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Racial/Ethnic Differences in Obesity and Overweight as Predictors of the Onset of Functional Impairment

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Abstract

Objectives—To examine racial/ethnic differences in the effects of body mass index (BMI) on the onset of functional impairment over 10 years of follow-up.

Design—Longitudinal analyses of a cohort from a nationally representative survey of community-dwelling American adults.

Setting—Six waves (1996-2006) of US Health and Retirement Study (HRS).

Participants—Two groups of HRS participants aged 50 without functional impairment at baseline (1996): 5,884 with no mobility difficulty, and 8,484 with no Activities of Daily Living (ADLs) difficulty.

Measurements—Mobility difficulty was a composite measure of difficulty in walking several blocks, walking one block, climbing several flights of stairs, and climbing one floor of stairs. ADL difficulty was measured by difficulty in dressing, bathing or showering, eating, and getting in or out of bed without help. The association between the baseline BMI categories and risk to develop functional impairment was estimated using generalized estimating equations (GEE) models.

Results—Overweight and obesity were significant predictors for functional impairment. Compared to the Whites in the same overweight and obese categories, Hispanics were 41% and 91% more likely to develop ADL disability. Blacks in the overweight and severely obese categories were also more likely than their White counterparts to develop ADL disability. Risk of developing ADL difficulty was higher for Hispanics than for Blacks in the obese category. For onset of mobility difficulty, no significant differences were found across racial/ethnic groups within any BMI Category.

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Conclusion—Blacks and Hispanics were at higher risk than Whites for ADL but not mobility impairment. In addition to weight control, prevention efforts should promote exercise to reduce functional impairment, especially for Blacks and Hispanics, who are at higher risk.

Keywords

obesity; overweight; mobility difficulty; ADL difficulty; racial/ethnic difference

INTRODUCTION

Prevalence of obesity in all age groups has increased during the past three decades in the United States.¹⁻³ Age-adjusted prevalence of obesity among US adults over age 20 rose from 23% between 1988 and 1994 to approximately 34% in 2008.⁴ An estimated 47.5 million US adults (21.8%) had at least one disability in 2005, an increase of 3.4 million from 1999; the prevalence of disability increased with age.^{5, 6} As average life expectancy and the number of older adults continue to rise in the US, increasing numbers of Americans are expected to experience some level of functional impairment.

Living free of functional impairment (e.g., mobility difficulty and difficulty with activities of daily living (ADLs)) has long been a targeted outcome of United States aging policy.⁷ Given that functional impairment is common in older Americans and the prevalence of obesity is increasing, it is important to examine the relationship between the two. Strong evidence suggests that obesity has an impact on onset of self-reported functional impairment.^{8-14, 30-32} However, relatively few longitudinal studies have focused on the role of obesity and overweight in the development of functional impairment across racial/ethnic groups.^{12, 13} Wee et al.,¹² using Medicare Beneficiary Survey data, found that adults aged 65 with higher body mass index (BMI) were more likely than those of normal weight to develop new disability, particularly ADL disability. In their sample, the association between obesity and onset of ADL disability was weaker for Black than for White elders. This sample included only persons aged 65 who were Medicare beneficiaries, Blacks were only minority group represented, and the follow-up period (2 years) was short, which may limit the generalizability of these findings. Dunlop et al.¹³ reported baseline obesity data from a 6-year study of disability onset in a sample of Americans aged 65 that included Hispanics, Blacks, and Whites, but obesity was not included as a predictor in their models. Because individuals can develop functional impairments (particularly mobility difficulty) before age 65, there is a need for longitudinal research on onset of functional impairment in middle-aged populations.^{11, 32}

The purpose of our study was to examine the long-term impact of overweight and obesity on onset of functional impairment in older Americans of three racial/ethnic groups (Black, Hispanic, White), controlling for confounders such as socio-demographic characteristics, health behaviors, and chronic clinical conditions. This study is unique in that it combines: 1) longitudinal research on a nationally representative U.S. sample with biennial data collection over a 10-year period; 2) sample members at baseline were predominantly middle-aged (50-64 years), allowing evaluation of the onset of functional impairment in this age group; and 3) a focus on the effects of obesity and overweight on functional impairment across the three

racial/ethnic groups. We propose two research questions: 1) Are there racial/ethnic differences in overweight and obesity as predictors of onset of functional impairment? 2) If such differences exist, are they consistent across different domains of functional impairment – specifically mobility difficulty and ADL difficulty?

Given the increasing size and diversity of the elderly population and the increasing prevalence of obesity and overweight among older adults, a better understanding of effects of obesity on functional impairment in this population is relevant to US health care planning. Information generated from this study could also help inform the discussion about the appropriateness of weight control in diverse elderly populations.

METHODS

Data and Study Population

We analyzed the effect of baseline BMI on the onset of functional impairment using six successive waves (1996 to 2006) from the US Health Retirement Study (HRS). The HRS is a biennial panel study designed to permit analyses of impacts and interrelationships of various changes and transitions for community-residing older Americans in the domains of health, finances, and family.¹⁵ The 1996 wave was used as baseline for this study because response options for functional limitation items in this and subsequent waves were different from those in the previous (1992 and 1994) waves. The 1996 wave included 12,622 persons; of these, 10,964 respondents (86.9%) completed the interview. Exclusion criteria for this study were: 1) respondents with race/ethnicity, gender, or BMI data missing (n=132); 2) respondents aged <50 at baseline (n=479); 3) respondents of any race/ethnicity other than White, Black, or Hispanic (n=229); 4) respondents in the “under normal weight” (BMI<18.5) category at baseline (n=131); 5) respondents missing functional impairment data in all follow-up waves (n=574).

