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Obesity and Hospitalization over the Adult Life Course: Does Duration of Exposure Increase Use?*

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Abstract

Consistent with a new genre of research on life-course analyses of health-service use, this study explores the consequences of long-term exposure to a risk factor. Drawing from cumulative-disadvantage theory, the study examines whether obesity, especially chronic obesity, increases hospitalization admission and length of stay. Analyses make use of hospital records abstracted over 20 years from a national survey of adults 41 to 77 years of age at baseline (n = 4,574). Multiple measures of body weight are used to calculate adult obesity duration. Results reveal that obesity increased hospital admissions and length of stay over the 20 years studied. Among persons obese at any time during the study, years of obesity also led to longer stays. The findings highlight the utility of measures of the duration of risk exposure for both life-course studies of health and tests of cumulative-disadvantage theory.

The prevalence of obesity in America has risen substantially in the past two decades, even though scores of studies during this time have illuminated the health risks of excess body weight (Kopelman 2000; Ogden et al. 2006). Given the rise in obesity prevalence and the costs associated with acute-care hospitalization, the relationship between obesity and hospitalization is a matter of substantial policy interest.

The health problems linked to excess adiposity make medical treatment more complicated, and obesity can therefore be expected to yield more and longer hospital stays (Quesenberry, Caan, and Jacobson 1998). Perhaps less well-recognized, however, is the potential impact of life-long obesity on health-care use in middle and later life. Overweight and obesity in early adulthood combines with the difficulty of sustained weight loss after becoming obese to portend a major demographic scenario of chronic obesity. How will years of living as an obese person influence the use of health-care services?

Research findings to date on obesity and hospitalization are inconsistent. Some studies show that obesity increases hospital-resource consumption (e.g., Raebel et al. 2004), while others show no difference in hospital use between obese and nonobese persons (e.g., Bertakis and Azari 2005). The present research draws from cumulative-disadvantage theory to address these discrepancies and to examine how the timing and duration of obesity shape the course of an individual's hospitalization experience. Knowing that a person's body mass index (BMI) exceeds 30 may be a useful piece of information in predicting hospitalization, but is the duration

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of exposure to this risk also important for understanding hospitalization experiences? Duration of exposure is a basic concept in epidemiology, but we are unaware of any study that systematically examines whether the duration of adult obesity influences hospitalization.

CUMULATIVE-DISADVANTAGE THEORY

Although hospitalization episodes may reflect urgent or suddenly developed complications, adult health conditions are a product of lifelong processes and development. In order to understand health outcomes and inequalities among various people, more is gained by a long view than by an isolated snapshot in time (Kuh et al. 2003). Emphasizing the development of health conditions over the life course implies that health status in later life is shaped by health status and resources earlier in the life course (Elder 1994; Riley 1987). Proponents of cumulative-disadvantage theory posit that advantages experienced early in life put one on a different pathway from those experiencing early disadvantage. These divergent processes are therefore likely to increase heterogeneity between groups over the life course and differentiate cohorts (Dannefer 2003; Ferraro and Kelley-Moore 2003; O'Rand 1996).

It could be argued that cumulative disadvantage is more of a perspective or model than a theory. It began largely as a metaphor, but it has been referred to as a theory by others using it to examine health outcomes (e.g., Ross and Wu 1996). Scholars have recently referred to it as cumulative-advantage theory (Pampel and Rogers 2004), cumulative advantage/disadvantage theory (Dannefer 2003), or the cumulative-adversity hypothesis (Hatch 2005). We consider it a theory, but one that needs considerable development and specification.

The process of health-disadvantage accumulation is often conceptualized as *chains of risk*, in which hazards or insults are closely connected with ensuing risks (Kuh et al. 2003). The course of disadvantage, then, is akin to a cascade, accelerating the rate of physical decline and deterioration through adulthood. Disadvantages are not isolated, discrete events but are conceptually linked to compromises in future functioning. Physiological weakening is likely as one grows older, but the timing and degree of such processes are altered by the experience of early disadvantage (Hatch 2005).

When considering cumulative-disadvantage theory in the study of health, it is important to clarify the mechanisms by which disadvantage accumulates over the life course. A logical starting point for explaining the development of disadvantage is to ascertain how long an individual has been exposed to a particular risk factor, a concept known as *duration of exposure*. A risk factor is viewed as something that may compromise some facet of a person's well-being, but how long must the exposure last for it to precipitate a deleterious effect? Although the link between duration of exposure and cumulative disadvantage seems obvious, there is a conspicuous absence of any discussion of the relationship in most theoretical papers on cumulative-disadvantage theory (see, for instance, Dannefer 2003; O'Rand 1996). We argue that a next step in the development of cumulative-disadvantage theory is the systematic integration of duration of risk exposure as a tenet for explaining individual trajectories and cohort differentiation. Primary attention in cumulative-disadvantage theory and health has been given to the timing at which a person is exposed to a risk such as obesity (Ferraro and Kelley-Moore 2003). Beyond early exposure, what is the role of duration?

Another important question to consider in applying cumulative-disadvantage theory to research on health is, “What constitutes the accumulation of disadvantage?” Much of the previous health research using cumulative-disadvantage theory views it largely as the growing gap between status groups in health outcomes: Early disadvantage amplifies inequality over time (e.g., Ross and Wu 1996). Cumulative disadvantage, however, could also emerge when different status groups are exposed to risk factors as a result of early disadvantage, thereby leading to divergent health outcomes. We favor this latter, more comprehensive view that emphasizes cumulative disadvantage as a life-course process, not just the difference in outcomes due to early disadvantage. As a result, we believe greater attention should be given to studying risk onset and duration to better explain the accumulation of disadvantage. For the present study, we view obesity as a health risk and assert that the duration of exposure to this risk is consequential to health and health care over the life course. We quantify the duration of exposure to obesity and also incorporate information on previous hospital visits to capture the dynamic process of cumulative disadvantage.

CUMULATIVE-DISADVANTAGE THEORY'S RELATIONSHIP TO OBESITY AND HOSPITALIZATION

Cumulative-disadvantage theory provides a central perspective for this study, with implications for both obesity and the hospitalization experience. Research on obesity illustrates several processes of cumulative health disadvantage. Persons obese as children, for example, are at heightened risk for a host of diseases and mortality through adulthood, denoting the sequential nature of risks (Must and Strauss 1999). Life-course trajectories are not easily redirected, as overweight children are more likely to be severely obese as adults (Ferraro, Thorpe, and Wilkinson 2003). In addition, the consequences of obesity for health vary according to the timing of onset, with early obesity escalating risk (Ferraro and Kelley-Moore 2003).

