight loss is a risk factor for nursing home use; however, a relationship with weight gain has not been demonstrated [4,20]. An identification of the effect of weight loss and weight gain on nursing home placement would facilitate a further understanding of the role of weight change in future health care use.

The reasons that weight gain and weight loss are related to nursing home utilization probably result from different mechanisms. Studies have shown weight gain to be associated with comorbidities such as diabetes mellitus type II [3,7,12], hypertension [13], coronary heart disease [2,10],

and decreased physical function and vitality [8,19]. The process of functional decline associated with weight gain leads individuals to be placed in nursing care facilities [21]. However, weight loss has been closely tied to the aging process and may be a result of the disability process [22]. Findings from mostly cross-sectional studies suggest that individuals gain weight until they reach their fifties or sixties, at which time they begin to lose weight [23–25]. Therefore, to investigate the full spectrum of weight change, study populations need to include a greater age range. Furthermore, the few studies that have focused on weight dynamics have largely ignored initial weight or body mass index (BMI) status. Several studies have shown initial BMI to have a mediating effect on the relationship between morbidity and weight change [16,17,26–28].

Although previous work has found obesity and weight loss to be associated with a greater hazard of nursing home placement, an association between weight gain and nursing care facility placement has not been demonstrated [4,20,29]. We focused on the total effect of longer-term weight change among middle-aged and older adults on nursing home placement. Using a national sample of US adults, we examined the association between weight measurements taken approximately 10 years apart and the relative risk of subsequent nursing home admission. We also examined whether

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the effect of weight change on nursing home admission varies by initial weight status.

2. Methods

2.1. Survey description

A cohort of 14,407 persons who were 25 years of age or older at the first National Health and Nutrition Examination Survey (NHANES I) baseline examination between 1971 and 1975 were followed through 1992. The NHANES I collected data from a national probability sample of the US civilian noninstitutionalized population and included a standardized medical examination and questionnaires that covered various health-related topics.

The NHANES I Nutrition Examination Survey Epidemiologic Followup Survey (NHEFS) is comprised of a series of four follow-up surveys conducted in 1982 through 1984, 1986, 1987, and 1992. For all of the waves, except in 1986, all persons who were between 25 and 74 years at their NHANES I examination were included. The second wave of data collection, the 1986 NHEFS, was conducted for members of the NHEFS cohort who were 55 to 74 years at their baseline examination. For this analysis, subjects 45 years and older at baseline ($n = 7957$) were included. The analysis sample is also restricted to white subjects ($n = 6746$) because nursing home admissions among other racial groups were too small to for us to investigate possible differences in the relation under study.

2.2. Weight variables

We examined the weight change that occurred between the baseline examination conducted from 1971 through 1975 and the first follow-up examination from 1982 through 1984. At baseline, weight (in disposable paper uniforms and slippers) and height were measured with standardized procedures in examination trailers [30]. At the follow-up survey in 1982–84, weight was measured (with indoor clothing and without shoes) on a portable scale in the subject's home. Because of limitations of the portable scales, weights were recorded only up to 300 lb (136.2 kg). After excluding participants with weights over 300 lb from the analysis ($n = 3$), we calculated percent weight change from their baseline measurement. We also calculated annual percent change values to adjust for different lengths of time between interviews. The annual values were then divided into quintiles, and we used the middle quintile as the referent. We calculated the annual change in kilograms and divided these values into quintiles.

The 1982–84 weights were not adjusted for indoor clothing because we have no data to estimate clothing weight. Our analyses would be unchanged by the subtraction of a constant estimated weight of indoor clothing from the follow-up weight.

No data were available regarding the volition of the weight change experienced by these subjects. Therefore, we were unable to distinguish involuntary and voluntary weight change.

By comparing models that included and excluded baseline overweight status, we investigated the influence of baseline overweight status on the association between weight change and nursing care facility admission. We used subjects' baseline BMI (weight in kilograms divided by height in meters, squared) and categorized it as <25 and ≥25.0 to signify not overweight and overweight [31]. We also investigated whether the association between weight change and nursing care facility admission varied by baseline overweight status. The model that we present is stratified by baseline weight.

2.3. Nursing home admissions

For this analysis, our outcome measure is the date of the first occurrence of nursing home admission because discharges back to the community are relatively rare [32,33]. We included only admissions that occurred during the ensuing years from the subjects' 1982–84 interview through 1992.