The remaining 9,419 respondents were eligible for the study. From this group, we selected two samples:

- Respondents who reported no mobility difficulties at baseline one group (n=5,884),
- Respondents who reported no ADL difficulties at baseline (n=8,484).

Measurement of Dependent Variables

Functional Impairment—Dependent variables assessed functional impairment in two domains: mobility difficulty and difficulty in performing activities of daily living (ADL). Mobility difficulty was a composite measure based on respondents’ answers to items asking if they had difficulty walking several blocks, walking one block, climbing several flights of stairs without resting, and climbing one flight of stairs without resting. ADL difficulty was a composite measure based on respondents’ answers to items asking if they had difficulty dressing, bathing or showering, eating, and getting in or out of bed without help. For each item, respondents who reported “Yes” or “Can’t do” were coded as “1”; those who responded “no” were coded as “0”; and those who answered “don’t do”, “don’t know”, or “refused” were set as missing. The outcome variable for each functional impairment domain (mobility or ADL) was coded as “1” (impairment) if respondents reported having difficulty

with any activity in the domain; otherwise it was coded as “0” (no impairment). Self-reported mobility difficulty and ADL difficulty have been shown to be valid in comparisons with objective measures of physical function.¹⁶ Standardized Cronbach's alphas for the four mobility difficulty items and the four ADL difficulty items were 0.84 and 0.77 respectively.

Baseline Body Mass Index (BMI) Category

Baseline BMI for all eligible respondents was calculated from self-reported body weight and height using the formula $BMI = [\text{weight in pounds} / (\text{height in inches} * \text{Height in inches})] * 703$. Body weight data (collected at all waves) were available in 1996 for all but 112 respondents. For those individuals, weight at the 1994 or 1992 waves was used as the baseline value. Body height had been recorded for all HRS participants in 1992 and 1994, but from 1996 on, it was recorded only for individuals who had not previously reported their height at an earlier wave. The most recent available body height value was therefore used for baseline BMI calculation. Following the NHLBI guidelines and previous research,¹⁷⁻¹⁸ we grouped respondents into five groups according to their baseline BMI: BMI < 18.5 (underweight), 18.5 BMI < 25 (normal weight), 25 BMI < 30 (overweight), 30 BMI < 35 (obese) and BMI 35 (severely obese).¹⁷

Socio-demographic Characteristics

Socio-demographic characteristics including age, gender, marital status, race/ethnicity, and education, which are well-known potential confounders of functional impairment,¹⁹ were coded as follows: Baseline age: age 65=1, age 50-64=0; gender: female=1, male=0; marital status: married=1, otherwise=0; education=actual years of schooling completed). Race/ethnicity was categorized as White, Black, or Hispanic.

Health Behaviors

Lack of physical activity and smoking are known risk factors for functional impairment,²⁰⁻²³ while moderate alcohol intake is a protective factor.²⁴ Drinking was assessed using a trichotomous variable derived from responses to items asking 1) whether participants ever drink alcoholic beverages (if no, code as nondrinkers); 2) average number of days/week that they drink; 3) average number of drinks/day on days when they drink. Respondents reporting drinking < 5 days/week (< 4 days/week for women) and average consumption of 1-4 drinks per week were coded as light/moderate drinkers; those reporting more frequent drinking or consumption of 15+ drinks/week were coded as heavy drinkers.²⁵ Smoking was assessed by classifying participants as never smoked, former smokers, or current smokers. Vigorous physical activity was coded as 1 if respondents reported participating in activities such as, sports, heavy housework, or a job involving physical labor at least 3 times per week during the past year, 0 otherwise.²⁶

Disease Severity

Self-reported diseases as risk factors for functional impairment have been explored in many studies.^{10, 27-29} HRS includes several questions which can be used to measure severity of seven major chronic diseases: hypertension, diabetes, lung disease, heart disease, stroke, arthritis, and cancer. Disease severity was assessed by assigning one point to participants

reporting ever having been diagnosed with the disease, and adding additional points for a) any report of current treatment of the disease, any report of having current symptoms of the disease.^{10, 18}

Data Analysis

Descriptive and multivariate analyses were performed using SAS 9.3 (SAS Institute Inc., Cary, NC). ANOVAs were used to compare means between Blacks and Whites and between Hispanics and Whites. Chi-square tests were used for proportional comparisons. We created 12 dummy variables based on combinations of BMI categories with racial/ethnic groups. Normal-weight Whites were chosen as a reference group in the analysis. Repeated measurements of health behaviors and disease severity were used in fitting GEE models to estimate the impact of BMI on the onset of functional impairment in both the mobility and ADL domains. For the onset of ADL disability outcome, baseline mobility difficulty was also added as an independent variable. Final models did not include terms for interactions between BMI categories and racial/ethnic groups because preliminary analyses revealed no significant interactions. Family income was excluded from this the study, because so many respondents (24%) did not report family income at the 1996 baseline wave. Model fit was assessed using quasi-likelihood under the independence model criterion (QIC). Significance of racial/ethnic differences within the each BMI category were tested using the GEE models adjusted for socio-demographic and health behavior variables (Model 1), and socio-demographic, health behavior, and disease severity scores (Model 2).

RESULTS

Descriptive Analysis

At study baseline (1996), the mobility difficulty sample included 5,884 participants (78.5% White, 13.4% Black, and 8.1% Hispanic) without mobility impairment. During the 10-year follow-up, 3,051 participants developed mobility difficulty (51.9% onset rate). Onset rates for mobility difficulty were significantly higher for Hispanics and Blacks than for Whites (Table 1). At the 2006 wave, 4,901 (83.3% of the original participants) remained in the sample; 522 (8.9%) had died. Descriptive statistics for each race/ethnicity group and the total sample are presented in Table 1.