Given the emerging evidence that chronic obesity influences health, it is surprising that relatively little attention has been given to how chronic obesity influences health-service use. For the present study, we expect that obesity will likely increase the consumption of hospital resources. Obesity heightens the risk of multiple comorbid conditions, especially diabetes, heart disease, and hypertension (Kopelman 2000), likely resulting in more complex and longer hospital stays because of more complex treatment and procedures requiring intensive monitoring. From a life-course perspective, therefore, obesity's role in affecting length of stay may become more pronounced throughout one's hospitalization history (i.e., accumulated disadvantage). Alternatively, it is possible that the treatment received during a hospitalization is sufficient to reduce the influence of obesity on the length of subsequent stays. Finally, it is possible that morbidity is antecedent to both obesity and hospitalization, and that persons in poor health become obese, rendering spurious the relationship between obesity and hospitalization. This reverse-causality explanation does not fit with past research on the effects of obesity on mortality (see Lawlor et al. 2006). Although there is ample evidence to suggest that duration of obesity is likely to precipitate more complex and longer stays, we examine prior hospital stays in a chain of risks to account for risk reduction due to treatment.

PRIOR RESEARCH ON OBESITY AND HOSPITALIZATION

Past studies on hospitalization differences among obese and nonobese persons have produced mixed results. Some research reports that obese individuals are more likely to be hospitalized (Quesenberry et al. 1998; Raebel et al. 2004). Other studies, however, have shown that obese individuals have rates of hospital visits that are comparable to nonobese persons (Bertakis and Azari 2005; Reidpath et al. 2002), and some even show that obese individuals have lower rates of hospital admission (Trakas, Lawrence, and Shear 1999).

To understand the inconsistencies of past findings, it is important to consider several features of the extant literature. First, the data have been largely drawn from HMO or clinical populations, often limiting the analysis to only those who have been hospitalized, thus constraining the generalizabilitity of the findings. Second, most studies are based on patterns of health-care use, which are either retrospective reports or are observed over a relatively short period of time (e.g., two weeks; Reidpath et al. 2002). The effects of obesity on hospitalization may be underestimated by studies of such short duration. Finally, some studies have controlled for morbidity, identifying health problems as an important intervening factor between obesity and health-care utilization (Bertakis and Azari 2005), while other studies have not controlled for morbidity, arguing that such statistical controls constitute overadjustment (Quesenberry et al. 1998; Zizza et al. 2004).

Zizza and colleagues (2004) used an age-representative, nonclinical sample and address the question of obesity and prospective hospital usage. The authors found that overweight and obese people spend more days in the hospital than normal-weight individuals at each of three follow-ups during a 20-year longitudinal study. Body mass, however, was measured only at baseline, precluding the question of whether long-standing obesity has differential consequences for hospitalization than recent-onset obesity. Addressing this issue, a recent longitudinal study featured measurements of BMI in middle age, with a 30-year follow-up to predict risk of hospitalization for heart disease and diabetes for older adults eligible for Medicare (Yan et al. 2006). The authors found that persons obese in their 40s were indeed at higher risk for hospitalizations due to those particular diseases in later adulthood. Still, body mass was measured only once.

Thus, the present study seeks to extend the literature by asking whether the *duration* of adult obesity exposure influences an individual's hospitalization experience. In addition to exploring this new conceptual dimension, we also build upon past research and conceptualize hospital stays in a life-course framework (Ferraro et al. 2006). Although most past research on obesity and length of hospitalization has either examined only a single hospital stay (Ray et al. 2005) or aggregated data from multiple stays (Zizza et al. 2004), the present study investigates both aggregate stay data and episodic data for individual stays. In this way, we seek to frame hospitalization as a strand of related experiences that are embedded in the individual's life course.

Episodic study of the sequence of hospital stays may help in (1) assessing whether length of stay varies from one hospitalization to another and (2) identifying the accumulation of disadvantage. For instance, a person's first observed stay may be considerably longer than ensuing stays if the first hospitalization leads to another episode of acute care or if early entry into the health care system decelerates further medical complications. On the other hand, length of stay may increase in tandem with a high number of hospitalizations, both of which may be indicative of marked health decline.

In addition to investigating length of stay, the present study analyzes another common indicator of hospital utilization: number of hospitalizations experienced. Both of these variables are common outcomes studied in the hospital-utilization literature (Franklin et al. 1999). Number of hospitalizations is a measure of medical-care access when faced with a serious health problem. Length of stay is a measure of the extensiveness of care required for an admission. Longer stays likely entail treating more complex health conditions and syndromes, and shorter stays likely involve treatments for less complicated health conditions. Whereas duration of obesity may be seen as an indication of chronic and accumulating risk, one would expect that it will lead to health complications and longer lengths of stay.

Drawing from cumulative-disadvantage theory and prior research, four general research questions guide the analysis. First, does obesity increase hospital admissions? Second, regardless of the number of admissions, do obese people have longer stays when hospitalized? Third, what role do morbidity and early exposure play in obesity's influence on hospitalization? Fourth, does the length of time a person is obese increase the length of hospital stays?

METHOD

Sample

The analyses for this study are based on data collected by the National Center for Health Statistics (NCHS) for the National Health and Nutrition Survey I (commonly referred to as NHANES I) and its Epidemiological Follow-Up Study (NHEFS). Baseline, or wave 1, data were collected between 1971 and 1975 from a multistage, stratified, probability sample of noninstitutionalized persons ages 25 to 74. Initial response rates were 98.6 percent for the interview and 70 percent for the medical examination (National Center for Health Statistics et al. 1987). Study participants received follow-up interviews between 1982 and 1984 (wave 2), in 1987 (wave 3), and in 1992 (wave 4). Follow-up rates for baseline participants were high: 88 percent of survivors took part in wave 2 interviews, and 89 percent of survivors completed interviews at waves 3 and 4. This study makes use of respondents who were given the “detailed component” of the baseline interview, including the “Health Care Needs Questionnaire” and the medical examination. The sample for this paper was restricted to persons 41 and older at baseline in order to take advantage of respondents’ recall of their weights when they were ages 25 and 40 (n = 4,574).

