The Effect of Obesity on Disability among Working Age Adults Living in the United States

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Abstract

In the United States, the rising prevalence of disability among young and middle age adults is attributable, at least in part, to a rising prevalence of obesity (Finkelstein et al., 2009, Barkin et al., 2010). Obesity dramatically reduces population labor force productivity and lowers overall health. This study estimates a multi-state hazard model to assess the relationship between obesity and disability, onset, recovery, and recurrence using data made available from the National Longitudinal Study of Youth 1979 (NLSY 1979) and the Health and Retirement Study (HRS). Preliminary findings suggest that obesity not only increases the likelihood that an individual will become disabled but also reduces the likelihood that an individual will recover from a disabling condition.

Introduction

Among young and middle age Americans, recent increases in disability have been attributed, at least in part, to a rise in the prevalence of obesity and the chronic conditions related to being obese (Biro and Wien, 2010, Alley and Chang, 2007). Obesity increases annual U.S. medical expenditures by 147 billion dollars and is expected to reduce lifetime wages of the incoming cohort of workers by 998.5 billion dollars (Finkelstein et al., 2009, Barkin et al., 2010). An extensive literature has documented that obesity increases older American's risk for developing a disability and weight loss may help them recover physical mobility (Rejeski et al., 2010). However, much less is known about the relation between obesity and disability among young and middle aged adults, ages 18-62. This gap in the literature is particularly important given the recent rise in the prevalence of disability in younger populations and the importance of these years for labor market productivity.

While some research has shown that obesity in young and middle ages increases the likelihood that an individual will develop a disability that limits labor force participation (Burkhauser and Cawley, 2004, Renna and Thakur, 2010, Lindeboom et al., 2010) almost no research has studied obesity's effect on the recurrence and recovery from disabling conditions in working age populations.

This paper employs a multi-state model and simulations to assess the effect of obesity on disability in two large longitudinal studies that have interviewed working age adults, the National Longitudinal Study of Youth 1979 (NLSY-1979) and the Health and Retirement Study (HRS). In doing so, this study aims to answer four questions:

a. How does obesity affect the likelihood that an individual will develop a disability that prevents labor force participation?

b. How does obesity affect the likelihood that an individual will recover from a disability?

c. How long is an obese individual expected to remain in a disabled state compared to a non-obese person?

d. How would the prevalence of disability change if effects of obesity on disability were systematically varied?

In using multiple data sets and employing a multi-state approach, this study aims to assess the cumulative impact of obesity on the disability experiences of working age adults.

Data

Data for this project comes from two sources: the National Longitudinal Study of Youth 1979 (NLSY 1979) and the Health and Retirement Study (HRS). The National Longitudinal Study of Youth is a longitudinal study that first interviewed a representative sample of American adolescents between the ages of 14 and 22 in 1979. Individuals selected into the sample were surveyed annually from 1979 to 1992 and biennially from 1994 to 2010. Across survey rounds, the NLSY has information on respondent health, labor force participation, and body mass index (bmi). The Health and Retirement Study (HRS) began collecting data in 1992 and surveyed a nationally representative sample of adults aged 50 and over. Every two years HRS respondents and their spouses have been re-interviewed and, similar to the NLSY, information on respondent health, labor force participation, and bmi is available. Additionally, the HRS tracks respondents who have exited the survey due to mortality. Using two data sets allows robust estimation of obesity and disability experiences throughout working ages.

Variables

A. Measures of Obesity and Disability

In both the NLSY and HRS obesity and disability are key constructs to be measured. Obesity is measured according to Center for Disease Control guidelines which define obesity status based on body mass index and classifies individuals as either underweight, normal weight, overweight, obese weight, or morbidly obese. As these weight classifications are based on somewhat arbitrary cut-points, a sensitivity analysis will use bmi as a continuous variable that may affect disability non-linearly across weight categories. Obesity is treated as a time varying covariate.

The measure of disability is similar across the NLSY and HRS studies: does the respondent's health currently prevent them from participating in the labor force? A key difference across studies is that only unemployed respondents in the NLSY are asked whether their health prevents them from being employed; whereas in the HRS, most respondents are asked this question. In a sensitivity analysis, other measures of disability will be used to determine the sensitivity of estimates to the definition of disability used.