At study baseline, the ADL difficulty sample included 8,484 participants (77.3% White, 14.6% Black, and 8.1% Hispanic) without ADL impairment. During the 10-year follow-up, 1,711 participants developed ADL difficulty (20.2% onset rate). Onset rates for ADL difficulty were significantly higher for Hispanics and Blacks than for Whites (Table 2). At the 2006 wave, 6,993 (82.4% of the original participants) remained in the sample, and 974 (11.5%) had died. Descriptive statistics for each race/ethnicity group and the total sample are presented in Table 2.

In both samples, the percentage of respondents in the normal weight range was significantly lower for Blacks (26.7%, 23.9%) and Hispanics (28.8%, 25.7%) than for Whites (39.8%, 36.4%). Correspondingly, Blacks (21.3%, 23.5%) and Hispanics (19.4%, 21.2%) had significantly higher prevalence of obesity than Whites (13.7%, 16.3%). Prevalence of severe

obesity was higher in Blacks (7.1%, 10.6%), than in Whites (2.9%, 5.5%) and Hispanics (3.8%, 5.8%). Furthermore, Blacks (46.3%, 16.2%) and Hispanics (43.5%, 18.1%) were significantly more likely than Whites (34.9%, 7.6%) to report a mobility difficulty and ADL difficulty at baseline (data were not presented in tables). Among those respondents who reported having mobility difficulty or ADL difficulty at baseline, Blacks and Hispanics had higher prevalence of mobility difficulty, ADL difficulty, and obesity than Whites.

Figure 1 shows differences among racial/ethnic groups in onset of mobility and ADL difficulty over the 10-year study period for participants in three baseline BMI groups: normal weight, overweight, and obese/severely obese. Within all racial/ethnic groups, onset rates for mobility difficulty were somewhat higher for overweight participants, and much higher for obese/severely obese participants, than for those of normal weight. A similar pattern was seen for the onset of ADL difficulty for White and Hispanic respondents. For Blacks, the onset rate was higher for obese/very obese participants, but not for overweight participants.

Multivariate Analysis

Mobility Difficulty—Among White respondents, those who were overweight, obese, or severely obese at baseline were at increased risk of having mobility difficulty when compared to those of normal weight (Table 3). After controlling for covariates, Whites who were overweight, obese, and severely obese were, respectively 1.51, 2.18, and 2.77 times more likely to experience onset of mobility difficulty than those of normal weight.

Among Blacks, normal weight, overweight, obese and severely obese respondents were, respectively, 1.35, 1.39, 1.87, and 3.14 times more likely to experience onset of mobility difficulty than normal weight Whites.

Hispanics who were normal weight, overweight, obese, and severely obese were 1.47, 1.48, 2.06, and 2.96 times more likely to experience onset of mobility difficulty than normal weight Whites.

ADL Difficulty

Whites who were severely obese were 1.75 times more likely to experience onset of ADL difficulty than Whites of normal weight. For Blacks, normal weight, overweight and severely obese respondents were 1.46, 1.44, and 2.76 times more likely to experience onset of ADL difficulty than normal weight Whites. Hispanics who were normal weight, overweight, obese or severely obese were 1.67, 1.55, 2.15, and 2.79 times more likely to experience onset of ADL difficulty than normal weight Whites.

Racial/Ethnic Differences

Racial/ethnic differences in the impact of BMI on functional impairment within the same BMI category were tested in both Model 1 and Model 2 (Table 4). Results summarized below are based on Model 2.

Among participants in the normal weight category at baseline, odds of developing mobility difficulty were significantly higher for both Blacks and Hispanics than for whites. . No significant racial/ethnic differences were found within any other BMI categories.

Among participants in the normal weight and overweight baseline BMI categories, risks of developing ADL difficulty were significantly higher for both Hispanics and Blacks than for Whites... Among those who were obese at baseline, Hispanics were significantly more likely to develop ADL difficulty than either Whites or Blacks. . Within the severely obese group, the odds for onset of ADL disability were higher for Blacks than for Whites.

DISCUSSION

Using the HRS, a nationally representative data, our study provides further evidence on the impact of both obesity and overweight on the onset of functional impairment in the mobility and ADL domains.^{11-13, 30-32} Compared with previous studies, our study used a longer follow-up time, and the findings suggest that high BMI may have a long-term effect on the development of functional impairment. More importantly, our study contributes to this body of literature by demonstrating that the long-term impact of obesity and overweight on the onset of functional impairment varies across racial/ethnic groups in the U.S. The racial/ethnic differences were more significant in domain of ADL difficulty than in mobility difficulty. Blacks and Hispanics, being more overweight and obese in middle age or early old age, were more likely to develop ADL difficulty over a 10-year follow-up than their White counterparts. Furthermore, obesity had more impact on the onset of ADL difficulty in Hispanics than in Blacks. However, with regard to onset of mobility difficulty, no significant differences were found across racial/ethnic groups. The findings that overweight and obesity had a more significant impact on the onset of functional impairment for Blacks than Whites were different from those of Wee et al¹² which shows weaker impact for Blacks. Differences between our findings and those of Wee et al. may partially be attributed to differences in length of follow-up (10 years in this study vs. two years in that of Wee et al.). In addition, different study populations are likely to be an important factor: most of the study population (87%) in our study was between the age of 50 and 64 years old. Blacks may be more likely to develop earlier onset of ADL difficulty than their White counterparts. Among Blacks, chronic diseases, rather than obesity, may have more significant impacts on the onset of function impairment in later life. Future research is warranted to further examine the racial/ethnic differences in impact of obesity on functional impairment among middle-aged and older adults. Our study found that Blacks and Hispanics are more likely to develop physical impairment than Whites for the same BMI. This result may partially be attributed to the different body fat composition across racial/ethnic groups. Previous studies have shown that in comparison to Whites, Blacks and Hispanics have a greater body fat and waist circumference for the same BMI.³³⁻³⁴ Presumably, abdominal fat may be more important than total obesity for disability in older adults.³⁵⁻³⁶ Our results showed that adjustment for disease severity attenuated the association between obesity and the onsets of functional limitations in both the mobility and ADL domains. The attenuation was stronger in ADL difficulty domain than in the mobility difficulty domain. After controlling for disease severity, the impact of obesity on development of functional impairment was reduced in severely obese participants for all racial/ethnic groups, although the association