Measurement of Hospitalization

At each follow-up, respondents were asked if they had had any overnight hospitalizations since the previous interview. Participants provided data on length of stay, reason for stay, and approximate date. After gaining respondent consent, researchers attempted to match the reported stays with hospital records or with death certificates, where applicable. A reported stay was categorized as a match if the given date was within one year of the verified records and if the reason given for the hospitalization was consistent with facility records. Recorded hospital stays provided information on date of admission, date of discharge, discharge destination, and diagnosis (based on the *International Classification of Diseases* [ICD], *9th Revision, Clinical Modification* [U.S. Department of Health and Human Services 1989]). Hospitalizations reported by respondent or by proxy but unable to be matched were dropped from the analyses. Among NHEFS respondents in the detailed component, the matching between reported and ascertained stays was 77 percent. Dropped stays tended to be for subjects with many stays (e.g., subject/proxy reported 12 stays, but only 11 had valid records). Routine childbirth admissions were excluded so that higher fertility did not inflate the frequency of hospitalization (and probably decrease length of stay). Hospital records were not systematically gathered by NCHS staff for mental-health and nursing-home stays; thus, this study focuses solely on acute-care hospitalization. Three hundred and sixty-three hospital stays included transfer to another hospital. For these cases, the two continuous stays were considered a single stay if the relocation was within three days of initial hospitalization and both stays had the same ICD code. Our final sample consists of 12,380 confirmed hospitalizations for 4,574 individuals over 20 years.

Analyses make use of a count of nights hospitalized for each of the first four matched facility stays, the mean length of stay of all hospitalizations, and the total number of overnight hospitalization episodes.[1] Although we consider it a measure of total number of stays, we used a survival-adjusted measure in the final analysis. We computed a rate of hospitalizations per year alive by dividing the total number of hospital stays by the number of years observed alive in the NHEFS.

[1]Although examining more than four stays may be informative, insufficient statistical power precluded such analyses.

Measurement of Body Mass Index and Obesity

The analysis makes use of measured height and weight at the baseline interview and recalled weights for earlier periods of the life course. At wave 1, research staff measured participants' weight on a self-balancing scale. Staff also measured respondents' height. Participants are classified by baseline body mass index (BMI = kilograms / meters^2) according to National Heart Lung and Blood Institute (1998) guidelines: underweight (BMI < 18.5), normal weight (BMI 18.5−24.9), overweight (BMI 25−29.9), and obese (BMI > 30). Although not a perfect measure of fatness or adiposity, BMI correlates highly with more exact measurements, such as triceps skinfold thickness (Must, Dallal, and Dietz 1991).

Individuals reinterviewed at subsequent waves were asked to recall their typical weight at ages 25, 40, and 65, where applicable. Self-reported weights are widely acknowledged as valid instruments for random samples of the adult population, but they probably underestimate overweight, especially when the recall period is long (Olivarius, Andreasen, and Loken 1997).

Two variables were constructed to assess history of obesity. The first is a dummy variable for whether the subject was obese (BMI > 30) at age 25 (obese = 1, nonobese = 0). In order to estimate the number of years of obesity exposure, persons obese at wave 1 or at any point prior to wave 1 were given a duration score calculated from their age and whether their wave 1 and reported weights at 25, 40, and 65 (where applicable) were indicative of obesity. For example, a 45-year-old individual who was obese at wave 1 and who reported obesity-level weight for ages 25 and 40 was given a duration score of 20 (age 45 – age 25 = 20 years of obesity duration). If that individual was not obese at 25 but was obese at 40 and at baseline, then they would be given a score of 5 (age 45 – age 40 = 5 years of obesity duration). Alternatively, if the subject was obese at 25 and 40 but not at baseline, they would be given a score of 15 (age 40 – age 25 = 15 years of obesity duration).

Individuals who were obese at a single point in adulthood before wave 1 and nonobese at wave 1 were given a score of 1. These cases were a minority, however (70 out of 388 cases coded as 1 manifested the pattern). The more common pattern was an increase in body mass and likelihood of obesity as subjects progressed through middle age. For the 318 subjects that were obese at wave 1 but not at any prior point, a score of 1 would likely underestimate obesity duration. Therefore, we adjusted these scores based on several variables available at wave 1. For subjects over 65 at wave 1, recalled weight at 65 could be used as an additional indicator, but for those ages 41−65 (n = 288), there was potentially a large unobserved window of obesity duration. Therefore, the coding algorithm for obesity duration was adjusted with the following scheme. Subjects ages 41−45 that were first observed as obese at wave 1 were still coded as 1. Subjects ages 46−50 were coded 2, 51−55 year-old-people were coded 3, 56−60 year-old-people were coded 4, and 61−65 year-old-people were coded 5. Therefore, the obesity-duration score took into account that the farther a subject is from age 40, the higher the number of years that obesity is likely to accrue before he or she was measured at wave 1. Because it likely takes longer to accumulate BMI scores far above the obesity threshold, we multiplied these revised scores by 2 if a subject's baseline BMI was greater than 35 (severely obese). Fifty-eight subjects fit the criteria of severe obesity and were adjusted in this manner.

Because older subjects had more possible years to be obese, it was also important to consider how age is confounded with years of obesity duration. To address this concern, the duration variable was divided by age to create an age-standardized marker of obesity duration. Given the coarseness of the measurement of obesity duration, a natural log transformation was performed on the duration variable to smooth the distribution.[2] We recognize the limitations of this method of estimating exposure—likely underestimating duration—and consider it as an initial step in attempting to quantify length of obesity duration.[3]

Missing Data

Several missing-data issues, particularly for the obesity variables, merit discussion. The complexities arise mostly because of the NHEFS protocol, which collected recalled measures of body weight at wave 2. As could be expected, 18.9 percent of the subjects ages 41−74 died between waves 1 and 2; and, as could also be expected, this rate was somewhat higher for subjects who were obese at wave 1 (22.1%). Thus, in a study of hospitalization, it is important to recognize the need to attend to the possible effects of mortality selection on the outcome as well as its relationship to such a key independent variable as obesity duration.

One of the strengths of NHEFS is that researchers were able to gain hospitalization data from proxy interviews for respondents who died between waves, minimizing potential attrition bias due to death. Therefore, all analyses include people who died between survey waves, because hospitalization data are available for these people. Cases lost due to inability to trace or refusal to participate, however, could not be matched to hospital records. Though these forms of attrition were considerably lower than mortality attrition (3.3% of all subjects across the four waves; 3.0% among obese subjects), selection-bias models were estimated to explore whether differential dropout rates introduced bias. The lambda coefficient in different model specifications, however, never came close to significance. We therefore concluded that nonresponse bias, if present, does not alter the conclusions.