For the NHEFS, reports of nursing home facility stays were elicited through a series of questions in the interview. Respondents were asked to report the date of all overnight facility stays since they were last surveyed, and thus time in this analysis can be viewed as continuous. With respondents' permission, all reported facilities were contacted by mail and asked to abstract information (subsequently referred to as abstract data) from the respondents' medical records on dates of admission. Self-reported dates of admission were used ($n = 50$) when abstract data were unavailable. Hazard ratios were similar whether or not self-reported admissions were included in the analysis.

2.4. Covariates

Andersen's conceptual model, which is commonly used to study health care utilization by the elderly population, and previous research provided the rationale for including the following variables at baseline: age, sex, marital status, education, height, smoking status, single- or multi-person household, presence of children, physical activity, region of residence, and urban/rural residence [20,21,34–39]. For this analysis, marital status was defined as married or not married at baseline. Not married included respondents who were widowed, never married, divorced, or separated. Level of education was defined as less than a high school degree or greater than or equal to a high school degree. Region was determined by dividing the United States into four geographic regions of approximately equal population; this deviated somewhat from the groups used by the Bureau of Census [30]. For the NHANES I survey, Texas, Oklahoma, Kansas, Nebraska, North Dakota, and South Dakota were considered in the west. The Bureau of Census includes Texas and Oklahoma in the south and Kansas, Nebraska, North

Dakota, and South Dakota in the midwest [40]. Another difference was that the midwest region was formerly labeled the North Central Region by the Bureau of Census before 1984. Urban areas included areas with populations of 2500 or more. Information on smoking status and presence of children were obtained from the 1982–84 survey because these data were not collected for the entire cohort at baseline. Smoking status was defined as current, former, or never. Physical activity was measured by two questions at baseline regarding recreational activity and usual day activity. We combined these two questions into one measure with subjects classified as (1) inactive if they reported being the least active in both questions, (2) very active if they reported being very active for either response, and (3) moderately active for all other combinations. These measures of physical activity had not been validated, but other research has shown these measures to be associated with chronic diseases [41–44].

The effect of pre-existing disease states, such as colon cancer, heart disease, colitis, and diabetes, was investigated in an additional analysis of subjects who lost weight. Self-reported data from the 1982–84 survey were used to create dummy variables and were included in a model. The weight loss coefficients were unchanged by the addition. We report the estimates from the model excluding these disease states. We excluded pre-existing disease states in this analysis of subjects who experienced weight gain because these states represent potential mediators of the relationship of weight gain to nursing care facility utilization [45,46]. Specifically, these diseases likely represent intermediate steps in the causal pathway between weight gain and nursing care facility admission, and we were interested in determining the total effect of weight change in this association.

2.5. Missing covariates

Multiple imputation was used to replace missing values for percent of poverty in approximately 25% of the sample [47,48; Proc Mi and Proc Mianalyze, SAS Institute, Cary, NC]. Prior research indicates that income could be an important determinant of health care use [21,35–39], and socioeconomic status has been linked to obesity [49]. Subjects with missing data in variables other than income were dropped from the analyses.

2.6. Analytical sample

Subjects were excluded if they were admitted to a nursing home before the second weight measurement (n = 543). Other subjects were excluded because they were not re-interviewed after their 1982–84 surveys (n = 473) or because they had incomplete data for variables other than income (n = 1988). After these exclusions, there were 605 admissions from a total sample of 3742.

To examine the impact of excluding participants, we compared the distribution of categorical variables for subjects admitted before 1982–84, subjects lost to follow-up, and

subjects in the final analytical sample (Table 1). The group of subjects admitted before the 1982–84 interview was older; contained more single persons, more childless individuals, and more individuals living alone; and contained fewer high school graduates and fewer very active individuals. Subjects lost to follow-up were also older and consisted of more men, childless individuals, and smokers and fewer married individuals, high school graduates, and very active individuals.