was still significant. The reason for this significant risk reduction can be partially explained by the higher prevalence of chronic diseases in severely obese American old adults.³⁷⁻³⁸ Our study also shows that all the chronic diseases included in the study had significant impact on onset of functional impairment. Given these chronic diseases are common among older adults (and particularly in those of minority race/ethnicity), in order to decrease the onset of functional impairment, a significant effort needs to be invested to reduce the development of chronic diseases.

Some recent research suggests obesity in older adults is not necessarily significantly associated with increased risk of mortality controlling for chronic diseases. Being slightly overweight might be associated with lower mortality risk,³⁹⁻⁴⁰ particularly among White older adults.⁴¹ The results from our competing risk analysis (data not shown) further demonstrated that both obesity and overweight were protective factors of mortality. Nonetheless, evidence suggests that obesity raises the risk of chronic diseases, and these diseases lead to an increased risk of mortality.⁴²⁻⁴⁴ Although overweight and obesity may be protective factors for mortality, each remains a risk factor for the onset of functional impairment. Studies suggest that weight control interventions, particularly when exercise is a component of the intervention, can improve muscle strength, pain symptoms, and overall physical functioning.⁴⁵ Thus, weight control is still a critical issue in relation to quality of life for middle-aged and older Americans.

This study is one of the few that have used longitudinal data to examine racial/ethnic differences paired with obesity and overweight as predictors of specific types of functional impairment. When interpreting these findings, certain limitations may merit further discussion. One limitation of this study is that the measurements of height and weight relied on self-reported data. However, previous studies have demonstrated the validity of self-reported weight and height, suggesting that self-reported and actual weight are correlated by more than 90%, even though respondents tend to overestimate their height and underestimate their weight.⁴⁶⁻⁴⁸ In addition, BMI does not indicate how weight is distributed over the body.³¹ Further, our GEE models relied on baseline BMI categories, thus, the models did not capture the effects of weight change over time on the development of functional impairment. Participant's BMI may change across different waves. However, our exploratory analysis suggests that changes in BMI in this community-dwelling sample of middle-aged and older Americans are more likely to involve transitions from lower to higher BMI categories. Meanwhile, dynamic measurements of disease scores and health behaviors over follow-up waves may also contribute to underestimation of obesity's impact. Therefore, use of baseline BMI categories in analysis may have underestimated the impact of obesity and overweight on the development of functional impairment. We found that baseline obesity increased risk of functional impairment, but weight change over the follow-up period may also have influenced the onset of functional impairment in this population. We are also aware that there are certain proxy biases. Interviews for 5.9% of 9,419 participants were obtained through their proxies. The percentage of proxy respondents varied from 4.0% to 7.7% in follow-up waves in both the ADL difficulty and mobility difficulty groups. Rates of onset for mobility and ADL difficulty were slightly higher (by about 1%) for proxy respondents than for respondents who were interviewed directly. Proxy respondents in all racial/ethnic groups were also more likely to be overweight and less likely to be obese than

interviewed respondents. Data for proxy respondents may be somewhat less accurate, and could have introduced additional error into the models.

CONCLUSIONS

In conclusion, this study demonstrates that both overweight and obesity are risk factors for onset of functional impairment. We found racial/ethnic differences exist in the long-term impact of obesity on onset of functional impairment; we also found that compared to Whites, Blacks and Hispanics are more likely to develop functional impairment at the same BMI. This study provides empirical evidence that policy and prevention strategies should target not only people who are obese but also those who are overweight. Prevention efforts should promote weight control intervention in both groups. However, interventions that incorporate exercise as a component with a focus on improving muscle strength, balance, and flexibility could reduce functional impairment in all BMI categories, especially for Blacks and Hispanics who are at higher risk.