The more serious challenge for the current study, however, is due to missing data on recalled weights for subjects who died between waves 1 and 2. There were 190 cases who were obese at wave 1 but died between wave 1 and wave 2. Generating a duration score based on weight-history variables is not feasible with only a single point of measurement. Because these 190 cases are a sizable proportion of the obese subjects (22%), we turned to multiple imputation, using the ICE add-on program for Stata 9.0. Variables used in the multiple imputation procedure for missing duration values included general findings from the wave 1 medical examination, several measures of morbidity (self-reported as well as physician-evaluated), and demographic indicators. Multiple imputation was used to fill in values for both variables, relying on two weight history measurements: obesity duration and obesity at age 25. In the latter case, BMI values for age 25 were imputed, and these were then used to generate an age 25 obesity dummy variable.

Measurement of Morbidity and Covariates

We include a number of additional variables related to hospital usage, each measured at baseline. Because obesity is strongly related to three serious chronic illnesses—diabetes, heart disease, and hypertension—it is important to first consider whether these factors explain why obesity may be related to hospitalization. NHANES researchers asked subjects whether a physician had ever diagnosed them with any of a number of illnesses, including diabetes, heart disease, and hypertension. For each condition, subjects who had been given such a diagnosis were given a score of 1, while those who had not been diagnosed were scored 0.

Age is assessed from baseline and coded from 41 to 77. Being black, another crucial factor in patterns of health-care usage (Ferraro et al. 2006), is coded as a binary variable (1 = black, 0

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[2]Epidemiological research estimating the effects of obesity duration on the etiology of diabetes has often relied upon similarly coarse measures. Wannamethee and Shaper (1999), for instance, used two BMI measures separated by five years to assess the impact of obesity duration on the incidence of type 2 diabetes.

[3]This method of approximating obesity duration is fallible; persons' obesity-duration scores are constructed from at least three discrete points in the life course, but the scores imply continual and uninterrupted obesity in cases where BMI levels are 30+ on the three separate instances. The inference of obesity continuity could bias our measure in that persons obese at an early point in life could become nonobese between the discrete points of measurement, then revert back to obesity by the next stage of measurement. However, using at least three points of reference in the life course provides a reasonable approximation of exposure to obesity and one that is certainly superior to a report of obesity at a single point in time.

= white). Living alone or with a partner or family may shape the course of one's hospital experience (Zizza et al. 2004); living alone is therefore coded as a binary variable and included in models. Sex is likewise coded as a binary variable (1 = female, 0 = male).

Two variables for socioeconomic status include education (eight categories [0 < eighth grade; 7 = postcollege education]) and annual household income (12 categories in 1970 dollars [1 < $1,000; 12 > $25,000]). These markers are important to consider because obesity is not distributed evenly across socioeconomic groups in the United States; likewise, access to medical care is shaped by socioeconomic resources. To more directly control for access to care, three indicators of health-care resources are also included. Medicaid coverage, private insurance, and whether one has a regular physician are each coded as 1 if present at baseline, and 0 otherwise.

Certain health-related behaviors may contribute to patterns of hospital use over the life course, so the following lifestyle covariates are included: heavy drinking, smoking, and sedentary behavior. Heavy drinking is a binary variable defined by having at least two drinks per day or 14 a week (1 = heavy drinker, 0 = not). Smoking is also a binary variable, indicated by self-reported consumption of cigarettes, cigars, or pipe tobacco (1 = smoker, 0 = not). The sedentary-lifestyle variable is constructed from two survey questions regarding exercise level from both recreation and occupation. Those indicating “no physical activity” as opposed to “a lot” or “a moderate” amount on both questions are coded 1, and all others are coded 0.

To control for considerable regional variation in both obesity rates and hospital availability and usage, models contain covariates for region of residence. Northeast, Midwest, South, and West are all included as binary covariates (we use Northeast as the omitted referent). Dwelling in a rural area is also coded as a binary variable (1 = rural, 0 = urban).

Finally, a number of analyses make use of variables relating to hospitalization history. Conceptualizing the hospitalization history as a string of interrelated episodes requires attention to how earlier hospitalizations are related to later stays. For models predicting length of specific stays, the preceding stay's length (in days) is used as an independent variable. Chronological time between stays may be another factor related to length of specific episodes, so these analyses utilize a dummy variable indicating whether the stay was less than six months from the previous stay. For analyses of average length of stay, a dummy variable was included that denoted whether the subject had more than four stays. This covariate adjusts for the effect that having many stays might have on the average stay length (likely inflating average length of stay).

Analyses presented below have been adjusted for sample weights and the complex sample design with Stata 9.0.

Analysis Plan

For this study, all of the outcome variables in question have positively skewed distributions. Length-of-stay variables are count variables; therefore, negative binomial regression equations were used to account for overdispersion in generating parameter estimates (Long 1997). Number of hospitalizations per year is likewise positively skewed and is also left-censored. In order to obtain parameter estimates for this rate variable, interval regression was used. Interval regression is a derivation of tobit regression, which accounts for censoring of the dependent variable's distribution (Hardin 2005). Another advantage of interval regression in Stata 9.0 is that one can account for complex sample designs.

The first stage of the analysis seeks to uncover whether individuals obese at baseline have more hospitalization episodes and longer average stays during those episodes. Negative binomial and interval regression models are first estimated with BMI classification groups and demographic covariates as the only predictor variables. Then, the three comorbidities are entered into both equations in order to estimate whether they explain why obesity may influence hospitalization. As a final step of the first stage of analysis, obesity at age 25 is included in the models to investigate whether being obese early in the life course nullifies the effects of obesity at baseline. All of these estimates use persons of normal weight as the reference group.

The second analytic stage is restricted to individuals who were measured as obese at wave 1 or reported a weight prior to wave 1 that would classify them as obese. The chief purpose of these analyses is to examine the effect of obesity duration on hospitalization, particularly in the length of stay across the sequence of hospitalizations experienced by obese persons. The second stage of the analysis uses negative binomial regression to model the various length-of-stay outcomes. Because these analyses examine the hospitalization sequence, particular attention is given to the role of hospitalization history; variables are included for time since previous stay and length of prior stay. Sample sizes decrease from length of first stay to length of fourth stay, as a smaller number of individuals had each subsequent hospitalization.