2.7. Statistical analysis

Nursing care facility admission rates were age adjusted based on 5-year age groupings by the direct method. Admission rates were stratified by baseline weight status to examine if weight change has a different effect on nursing care facility admission based on overweight status. Data were analyzed using Cox proportional hazards models [50; Proc PHREG; SAS Institute, Cary, NC]. We used Cox proportional hazards models because we were more interested in the underlying time process rather than the probability or frequency of nursing home admission. Also, Cox proportional hazards models can account for the varying lengths of follow-up time in the NHEFS. The Cox proportional hazards model

Table 1
Distribution of baseline characteristics for white participants ≥45 years of age[a]

	Admitted before 1982–84 (n = 543)	Lost to follow-up (n = 473)	Final analytical sample (n = 3742)
Baseline BMI ≥25	53	59	55
Age, yr			
45–60	15	55	66
60–75	85	45	34
Female	59	45	58
Single-person household	33	19	14
Married	55	70	78
Have children[b]	75	79	84
High school[c]	32	35	52
Smoking status[b]			
Current	22	40	29
Former	15	18	20
Never	63	42	51
Urban region	59	62	60
Northeast	18	26	23
Midwest	27	25	24
South	22	25	24
West	33	24	28
Activity			
Very active	31	41	47
Moderately active	50	50	47
Inactive	20	9	6

Abbreviation: BMI, body mass index.
[a] Values are percentages. Values do not add to 100% due to rounding.
[b] Information on smoking status and presence of children was obtained from the 1982–84 survey.
[c] Level of education was defined high school graduate or more.

has been determined to be a more appropriate method than a logistic model for this data set [51].

The time frame for this analysis was the number of years from the 1982–84 follow-up survey to nursing care facility admission. Subjects not admitted to a nursing care facility were censored at the date of their last follow-up survey.

By using interaction terms in our models, we examined whether the association between weight change and nursing home admission varies by baseline weight status, sex, and age. We also examined whether age varied the association between weight change and nursing home admission by stratifying the model on age.

Assumptions of proportionality were assessed with log-log survival plots, and the assumptions seemed to be satisfied. We analyzed the NHEFS as a cohort study and did not incorporate sampling weights because the weights are not adjusted for nonresponse and loss to followup. Our results do not reflect survey design corrections because other authors have shown that design corrections do not appreciably alter results from the NHEFS [51].

3. Results

Descriptive statistics are presented in Table 1. Median follow-up times for subjects admitted to a nursing facility and for subjects who were censored were 5.29 (range 0.07–10.71) and 9.29 (range 2.08–11.09) years, respectively. Participants who were admitted to a nursing home were older and more likely to be overweight, female, single, childless, never smokers, less educated, and less active. We labeled the annual percent change quintiles as large gain, moderate gain, maintain, moderate loss, and large loss. The ranges for each quintile were 7.59% to 0.78%, 0.78% to 0.28%, 0.28% to −0.13%, −0.13% to −0.63%, and −0.64% to −5.55%, respectively.

Age standardized rates of nursing care facility admissions are presented for each weight change category for overweight and non-overweight subjects in Table 2. Subjects who maintained their weight had the lowest rate of nursing care

facility admissions, and the 95% confidence interval (CI) of overweight and non-overweight subjects overlapped. Groups that lost or gained weight had admission rates that increased relative to their loss or gain. Large weight gain was the only category of weight change in which there seemed to be a difference between overweight and non-overweight subjects, and the CIs for these estimates did not overlap. In addition, in overweight subjects, the CIs did not overlap for those who gained the most and those who maintained their weight. However, among non-overweight subjects, those who gained the most were similar to those who maintained. Overweight and non-overweight subjects who experienced moderate weight gain and moderate weight loss had increased rates of nursing care facility admission, but their 95% CIs overlapped those who maintained their weight. Overweight and non-overweight subjects who lost the most weight had elevated admission rates compared with subjects who maintained their weight.

Results from the Cox proportional hazard modeling are presented in Table 3. We found the results from the annual change in kilograms (data not shown) and the annual percent change to be similar, so we present only values for the annual percent change. Weight change interaction terms with sex, age, and baseline weight status were not significant in our modeling. Examination of the age-stratified models also indicated that the association between weight change and nursing care facility admission did not vary by age (data not shown). Regarding baseline overweight status, our modeling showed that the association between weight change and nursing care facility admission was not appreciably changed by its addition (data not shown). The association of weight change and nursing care facility admission was also not altered by the physical activity variables.