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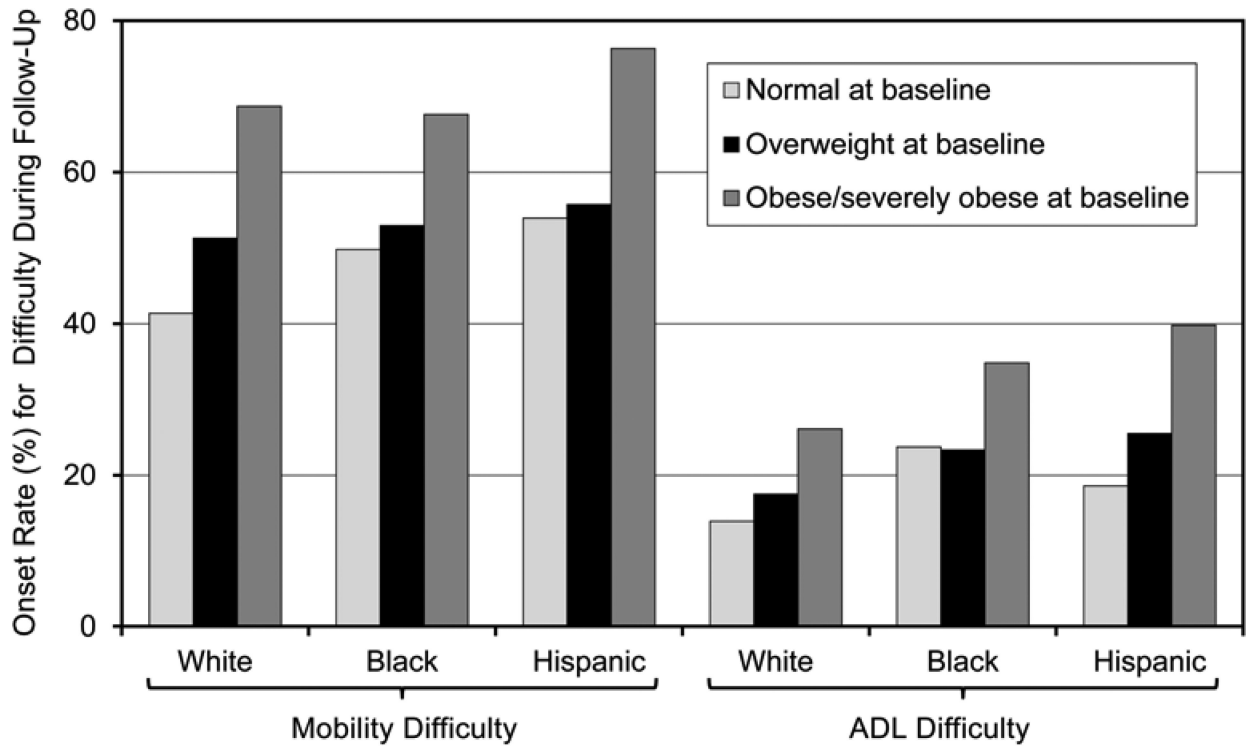


Figure 1.
Racial-Ethnic Differences in Effects of Baseline BMI on 10-year Onset Rates for Mobility Difficulty and ADL Difficulty.

Table 1

BMI Categories, Socio-demographic Characteristics, Health Behaviors, Disease Severity Scores, and Onset of Mobility Difficulty during Follow-up, by Race/Ethnicity, in U.S. Older Adults Who Were Free of Mobility Difficulty at Baseline.

Variables		White ^b (N=4618)	Black (N=791)	Hispanic (N=475)	Total (N=5884)
BMI Categories (%)					
Normal (18.5 BMI < 25)		39.8	26.7 ^{***}	28.8 ^{***}	37.1
Overweight (25 BMI < 30)		43.6	44.9	48.0	44.1
Obese (30 BMI < 35)		13.7	21.3 ^{***}	19.4 ^{***}	15.2
Severely obese (BMI ≥ 35)		2.9	7.1 ^{***}	3.8	3.6
Socio-demographic Characteristics					
Age group 50-64 years (%)		86.9	89.4	86.9	87.2
Age group 65+ years (%)		13.1	10.6	13.1	12.8
Education, years: mean (SD)		13.1(2.6)	11.6(3.1) ^{***}	9.0(4.4) ^{***}	12.6(3.1)
Female (%)		47.0	50.6	45.1	47.3
Married (%)		84.9	63.3 ^{***}	81.3 [*]	81.7
Health Behaviors (%)					
Light/moderate drinker		46.7	40.9 ^{**}	40.0 ^{**}	45.4
Heavy drinker		14.7	5.6 ^{***}	6.1 ^{***}	12.8
Former smoker		48.3	41.2 ^{***}	42.7 [*]	46.9
Current smoker		17.8	21.5 [*]	17.7	18.3
Vigorous physical activity		63.2	56.0 ^{***}	52.6 ^{***}	61.4
Disease Severity Scores (%)					
	Score				
Hypertension	0	67.4	47.4 ^{***}	65.3	64.6
Ever told had hypertension (1 pt.)	1	8.9	11.8 [*]	11.4	11.4
Taking medication (1 pt.)	2	23.7	40.8 ^{***}	23.3	23.4
Diabetes	0	93.2	84.6 ^{***}	87.6 ^{***}	91.6
Ever told had diabetes (1 pt.)	1	2.5	3.4	3.6	2.7
Taking oral medication (1 pt.)	2	4.1	11.4 ^{***}	8.4 ^{***}	5.4
Using insulin (1 pt.)	3	0.2	0.6 [*]	0.4	0.3
Lung disease	0	91.8	92.2	94.1	92.0
Ever told had COPD (1 pt.)	1	6.3	6.8	4.8	6.3
Taking medication (1 pt.)	2	1.3	0.6	0.8	1.2
Report respiratory symptoms (1 pt.)	3	0.5	0.4	0.0	0.5
Report limitation in activities (1 pt.)	4	0.1	0.0	0.2	0.1
Heart disease	0	88.6	92.2 ^{**}	93.5 ^{**}	89.5