RESULTS

Table 1 presents the range (minimum to maximum), mean, and, for interval measures, the standard deviation for each variable used in the analyses, for the total sample and across weight classifications. Underweight, overweight, and obese BMI classifications are shown in comparison to normal-weight persons, indicating that some variables show a curvilinear pattern (e.g., underweight and obese persons both have lower income and education and higher rates of living alone than normal-weight and overweight individuals).

The most pronounced finding in this descriptive table is the higher rate of each of the diseases among obese subjects, particularly for hypertension, which affects 46 percent of obese subjects but only 21 percent of normal-weight subjects. Obese persons are also more likely to be older, black, and female, have lower education levels and incomes, live alone, be on Medicaid, have a sedentary lifestyle, and live in rural areas. Obese individuals are also less likely to have private insurance, drink heavily or smoke, or live in the West.

Table 2 presents parameter estimates for the number of hospital admissions per year and average length of stay across all hospitalizations. In the first column, obesity is the only BMI classification that is associated with more hospital admissions per year. When adjusting for comorbidity in the second column, obesity is no longer significant, whereas each of the diseases is related to a higher rate of admissions. The strong effect of the comorbidities on hospital admission and nonsignificance of obesity suggests that obese persons are admitted to the hospital with more frequency because of serious illnesses. Finally, the third column displays the results when obesity at age 25 was added to the equation. Including this variable has little effect on the other coefficients in the model and is itself nonsignificant. In addition to weight classifications, other predictors of more stays per year include age, having a regular physician, smoking, sedentary lifestyle, and living in rural, Southern, and Midwestern locations. Being black or female, having a higher income, and living in the West predict fewer stays per year.

The remaining columns present equations for average length of hospital stay, first regressing days hospitalized on BMI classification variables and demographic covariates (model 1), then adding the comorbidity variables (model 2), and ending with obesity at age 25 included in the equation (model 3). As with the analysis of hospital admissions, obesity was the only BMI group having longer stays. Distinct from the earlier analyses, however, obesity retains its significance across models 1, 2, and 3, attenuating only slightly across the three equations. Comorbidity variables, on the other hand, are nonsignificant in model 2 and 3, also a difference from the analysis of hospital admissions. Similar to the results of the prior analysis, however, obesity at age 25 is not related to longer average stays.

Several covariates display a similar pattern to the results of the stays–per-year models. Higher income levels are indicative of shorter average stays, as is living in the West, whereas age and having a sedentary lifestyle are associated with longer stays. On the other hand, subjects with a regular physician had shorter average stays despite more frequent hospitalizations, and those in rural areas, the South, and the Midwest likewise had shorter average stays despite higher rates of hospitalization. Heavy drinking was related to longer stays only before adjusting for comorbidity, while smoking was not predictive of length of stay in any of the models.[4]

A subsample analysis of obese individuals is presented in Table 3, which models five dependent variables. Findings are presented for average length of stay and for length of stay during the first, second, third, and fourth admissions. In the first column, higher scores of obesity duration are associated with a greater average length of stay. Also influencing average stays among subjects ever obese are age, having a regular physician, and living in rural areas. Interestingly, having heart disease was associated with shorter average stays. Supplementary analyses (not shown) revealed that approximately 26 percent of the obese adults with heart disease died in the hospital, compared with about 21 percent of the obese adults without heart disease. Having hypertension was predictive of longer average stays, whereas diabetes was unrelated to average length of stay. In order to safeguard against the possibility that having a large number of hospitalizations could inflate length of stay, and because only the first four stays are analyzed separately, a dummy variable was included that denoted whether the subject had five or more hospitalizations. As expected, this variable was positive and significant but did not render the effect of obesity duration nonsignificant.

When examining the next four columns, the lengths of stays one through four, several interesting patterns emerge. First, obesity duration does not have a uniform effect across the four stays. Greater duration-of-obesity scores were associated with longer first stays, but at the second stay obesity duration was nonsignificant. At the third stay, however, obesity duration was again significant and positive, and it remained as such for stay four.

Second, comorbidity variables manifest rather meager effects across the four stays. Among persons ever obese, hypertension is associated only with a longer initial stay, and diabetes predicts shorter second stays. By the third hospitalization, none of the comorbidity variables is associated with length of stay, and heart disease does not have a significant effect on any of the individual stays. Supplementary analyses (not shown) that excluded obesity duration reveal that heart disease is related to length of stay, but including both renders heart disease nonsignificant.

Third, variables related to hospitalization history are indeed consequential for understanding a given hospitalization. The second stay's duration is contingent upon how long the individual was hospitalized during his or her initial stay, and the fourth stay is related to the length of the third. For stays three and four, being admitted to the hospital less than six months since being previously discharged is indicative of a longer episode.

[4]We also considered the possibility that the diagnoses associated with each stay might lead to differences in length of stay between obese individuals and their leaner counterparts. Thus, we selected subjects' first hospital admissions for circulatory diagnoses, the most common ICD classification for hospital stays in the NHEFS, and reestimated the models in Table 2 after adjusting for admissions due to a circulatory condition. The original results were unchanged.

DISCUSSION

To our knowledge, this is the first attempt to estimate the role of obesity duration in affecting hospitalization outcomes. Drawing upon cumulative-disadvantage theory, we investigated whether hospitalization patterns correspond to obesity duration. Prior research shows that excessive body mass leads to disadvantages that accumulate over time (Ferraro and Kelley-Moore 2003). One can conceptualize the life course as involving a set of trajectories for various outcomes, and obesity has the power to alter trajectories related to health and health-service use. We integrated the concept of duration into the analysis to better understand how risks accumulate, and we found that the longer obesity persists, the more consequential it is in altering hospital length of stay. The present analysis shows that long-standing obesity has a greater effect on hospital-resource consumption than does relatively nascent obesity. Stated differently, there is evidence from this investigation that reducing the duration of obesity over the adult life course will translate into reduced consumption of hospital resources. The mere presence of obesity at an early point in adulthood failed to explain why obesity matters for hospitalization; more important than early exposure seems to be the *duration* of the exposure.

The first three research questions articulated earlier addressed whether obese individuals have more hospitalizations and longer lengths of stay relative to healthy-weight persons. Past research, also using NHEFS data, found that obese persons spent more days in the hospital than their counterparts with healthy BMI levels (Zizza et al. 2004). We also discovered increased utilization among individuals obese at baseline when examining separately the total number of hospitalization episodes (stays per year) and average length of stay. Although obesity was the BMI group of main interest, it is interesting to note that being underweight was not associated with length of stay; past research has found underweight to be an important predictor of increased hospital usage (Zizza et al. 2004).