B. Controls

In the NLSY and HRS, a respondent's gender and race are treated as time invariant factors that may affect both an individual's propensity to become obese and to develop a disability. In the HRS, education, race, and history of smoking are also treated as time invariant factors that may influence both an individual's propensity to become obese and to develop a disability. In the NLSY, education and smoking history are treated as time varying covariates. Smoking history is measured as whether the individual reported having ever smoked more than 100 cigarettes at the time of the survey round. It is a particularly important control as smokers have a lower body mass index but a higher risk of being in poor health and an excess mortality risk (LaCroix et al., 1993). In both studies, marital status and current smoking status will enter into models as time varying covariates. Finally, time dependent effects will be explored examining the effects of age on an individual's likelihood of transitioning across disabled and non-disabled states. Adjusting for these factors increases confidence that any observed differences in the transitions into and out of disability by obesity status are related to obesity and not a confounding factor.

Methodological Approach

The key methodological contribution of this paper is to construct a multi-state model that estimates the likelihood an individual will transition across two states: non-disabled and disabled based on their obesity status while controlling for potential confounders described in Controls and to use simulations to assess how disability would change if effects of obesity were systematically varied.

A. Multi State Hazard Mode

The first multi-state hazard model is computationally equivalent to a continuous-time multi state Markov model: an individual's time in a given state is assumed to follow an exponential distribution and transitions across states are governed by a transition intensity matrix whose rows sum to zero with unknown parameters estimated using the maximum likelihood function that minimizes the minus log likelihood without adjusting for covariates. The next model repeats this exercise but adjusts for time invariant covariates that may affect state transitions. The third model will keep the assumptions described above but will add time varying covariates and time dependent effects. The final model will allow for violations of the memory-less assumptions of the Markov model and allow an individual's probability of moving across states to not only depend on the current state and covariates but also on an individual's prior history of obesity and disability.

A key issue across all model formulations is the handling of missing data and respondent attrition. Because respondents who become disabled may be more likely to be non-responders, estimates of transitions across disabled and non-disabled states may be biased if attrition is not considered. I will compare model results across three different procedures for handling missing data.

1. Complete case analysis–cases are retained in the analysis unit the first instance of item or wave missingness.

2. Multiple imputation via chained equations is used to impute information for respondents who have item but not wave missingness. Respondents exit the analysis upon first instance of item missingness.

3. Imputation is used to account for item missingness, but individuals will also be allowed to transition between non-disabled, disabled, missing, and censored states The missing state will be a non-absorbing state that indicates that the respondent was not observed for a given survey round but that the respondent returned to the survey at a later round. The censored category will be an absorbing state for individuals who permanently attrite from the surveys. Individuals will only exit the analysis when they are censored.

Estimating this multi-state model will answer the first two research questions, how obesity may affect the onset, recurrence, and recovery from disability while also acknowledging how conclusions may be affected by missing data. A summary of all possible model states to be estimated is shown in Figure 1.

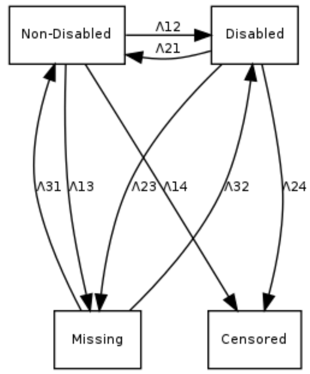

Figure 1: Total Possible States Estimated

B. Simulations

The simulation exercise will be crucial for answering questions two and three, how long an obese person would be expected to remain in a disabled state compared to a non-obese person and how the prevalence of disability would change if the prevalence of obesity was significantly altered. The exercise begins by modeling cohorts with the starting characteristics of each data set. The first simulation will be a base case where the simulated cohorts are run through the model for all survey waves. The second simulation will be a case where the prevalence of disability is doubled at all ages. The third simulation run will start with the same cohorts but it will be assumed that obesity has no effect on transitioning across non-disabled and disabled states. Key parameters extracted and compared across all three simulations will be the percentage of people in a disabled at each age and the total number of periods each cohort is expected to spend in a disabled state. Stochastic error will enter into the simulations on two levels. First, individual selection into a given state at a given period is probabilistic. Second, transition probabilities will be allowed to vary normally using the standard error bounds obtained when estimating the multi-state model. To obtain a range of predicted values in the simulations, the simulation exercise for each case will be run 500 times.