Variables		White ^b (N=4618)	Black (N=791)	Hispanic (N=475)	Total (N=5884)
Ever told had heart attack, coronary heart disease, angina, congestive heart failure, or other heart problem (1 pt.)	1	4.5	3.7	3.0	4.3
Taking or carrying medications (1 pt.)	2	4.9	3.0*	2.7*	4.5
Had any angina or chest pain (1 pt.)	3	1.8	1.0	0.4*	1.6
Ever had cardiac surgery (1 pt.)	4	0.2	0.1	0.4	0.2
Stroke	0	98.2	97.4	98.1	98.1
Ever had a stroke (1 pt.)	1	1.0	1.4	1.3	1.1
Taking medications (1 pt.)	2	0.5	1.1*	0.6	0.6
Still have remaining problem (1 pt.)	3	0.3	0.1	0.0	0.2
Arthritis	0	61.6	61.4	68.0**	62.1
Ever had arthritis or rheumatism (1 pt.)	1	7.1	7.0	9.3	7.3
Taking medication or other treatment (1 pt.)	2	22.6	22.4	16.0***	22.1
Had pain, stiffness or swelling in joints (1 pt.)	3	8.6	9.2	6.7	8.5
Cancer	0	93.2	96.7***	95.8*	93.9
Ever told had cancer (1 pt.)	1	5.9	2.8***	3.6*	5.3
Receiving treatment for cancer (1 pt.)	2	0.8	0.5	0.6	0.8
Onset of mobility difficulty during follow-up ^b (N)		2321	445	285	3051
Onset rate ^c for mobility difficulty (%)					
Total sample		50.3	56.3*	60.0***	51.9
Participants with normal weight at baseline		41.4	49.8*	54.0**	43.0
Participants overweight at baseline		51.3	53.0	55.7	51.9
Participants obese or severely obese at baseline		68.7	67.6	76.4	69.2
Participants in each weight category at baseline					
Normal weight at baseline(N)		1837	211	137	2185
Overweight at baseline(N)		2012	355	228	2595
Obese or severely obese at baseline(N)		769	225	110	1104

Notes: Mobility difficulty was a composite measure of difficulty in walking several blocks, walking one block, climbing several flights of stairs, and climbing one floor of stairs.

^aThe reference category for racial/ethnic group is White.

BMI = Body Mass Index; SD = Standard Deviation; COPD = Chronic Obstructive Pulmonary Disease.

^bTotal number of participants in sample with onset of mobility difficulty between 1996 and 2006.

^c10-year onset rate = (number of participants with onset of mobility difficulty during follow-up)/(number of participants at baseline).

* p<0.05

** p<0.01

*** p<0.001.

Table 2

BMI Categories, Socio-demographic Characteristics, Health Behaviors, Disease Severity Scores, and Onset of ADL Difficulty during Follow-up, by Race/Ethnicity, in U.S. Older Adults Who Were Free of ADL Difficulty at Baseline

Variables		White ^a (N=6559)	Black (N=1237)	Hispanic (N=688)	Total (N=8484)
BMI Categories (%)					
Normal (18.5 BMI < 25)		36.3	23.9 ***	25.7 ***	33.7
Overweight (25 BMI < 30)		41.9	42.0	47.3 **	42.3
Obese (30 BMI < 35)		16.3	23.5 ***	21.2 ***	17.7
Severely obese (BMI ≥ 35)		5.5	10.6 ***	5.8	6.3
Socio-demographic Characteristics					
Age group 50-64 years(%)		87.0	89.0	87.2	87.3
Age group 65+ years(%)		13.0	11.0	12.8	12.7
Education, years: mean (SD)		12.8(2.6)	11.5(3.1) ***	8.8(4.4) ***	12.3(3.1)
Female (%)		51.9	58.5 ***	52.0	52.9
Married (%)		83.1	61.0 ***	78.3 **	79.5
Health Behaviors (%)					
Light/moderate drinker		44.4	36.8 ***	36.4 ***	42.6
Heavy drinker		13.5	5.4 ^b	5.5 ***	11.7
Former smoker		46.8	41.2 ***	39.7 ***	45.4
Current smoker		19.9	23.0 *	17.9	20.1
Vigorous physical activity		55.9	47.5 ***	44.6 ***	53.7
Disease Severity Scores (%)					
	Score				
Hypertension	0	62.4	40.8 ***	58.6	58.9
Ever told had hypertension (1 pt.)	1	9.3	11.7 **	12.3 *	9.9
Taking medication (1 pt.)	2	28.3	47.5 ***	29.1	31.2
Diabetes	0	90.8	80.3 ***	83.1 ***	88.6
Ever told had diabetes (1 pt.)	1	2.9	3.8	4.4 *	3.2
Taking oral medication (1 pt.)	2	5.9	14.4 ***	11.2 ***	7.6
Using insulin (1 pt.)	3	0.4	1.5 ***	1.3 **	0.6
Lung disease	0	87.0	87.5	92.3 ***	87.5
Ever told had COPD (1 pt.)	1	8.4	8.7	4.9 **	8.1
Taking medication (1 pt.)	2	2.3	1.5	1.9	2.1
Report respiratory symptoms (1 pt.)	3	1.5	1.8	0.4 *	1.5
Report limitation in activities (1 pt.)	4	0.8	0.5	0.4	0.7