The reason that obese individuals have more hospitalizations than other subjects was explained by their higher prevalence of diabetes, heart disease, and hypertension. However, these three illnesses did not help explain why obesity was related to longer average stays. Obesity at age 25 was presumed to be consequential, yet our findings suggest that if obesity matters for hospital usage, its effects may unfold as a factor of its duration. Mere exposure to obesity early in the adult life course did not independently influence hospitalization.

Our remaining, and primary, research question addressed the relationship between body mass and hospital usage, emphasizing the life-course context. Given that obese persons are hospitalized more often and for longer amounts of time, does the duration of their obesity matter? In the terminology of life-course epidemiology, is the chain of risk associated with high body mass manifest in patterns of hospital consumption? The findings support our expectations derived from cumulative-disadvantage theory. Among individuals with a BMI of 30 and above at some point in adulthood, the duration of years obese leads to higher average length of stay, even after controlling for comorbidity and numerous covariates.

The results also reveal an interesting effect of obesity duration on episodic patterns. Obesity duration extends the stay during initial hospitalization, adjusting for comorbidity and for a number of other factors. Following this first stay, the next stay is not affected by obesity duration. However, by the third—and especially the fourth—hospitalization, length of stay again increases for higher levels of obesity duration. In terms of cumulative-disadvantage theory, the gap seems to close after the beginning of one's hospitalization history—the hospitalization moderates risk somewhat—but the risk reduction is limited to the early stages of one's adult hospitalization episodes.

An additional insight is gained from examining the hospitalizations in a life-course context: Stays have a cumulative effect on their succeeding episodes. Therefore, although obesity duration failed to predict longer second stays, its influence was indirect, partially transmitted through the first hospitalization. By the third stay, obesity duration had again become a significant factor, and this elongated third stay had an influence on the fourth stay. Similarly, there is evidence that having several stays within a short period of time is associated with longer stays, as having been discharged fewer than six months from one's last stay increased stay length by the third and fourth hospitalization. The overall picture is that obesity duration contributes to longer stays, and stays themselves contribute to longer stays the next time an individual enters the hospital. This is a clear picture of what one would expect based on cumulative-disadvantage theory: Early disadvantage has long-term effects, but trajectories can be modified by the institutional encounter.

Although the current study adds to the body of sociological literature on obesity and increasing health disadvantage over the life course, several limitations warrant discussion. Since our main objective involved uncovering the duration of obesity among persons with a BMI of at least 30, we relied upon utilizing subjects' recalled weights. Self-reported weights were the only means of garnering such life-course weight measurements (measured weight and height were used for wave 1). The most likely drawback of using these recalled weight variables is underreporting of excessive weight (Olivarius et al. 1997). This underestimation would make obese respondents more likely to have shorter duration scores than would actually befit them, thereby making our estimates conservative.

The second limitation of using recalled weight values in order to estimate duration is the coarseness of our measure of duration of exposure. Obesity duration, in this analysis, is calculated using at least three discrete points of BMI measurement (i.e., ages 25 and 40, and wave 1 as well as age 65 for older subjects). It would be optimal to use annual or biannual measurements; data limitations, however, preclude a more refined duration algorithm. Although our approach is far from ideal, it is an improvement over previous research and suggests the utility of duration variables in the study of health risks.

Another shortcoming of this study is that the measurement of obesity duration does not encompass the entirety of a participant's life course. Drawing upon body weight indicators from early adulthood (age 25) is a step in the right direction, but extending such measurement to childhood and adolescence may yield fresh insight for understanding how chronic obesity influences health and health-service use. Along similar lines, more complete data on the life-course development of morbidity may also help substantiate the assumption that long-term obesity leads to greater health problems, which in turn lead to increased hospitalization, and such a finding may rule out the explanation that health problems are antecedent to both obesity and to hospitalization. Unfortunately, we did not have comprehensive morbidity data prior to age 25, when weight was first assessed.

The current study offers several distinct improvements over previous research on the topic. First, the NHEFS data set provides 20 years of hospitalization records from a nationally representative sample, rather than data from those admitted to a hospital (Bertakis and Azari 2005) or in a regional HMO (Quesenberry et al. 1998; Raebel et al. 2004). The available hospitalization records for subjects who died between waves are also a unique strength, reducing concerns about missing data. Obviously, parallel research with more recent data would be welcome.

Second, our approach makes use of bodyweight indicators representing BMI at multiple points in the life course. Exploiting weight values across adulthood represents an improvement over measures of weight at a single point in time. Our aim is to apply as thorough a life-course approach to the topic as possible, an approach with growing scientific reputability (Kuh et al. 2003). Although the measure of obesity duration is fallible, it is a parsimonious attempt to quantitatively differentiate between long-standing and nascent obesity, and it is a means of addressing the question of whether hospital-resource consumption is sensitive to obesity during the adult life course. Other attempts to estimate duration of exposure scores or explicate mechanisms of risk accumulation have employed similarly coarse measurements, yet have made compelling conceptual and theoretical contributions (Hallqvist et al. 2004; Holland et al. 2000).

We believe this study—the first study to use measures of obesity duration to predict hospital utilization, as far as we know—offers promising directions for future research and the development of cumulative-disadvantage theory. Researchers studying the consumption of health-care resources can examine other hospitalization outcomes and consider how long-term obesity affects initial entry into the hospital system. Some research finds lower levels of preventive health behavior among obese persons (Fontaine and Bartlett 2000), while other studies suggest that obese individuals are more likely than nonobese persons to use primary care or diagnostic services (Bertakis and Azari 2005) or to consult physicians (Trakas et al. 1999). Although information about physician visits are not available in NHEFS, further research can examine how hospitalization experiences fit into the broader context of health-service usage among obese individuals.

Tenets of cumulative-disadvantage theory suggest that, over time, heterogeneity increases between different groups based upon their relative advantage or disadvantage (Ross and Wu 1996). Consistent with this principle, obese adults' duration of excess body mass plays an important role in affecting length of hospital stay: Length of obesity duration shapes hospital length of stay. However, there may be other processes by which health disadvantage accumulates through the life course that may have relevance for the case of obesity and hospitalization. Other authors contend that the mechanisms of risk accumulation are not easily disentangled (Hallqvist et al. 2004). Plainly, more work is needed to advance cumulative disadvantage beyond a simple metaphor of how inequality is manifested over the life course to a rigorous and falsifiable theory that can be used as a foundation for testing how duration, timing, and severity of risk factors each produce and intensify heterogeneity between groups.