Although the overall test of significance for interaction was not significant for the baseline weight and weight change interaction terms, the *P* value for the overweight and large gain term was noteworthy (*P* = .08). Because there seems to be some suggestion of a different effect of weight

Table 2

Age-adjusted rates[a] of nursing care facility admission in NHEFS white participants 45 years and older at baseline

Weight change category[b]	BMI <25			BMI ≥25		
	Unadjusted admissions	Person-years	Rate[c]	Unadjusted admissions	Person-years	Rate[c]
Large gain	44	3925	17.71 (12.28–23.15)	48	2631	29.78 (24.56–34.13)
Moderate gain	37	3116	13.21 (8.97–17.45)	51	3331	18.06 (13.68–21.56)
Maintain	35	2870	11.75 (7.88–15.62)	44	3576	12.51 (8.85–16.17)
Moderate loss	56	2416	19.88 (14.70–25.07)	76	3737	17.62 (13.08–23.05)
Large loss	66	1714	27.73 (20.86–34.60)	148	3730	29.35 (20.88–38.69)
Overall	238	14,041	17.52 (15.33–19.71)	367	17,005	20.9 (18.81–22.99)

Abbreviations: BMI, body mass index; NHEFS, first National Health and Nutrition Examination Survey Epidemiologic Followup Survey.

[a] Age-standardized by the direct method, with the person-year distribution in 5-year baseline age strata of the entire NHEFS sample 45 years of age and older.

[b] Weight change categories based on quintiles of annual percent change in weight between 1971–75 and 1982–84.

[c] Per 1000 person-years (95% CI in parentheses).

gain in overweight and non-overweight subjects, we present hazard ratios stratified by initial baseline weight status (see Table 3).

Change in weight was not associated with nursing care facility admission in a linear fashion in overweight subjects. Overweight subjects who experienced large weight loss were at greatest risk, followed by those who experienced large weight gain. Overweight subjects who experienced moderate weight loss also had an increased relative risk compared with overweight subjects who maintained their weight. However, in the same group, subjects who had moderate weight gain did not show an increased relative risk. Non-overweight subjects who lost the most weight were at greatest risk, followed by those who lost a moderate amount of weight. Non-overweight subjects who gained a large or moderate amount of weight did not show a statistically significant increased relative risk when compared with non-overweight subjects who maintained their weight.

4. Discussion

We found large weight gain to be a risk factor for subjects who were initially overweight, and we found weight loss to be a risk factor regardless of initial weight. The unique contribution of this study is the finding that large weight gain in overweight individuals is associated with an increased risk of nursing care facility use. A relatively small body of literature has shown obesity and underweight status to be associated with increased use of health services [29,52–54]. Finding large weight gain and weight loss to be risk factors suggests a J- or U-shaped relationship between weight change and nursing care facility admissions in overweight subjects. This result is consistent with studies that have shown a J- or U-shaped relationship with weight change and mortality [18,26,55]. However, in a study that simultaneously controlled for weight change and weight status [26], weight gain regardless of initial BMI was a weak risk factor for

mortality. We did not find moderate weight gain to be a risk factor for admission. Other research has shown adults with modest weight gain have the lowest mortality [1,56].

Like other studies [4,20], we found weight loss to be associated with an increased relative risk of nursing care facility admission. These two studies [4,20] defined weight loss as >5 kg over 6 months and as >10% over the previous 6 months with marked physical signs of malnutrition. A comparison of our results with these studies is difficult because different time frames were observed. However, it seems that our study found smaller levels of weight loss to be a risk factor. We found that, regardless of initial weight status, weight loss was a relative risk factor for nursing home admission. It has been suggested that a higher BMI offers "protection" against weight loss in later years. Our results were not consistent with that hypothesis, and a higher initial BMI did not prevent poor health outcomes and subsequent health care utilization associated with weight loss.

We were not able to determine whether weight loss in these subjects was voluntary or involuntary. Consequently, our sample includes subjects who have involuntarily lost weight for a variety of reasons (e.g., acute illness, starvation, or aging) and subjects who have voluntarily lost weight through dieting. During involuntary weight loss, the depletion of lean body mass may lead to the loss of nonspecific and specific host defenses and to the loss of the metabolic reserves of the body [57]. Thus, involuntary weight loss facilitates negative outcomes. On the other hand, intentional weight loss has been associated with improved outcomes for persons with symptoms of diabetes [3,58,59], triglycerides, and systolic and diastolic blood pressure [60–63]. The results from this study indicate that weight loss in adults aged 45 years and older was associated with an increased relative risk of admission to a nursing care facility. Other researchers have found similar results when examining the relationship between weight loss and mortality [16,17,56]. For instance, Pamuk [16,17] found any type of weight loss in individuals 45 to 74 years of age to be associated with an increased risk of death even after controlling for pre-existing disease and cigarette smoking. Similarly, we found weight loss to be associated with nursing care facility admission regardless of pre-existing diseases. Other research has found voluntary and involuntary weight loss to be associated with an increased risk of death [56,64]. However, the effect of voluntary weight loss remains controversial because other studies have found it to have no association with mortality [28,65,66], whereas others have found intentional weight loss, particularly in diabetic subjects, to be associated with a reduced mortality rate [66,67].