Variables		White ^a (N=6559)	Black (N=1237)	Hispanic (N=688)	Total (N=8484)
Heart disease	0	84.5	86.7	91.1 ^{***}	85.4
Ever told had heart attack, coronary heart disease, angina, congestive heart failure, or other heart problem (1 pt.)	1	5.3	4.8	3.8	5.1
Taking or carrying medications (1 pt.)	2	6.2	5.5	3.6 ^{**}	5.9
Had any angina or chest pain (1 pt.)	3	3.4	2.9	1.2 ^{**}	3.2
Ever had cardiac surgery (1 pt.)	4	0.5	0.1	0.3	0.4
Stroke	0	97.4	95.9 ^{**}	97.7	97.2
Ever had a stroke (1 pt.)	1	1.2	2.3 ^{**}	1.3	1.4
Taking medications (1 pt.)	2	0.8	1.1	0.7	0.8
Still have remaining problem (1 pt.)	3	0.6	0.7	0.3	0.6
Arthritis	0	54.1	51.2	60.8 ^{***}	54.2
Ever had arthritis or rheumatism (1 pt.)	1	7.0	6.5	10.3 ^{**}	7.2
Taking medication or other treatment (1 pt.)	2	25.5	26.7	16.8 ^{***}	25.0
Had pain, stiffness or swelling in joints (1 pt.)	3	13.4	15.6 [*]	12.1	13.6
Cancer	0	92.6	95.3 ^{***}	95.4 ^{**}	93.2
Ever told had cancer (1 pt.)	1	6.4	3.6 ^{***}	3.6 ^{**}	5.8
Receiving treatment for cancer (1 pt.)	2	1.0	1.1	1.0	1.0
Mobility Difficulty at Baseline (%)		30.8	37.2 ^{***}	33.4	31.9
Onset of ADL difficulty during follow-up ^b (N)		1183	338	190	1711
Onset rate ^c for ADL difficulty (%)		18.0	27.3 ^{***}	27.6 ^{***}	20.2
Total sample		18.0	27.3 ^{***}	27.6 ^{***}	20.2
Participants with normal weight at baseline		13.9	23.7 ^{***}	18.6	15.2
Participants overweight at baseline		17.5	23.3 ^{**}	25.5 ^{***}	19.0
Participants obese or severely obese at baseline		26.1	34.8 ^{***}	39.8 ^{***}	29.1
Participants in each weight category at baseline					
Normal weight at baseline (N)		2384	295	177	2856
Overweight at baseline (N)		2748	520	325	3593
Obese or severely obese at baseline (N)		1427	422	186	2035

Notes: ADL difficulty was measured by difficulty in dressing, bathing or showering, eating, and getting in or out of bed without help.

BMI = Body Mass Index; ADL = Activities of Daily Living; SD = Standard Deviation; COPD = Chronic Obstructive Pulmonary Disease.

^aThe reference category for Racial/ethnic group is White.

^bTotal number of participants in sample with onset of mobility difficulty between 1996 and 2006.

^c10-year onset rate = (number of participants with onset of mobility difficulty during follow-up) / (number of participants at baseline).

* p<0.05

**
p<0.01

p<0.001.

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Table 3

Results of GEE Models for Onset of Mobility Difficulty and ADL Difficulty During 10 Years of Follow-up.

Variable	Mobility Difficulty ^a (N=5884)		ADL Difficulty ^b (N=8484)	
	Model 1 ^c OR (95% CI)	Model 2 ^d OR (95% CI)	Model 1 ^c OR (95% CI)	Model 2 ^d OR (95% CI)
Combined Groups of BMI Categories and Race/Ethnicity:				
Normal Weight (18.5 ≤ BMI < 25)				
White ^e	(Ref)	(Ref)	(Ref)	(Ref)
Black	1.30(1.02-1.66) [*]	1.35(1.06-1.72) [*]	1.55(1.15-2.09) [*]	1.46(1.08-1.98) ^{**}
Hispanic	1.15(0.85-1.56)	1.47(1.09-1.97) [*]	1.16(0.76-1.76)	1.67(1.11-2.51) ^{**}
Overweight (25 ≤ BMI < 30)				
White	1.56(1.39-1.75) ^{***}	1.51(1.34-1.70) ^{***}	1.27(1.08-1.50) ^{**}	1.10(0.93-1.30)
Black	1.38(1.14-1.68) ^{**}	1.39(1.14-1.69) ^{**}	1.63(1.27-2.10) ^{***}	1.44(1.12-1.86) ^{**}
Hispanic	1.27(1.01-1.60) [*]	1.48(1.19-1.84) ^{**}	1.33(0.99-1.77)	1.55(1.17-2.05) ^{**}
Obese (30 ≤ BMI < 35)				
White	2.37(2.05-2.74) ^{***}	2.18(1.88-2.53) ^{***}	1.66(1.37-2.01) ^{***}	1.14(0.93-1.39)
Black	2.02(1.56-2.62) ^{***}	1.87(1.45-2.42) ^{***}	1.57(1.17-2.10) ^{**}	1.27(0.93-1.72)
Hispanic	2.01(1.48-2.73) ^{***}	2.06(1.51-2.80) ^{***}	2.23(1.59-3.11) ^{***}	2.15(1.55-2.98) ^{***}
Severely Obese (BMI ≥ 35)				
White	3.29(2.60-4.18) ^{***}	2.77(2.14-3.56) ^{***}	3.03(2.40-3.84) ^{***}	1.75(1.36-2.25) ^{***}
Black	4.07(2.74-6.04) ^{***}	3.14(2.10-4.71) ^{***}	4.75(3.48-6.53) ^{***}	2.76(1.99-3.84) ^{***}
Hispanic	2.98(1.51-5.90) ^{**}	2.96(1.57-5.60) ^{***}	3.40(1.83-6.32) ^{***}	2.79(1.54-5.06) ^{***}
Socio-demographic Characteristics				
Age ≥ 65 years	1.53(1.35-1.74) ^{***}	1.32(1.16-1.49) ^{***}	1.60(1.37-1.87) ^{***}	1.27(1.09-1.50) ^{**}
Female	1.47(1.35-1.62) ^{***}	1.66(1.51-1.82) ^{***}	0.92(0.82-1.04)	0.81(0.72-0.92) ^{**}
Education (years)	0.93(0.92-0.95) ^{***}	0.94(0.93-0.96) ^{***}	0.92(0.91-0.94) ^{***}	0.95(0.93-0.97) ^{***}
Married	NA ^f	NA ^f	0.76(0.66-0.87) ^{***}	0.83(0.72-0.95) ^{**}
Health Behaviors				
Former Smoker	1.15(1.05-1.27) ^{**}	1.10(0.99-1.21)	1.15(1.02-1.31)	1.04(0.92-1.18)
Current Smoker	1.12(0.99-1.27)	1.19(1.05-1.35) [*]	0.99(0.85-1.18)	0.92(0.78-1.09)
Vigorous Physical Activity	0.53(0.50-0.56) ^{***}	0.54(0.51-0.57) ^{***}	0.48(0.44-0.52) ^{***}	0.53(0.48-0.58) ^{***}
Light/Moderate Drinking	0.86(0.80-0.93) ^{***}	0.89(0.82-0.95) ^{**}	0.68(0.61-0.75) ^{***}	0.75(0.68-0.84) ^{***}
Heavy Drinking	0.76(0.68-0.86) ^{***}	0.80(0.71-0.90) ^{***}	0.60(0.50-0.71) ^{***}	0.73(0.60-0.87) ^{***}
Disease Severity Scores				
Hypertension		1.10(1.05-1.14) ^{***}		1.05(0.99-1.11)