One of the aims of this analysis was to show the utility of duration of exposure for studies applying cumulative-disadvantage theory. Granted, there are many ways to incorporate timing effects into life-course studies, but cumulative-disadvantage theory needs greater specification regarding precisely how risks accumulate and lead to divergent trajectories. We have shown that duration of exposure to a risk factor is an important consideration for quantifying how adults enter the hospital and how long they stay. Our hope is that these findings will prove useful to others seeking to further develop cumulative-disadvantage theory and to privilege duration of exposure as a concept for studying health-related outcomes over the life course.

Biography

Markus H. Schafer is a graduate student at Purdue University, having recently completed his M.S. in Sociology. His research interests include the antecedents and consequences of adult obesity, age stratification, and the accumulation of inequality over the life course.

Kenneth F. Ferraro is Professor of Sociology and Director of the Center on Aging and the Life Course at Purdue University. His recent research focuses on cumulative disadvantage and health, especially between white Americans and African Americans. Recent publications appear in the American Sociological Review, Journal of Health and Social Behavior, and *Social Forces*. He is currently editor of the *Journal of Gerontology: Social Sciences.*

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TABLE 1

Means and Standard Deviations of Key Variables by Baseline BMI Classification

Variable	Range	Total (N = 4,574)	Underweight (N = 137)	Normal (N = 1,904)	Overweight (N = 1,681)	Obese (N = 852)
BMI Wave 1						
Underweight W1	0−1	.03				
Normal weight W1	0−1	.42				
Overweight W1	0−1	.37				
Obese W1	0−1	.19				
Life course obesity						
Obese age 25	0−1	.04				
Obesity duration	1−46	9.59 (10.00)				
(age adjusted, ln)	−.05−.09	.03 (.02)				
Morbidity						
Diabetes		.07	.07	.05	.08***	.09***
Heart disease		.10	.11	.08	.09	.13***
Hypertension		.29	.25	.21	.30***	.46***
Status characteristics						
Age	41−77	56.73 (9.38)	58.47 (9.76)*	56.07 (9.56)	57.03 (9.27)*	57.31 (9.05)***
Black	0−1	.13	.20**	.11	.12	.20***
Female	0−1	.53	.55	.55	.44***	.64***
Education	0−7	3.37 (1.59)	3.07 (1.58)***	3.57 (1.58)	3.37 (1.57)***	2.99 (1.55)***
Income	1−12	7.31 (2.89)	5.97 (3.24)***	7.61 (2.82)	7.41 (2.84)*	6.64 (2.93)***
Lives alone	0−1	.15	.21**	.13	.14	.18**
Health care resources						
Medicaid	0−1	.04	.07*	.04	.03	.06*
Private insurance	0−1	.84	.77*	.85	.86	.80***
Regular physician	0−1	.87	.85	.87	.85	.88
Lifestyle	0−1					
Heavy drinker	0−1	.12	.15	.13	.12	.09**
Smoker	0−1	.39	.63***	.45	.37***	.28***
Sedentary lifestyle	0−1	.09	.15***	.07	.09	.13***
Place of residence						

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Variable	Range	Total (N = 4,574)	Underweight (N = 137)	Normal (N = 1,904)	Overweight (N = 1,681)	Obese (N = 852)
Rural	0−1	.42	.55**	.40	.40	.45*
Northeast	0−1	.24	.19	.22	.25	.24
South	0−1	.24	.19	.23	.25	.25
West	0−1	.26	.41	.29	.25*	.23**
Midwest	0−1	.26	.21***	.26	.25	.27
Hospitalization						
Stays per year	0−4.86	.17 (.26)	.22 (.28)**	.16 (.25)	.18 (.26)**	.20 (.25)***
Average length of stay	.5−307.5	9.95 (11.59)	10.26 (10.27)	9.40 (10.58)	9.99 (13.21)	10.96 (10.29)**

Source: National Health and Nutrition Examination Survey I, Epidemiological Follow-up Study.

Notes: BMI = body mass index. Standard deviations in parentheses. Reference group for significance tests is “normal” BMI category. Mean differences between continuous variables are compared with *t*-tests, and differences between binary variables are compared with χ^2 tests.

* $p < .05$

** $p < .01$

*** $p < .001$ (two-tailed tests)

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TABLE 2

Parameter Estimates for Hospitalizations per Year and Length of Stay over 20 Years

	Stays Per Year[a]			Average Length of Stay[b]		
Independent Variables	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
BMI category Wave 1						
Underweight W1	.006[c] (.033)[d]	.001 (.033)	.001 (.034)	−.075 (.089)	−.071 (.090)	−.070 (.090)
Overweight W1	.017 (.011)	.009 (.010)	.010 (.009)	.060 (.037)	.053 (.038)	.051 (.037)
Obese W1	.048** (.016)	.030 (.017)	.029 (.016)	.169*** (.045)	.156*** (.047)	.147** (.051)
Status characteristics						
Age	.007*** (.001)	.006*** (.001)	.006*** (.001)	.014*** (.002)	.014*** (.002)	.014*** (.002)
Black	−.059*** (.018)	−.070*** (.018)	−.071*** (.018)	.112 (.089)	.102 (.084)	.100 (.084)
Female	−.045*** (.011)	−.045*** (.010)	−.043*** (.010)	−.024 (.028)	−.028 (.027)	−.026 (.027)
Education	−.003 (.004)	−.001 (.004)	−.001 (.004)	−.007 (.017)	−.007 (.015)	−.006 (.014)
Income	−.006*** (.002)	−.005** (.002)	−.005** (.002)	−.025 (.011)	−.025* (.011)	−.025* (.011)
Lives alone	−.023 (.021)	−.021 (.018)	−.022 (.018)	.071 (.111)	.072 (.113)	.068 (.115)
Health care resources						
Medicaid	−.041 (.038)	−.047 (.038)	−.047 (.038)	−.038 (.122)	−.040 (.123)	−.040 (.123)
Private insurance	−.001 (.013)	.005 (.011)	.004 (.012)	−.070 (.082)	−.069 (.081)	.071 (.081)
Regular physician	.058*** (.015)	.047*** (.015)	.051*** (.014)	−.258* (.106)	−.268** (.103)	−.268** (.103)
Lifestyle						
Heavy drinker	−.012 (.018)	−.006 (.018)	−.006 (.017)	.121* (.061)	.124 (.064)	.127 (.066)
Smoker	.037*** (.011)	.038** (.012)	.039*** (.012)	.080 (.045)	.080 (.048)	.079 (.049)
Sedentary lifestyle	.088*** (.015)	.080*** (.016)	.080*** (.016)	.265* (.115)	.258* (.117)	.254 (.115)