The NHEFS allowed us to examine the association between nursing care facility admission and long-term weight change. We were able to study this association in a population that included a wider age range than previously studied. A limitation of our study is that we were able to demonstrate these results only in whites. Further research is needed to

Table 3
Hazard ratios and 95% confidence intervals for nursing care facility admission in white NHEFS participants 45 years of age and older at baseline stratified by baseline overweight status (n = 3742)[a]

Weight change category[b]	Hazard ratio (95% CI), BMI <25	Hazard ratio (95% CI), BMI ≥25
Large gain	1.20 (0.76–1.89)	2.13 (1.40–3.23)
Moderate gain	0.99 (0.62–1.59)	1.37 (0.90–2.04)
Maintain	1.00 (NA)	1.00 (NA)
Moderate loss	1.60 (1.04–2.47)	1.47 (1.01–2.14)
Large loss	2.41 (1.58–3.66)	2.78 (1.98–3.92)

Abbreviations: BMI, body mass index; CI, confidence interval; NHEFS, first National Health and Nutrition Examination Survey Epidemiologic Followup Survey.

[a] Adjusted for baseline age, sex, marital status, single-person household, presence of children, education, height, smoking status, region of residence, urban/rural residence, income, and activity.

[b] Weight change categories based on quintiles of annual percent change in weight between 1971–75 and 1982–84.

determine whether this relationship exists in other races and ethnic groups. We were also unable to examine whether weight change had a different effect in underweight individuals because our sample of underweight subjects was too small. Weight loss in underweight individuals might be even more deleterious.

Another limitation of this study is that the weight change represents the differences between only two points in time, and those two measurements were collected from 6 to 12 years apart. We examined long-term weight change that is an average over these years. Although the magnitude of our weight change categories may seem small, the amounts should be viewed over the time span during which the measurements were collected. We also realize that some of the subjects with weight loss may represent short-term loss, particularly if it was caused by illness, whereas some may represent long-term loss, particularly if it was associated with aging. With respect to weight gain, studies examining health outcomes, such as hypertension and diabetes mellitus type II, have shown that long- and medium-term weight gain are similarly detrimental [12,13]. Also, because weight was measured only at two points in time, we were not able to examine the phenomenon of weight cycling. Studies examining weight cycling have not been conclusive, but some suggest that the pattern of weight change is important [9,68–71].

A proportion of the participants were lost to follow-up. This reduces the extent to which our sample was representative of the US population. The potential for lost to follow-up due to nursing home admission could also be present in this sample. There are no data available to determine if this mechanism is at work. Subjects lost to follow-up generally had poorer prognosis, as illustrated in their distribution of covariates, and thus the resulting analytical sample most likely exhibited a longer time to admission. Therefore, our estimates of the effect of weight change on time to admission might be conservative, but this cannot be known with certainty.

The growing obesity epidemic and the large increase in the elderly population have the potential to severely tax the health care system in the United States. Although these estimates may seem modest, the financial implications are considerable. Using 1993 Medicaid Nursing Home Expenditures and 1992 data from Health Data Associates, Ladd et al. estimated the average Medicaid daily nursing home costs to be $71.03 [72]. We predicted survival times with our data and found that persons who maintained their weight delayed nursing home admission by 1.5 to 4.7 years, which translates to an additional cost ranging from $38,000 to $111,000 for those who lost or gained weight. Studying the dynamics of weight change in the United States may provide suggestions to avoid the drain on our health care system. In the process of functional decline that results in nursing care facility admission, weight loss may be a sign of acute illness, starvation, or aging. Preventing weight loss may help delay this process. In overweight subjects, weight gain may also play a role in functional decline. Thus, preventing weight gain may also delay or prevent the sequence of events leading to nursing care facility admission.

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