Robustness Checks

A number of checks will be done to check the robustness of the **Methodological Approach** described above. First, starting values for the multi-state model will be varied to ensure that results are reproducible. Second, the optimization method used to estimate transition intensities will be systematically varied again to check the reproducibility of the transition intensities described above. Third, measures of obesity and disability will be varied using available data and as discussed in **Variables.** Fourth, the differential handling of missingness can itself thought to a check on the robustness of conclusions. Finally, as there is some overlap in the ages covered by the HRS and NLSY-1979 , we can compare estimated hazards of moving across disabled and non-disabled states by obesity status across the two surveys. If the hazards are of similar magnitude and direction, this would strengthen our conclusions about obesity's effect.

Results and Future Analyses

The total number of transitions that take place across: 1. non-disabled 2. disabled 3. missing 4. censored states in the NLSY and HRS are shown in Table 1.

NLSY	Non-Disabled	Disabled	Missing	Censored
Non-Disabled	180921	3161	4998	4592
Disabled	3056	1581	134	176
Missing	5198	211	4476	0
Censored	0	0	0	46631
HRS	Non-Disabled	Disabled	Missing	Censored
Non-Disabled	76361	11988	2561	6822
Disabled	7020	20159	767	7269
Missing	2936	1340	3176	0
Censored	0	0	0	43537

Table 1: Total Transitions

These results confirm significant movement across non-disabled and disabled states, demonstrating the need for a multi state model, as well as significant wave missingness and sample attrition. Figure 2 shows findings from a preliminary multi-state hazard model where only complete cases are used and obesity is included as the sole covariate used to estimate the hazard of moving across disabled and non-disabled states in the NLSY and HRS. Figure 2 shows these hazards as the predicted probabilities of moving across non-disabled and disabled states.

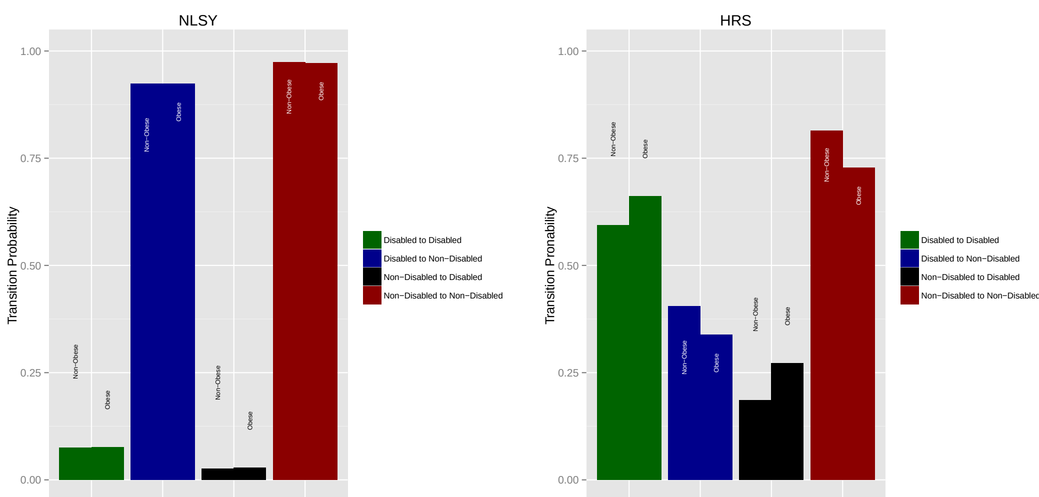

Figure 2: Transition into and out of Disability by Obesity

These results from both the NLSY and HRS shown in Figure 2 suggest that being obese not only increases the chance that an individual will become disabled but reduces the likelihood that the person will transition into a non-disabled state as well. The effects of obesity on disability are significantly smaller at younger ages captured in the NLSY, suggesting obesity has a greater effect on disability as individuals age. Additionally, the probability that an individual will recover from a disability is significantly higher in the NLSY. This may be due to faster recovery from disability at younger ages or it may be an artifact of differences in as described in **Methods**. Future analyses will incrementally adjust for time in-varying covariates, time varying and time dependent effects as well as explore alternative approaches for handling missing data also described in **Methods**. These final estimation hazards will serve as the foundation for the simulation exercise. The simulation model will then be used to infer the effects of population trends of obesity on the disability experiences of working age adults in the United States.

If preliminary results are confirmed, current trends in obesity have important implications for the disability burden of working age adults.

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