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Independent Variables	Stays Per Year[a] Model 1	Stays Per Year[a] Model 2	Stays Per Year[a] Model 3	Average Length of Stay[b] Model 1	Average Length of Stay[b] Model 2	Average Length of Stay[b] Model 3
Place of residence						
Rural	.034** (.012)	.035** (.012)	.035** (.013)	−.184*** (.033)	−.189*** (.033)	−.187*** (.032)
South	.039** (.014)	.036* (.015)	.037** (.014)	−.256*** (.050)	−.258*** (.050)	−.258*** (.050)
West	−.038** (.014)	−.035** (.014)	−.034* (.014)	−.305*** −.070	−.307*** (.071)	−.305*** (.071)
Midwest	.025*** (.007)	.024** (.008)	.024** (.008)	−.134* (.055)	−.136* (.055)	−.135* (.055)
Morbidity						
Diabetes		.149*** (.022)	.149*** (.022)		.040 (.047)	.039 (.047)
Heart disease		.095*** (.018)	.095*** (.018)		.006 (.117)	.008 (.118)
Hypertension		.037*** (.009)	.036*** (.009)		.063 (.059)	.060 (.060)
Early obesity						
Obese age 25			.021 (.028)			.074 (.089)
Hospitalization history						
Five or more stays				.260*** (.059)	.254*** (.065)	.254*** (.065)
Constant	−.324*** (.075)	−.295*** (.065)	−.305*** (.066)	2.016*** (.356)	2.034*** (.355)	2.030 (.356)
Wald chi-square (*df*)	1405.85 (19)	1857.82 (22)	1897.50 (23)	2024.35 (20)	2748.44 (23)	3091.39 (24)
N	4,398	4,398	4,398	3,139	3,139	3,139

Source: National Health and Nutrition Examination Survey I, Epidemiological Follow-Up Study.

Note: Normal weight and Northeast region are reference groups.

* $p < .05$

** $p < .01$

*** $p < .001$ (two-tailed tests)

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[a]Models for Stays per Year estimated with interval regression.

[b]Models for Average Length of Stay estimated with negative binomial regression.

[c]Unstandardized coefficients.

[d]Standard errors.

TABLE 3

Parameter Estimates for Hospitalizations per Year and Length of Stay over 20 Years among Individuals Who Were Ever Obese

Independent Variables	Average Length of Stay	Length of Stay, 1	Length of Stay, 2	Length of Stay, 3	Length of Stay, 4
Obesity duration (age adjusted, ln)	5.301^{*a} $(.211)^{b}$	5.594^{*} (2.248)	3.808 (3.427)	4.399^{*} (2.131)	5.296^{**} (1.995)
Status characteristics					
Age	$.292^{***}$ (.062)	$.018^{***}$ (.005)	.010 (.007)	.012 (.008)	.003 (.009)
Black	.074 (.095)	.071 (.094)	.077 (.129)	$.259^{*}$ (.130)	.377 (.197)
Female	−.008 (.102)	.106 (.137)	$-.199^{*}$ (.099)	.047 (.092)	$-.222^{*}$ (.103)
Education	−.006 (.019)	−.069 (.038)	$.052^{*}$ (.026)	$.051^{*}$ (.025)	.028 (.035)
Income	−.011 (.014)	.013 (.256)	−.032 (.018)	−.025 (.013)	−.012 (.021)
Live alone	.186 (.142)	$.405^{**}$ (.133)	−.170 (.125)	−.184 (.147)	.123 (.089)
Health care resources					
Medicaid	−.144 (.203)	−.299 (.167)	.134 (.239)	.081 (.211)	−.027 (.122)
Private insurance	−.058 (.109)	−.049 (.121)	−.106 (.108)	−.236 (.213)	$.249^{*}$ (.127)
Regular physician	$-.409^{*}$ (.195)	−.365 (.266)	−.235 (.180)	−.129 (.277)	.235 (.238)
Lifestyle					
Heavy drinker	.204 (.125)	.125 (.163)	.407 (.252)	−.076 (.180)	−.152 (.158)
Smoker	.074 (.066)	$.175^{*}$ (.088)	.058 (.125)	−.020 (.089)	−.103 (.113)
Sedentary lifestyle	.355 (.208)	.263 (.214)	.280 (.162)	.168 (.103)	.183 (.122)
Place of residence					
Rural	$-.201^{***}$ (.040)	−.105 (.054)	−.041 (.056)	−.096 (.065)	−.312 (.193)
South	−.242 (.131)	−.230 (.160)	.052 (.139)	.078 (.089)	.002 (.114)
West	−.219 (.132)	−.192 (.167)	−.145 (.140)	−.024 (.082)	.166 (.210)

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Independent Variables	Average Length of Stay	Length of Stay, 1	Length of Stay, 2	Length of Stay, 3	Length of Stay, 4
Midwest	−.067 (.156)	−.060 (.145)	−.053 (.153)	−.081 (.150)	−.117 (.114)
Morbidity					
Diabetes	−.033 (.071)	.044 (.087)	−.172* (.072)	.076 (.118)	.083 (.095)
Heart disease	−.190* (.091)	−.168 (.112)	−.224 (.130)	−.146 (.096)	.150 (.087)
Hypertension	.122* (.062)	.240** (.087)	−.108 (.128)	−.045 (.068)	−.002 (.113)
Hospitalization history					
Length of previous stay			.015** (.005)	.010 (.007)	.012* (.005)
Less than six months from previous stay			.209 (.110)	.222*** (.062)	.477** (.157)
Five or more stays	.292*** (.062)				
Constant	1.819*** (.369)	1.395*** (.379)	1.885*** (.461)	1.595* (.660)	1.375* (.619)
Wald chi-square (df)	1162.15 (21)	1942.36 (20)	407.14 (22)	373.48 (22)	302.02 (22)
N	709	709	545	430	321

Source: National Health and Nutrition Examination Survey I, Epidemiological Follow-Up Study.

Note: Models estimated with negative binomial regression. Northeast region is reference group.

* $p < .05$

** $p < .01$

*** $p < .001$ (two-tailed tests)

[a] Unstandardized coefficients.

[b] Standard errors.