Variable	Mobility Difficulty ^a (N=5884)		ADL Difficulty ^b (N=8484)	
	Model 1 ^c OR (95% CI)	Model 2 ^d OR (95% CI)	Model 1 ^c OR (95% CI)	Model 2 ^d OR (95% CI)
Diabetes		1.23(1.17-1.30) ***		1.23(1.16-1.30) ***
Lung Disease		1.71(1.59-1.84) ***		1.32(1.24-1.40) ***
Heart Disease		1.31(1.25-1.38) ***		1.14(1.09-1.20) ***
Stroke		1.67(1.52-1.83) ***		1.74(1.60-1.88) ***
Arthritis		1.31(1.25-1.38) ***		1.39(1.33-1.45) ***
Cancer		1.45(1.33-1.57) ***		1.32(1.20-1.46) ***
Mobility Difficulty at Baseline^g				2.12(1.87-2.39) ***
QICu	27893	26135	19009	17176

Notes. Mobility difficulty was a composite measure of difficulty in walking several blocks, walking one block, climbing several flights of stairs, and climbing one floor of stairs. ADL difficulty was measured by difficulty in dressing, bathing or showing, eating, and getting in or out of bed without help.

GEE = Generalized Estimating Equations; ADL = Activities of Daily Living; BMI = Body Mass Index; OR = Odds Ratio; CI = Confidence Interval; QICu= Approximation of Quasilikelihood under the Independencemodel Criterion (QIC).

^a Onset of mobility difficulty between 1996 and 2006.

^b Onset of ADL difficulty between 1996 and 2006.

^c Model 1: controlling for socio-demographic characteristics and health behaviors.

^d Model 2: controlling for socio-demographic characteristics, health behaviors, and disease severity.

^e White with normal weight is the reference group.

^f NA: Removed from Mobility Difficulty models because p value > 0.15.

^g Mobility Difficulty at Baseline was included only in ADL Difficulty Model 2.

* p<0.05

** p<0.01

*** p<0.001.

Table 4

Racial/Ethnic Differences Within Each BMI Category in Risk of Onset of Mobility Difficulty and ADL Difficulty during 10 Years of Follow-up: Results from GEE Models.

Combined Groups of BMI Categories and Race/Ethnicity	Mobility Difficulty ^a (N=5884)		ADL Difficulty ^b (N=8484)	
	Model 1 ^c OR (95% CI)	Model 2 ^d OR (95% CI)	Model 1 ^c OR (95% CI)	Model 2 ^d OR (95% CI)
Normal Weight (18.5 BMI < 25) at Baseline				
Black vs. White	1.33(1.05-1.70) *	1.35(1.06-1.73) *	1.55(1.15-2.09) **	1.46(1.08-1.98) *
Hispanic vs. White	1.15(0.85-1.57)	1.47(1.09-1.97) *	1.16(0.76-1.76)	1.66(1.11-2.51) *
Hispanic vs. Black	0.87(0.60-1.25)	1.08(0.76-1.55)	0.75(0.46-1.20)	1.14(0.71-1.84)
Overweight (25 BMI < 30) at Baseline				
Black vs. White	0.90(0.75-1.09)	0.93(0.77-1.12)	1.28(1.01-1.63) *	1.31(1.03-1.67) *
Hispanic vs. White	0.82(0.66-1.02)	0.98(0.80-1.21)	1.04(0.78-1.38)	1.41(1.07-1.85) *
Hispanic vs. Black	0.91(0.70-1.18)	1.06(0.82-1.37)	0.81(0.58-1.13)	1.07(0.78-1.48)
Obese (30 BMI < 35) at Baseline				
Black vs. White	0.87(0.67-1.14)	0.86(0.66-1.12)	0.95(0.70-1.28)	1.14(0.84-1.55)
Hispanic vs. White	0.85(0.62-1.16)	0.94(0.69-1.29)	1.34(0.96-1.89)	1.91(1.37-2.68) **
Hispanic vs. Black	0.98(0.67-1.42)	1.10(0.76-1.59)	1.42(0.95-2.11)	1.70(1.39-2.53) *
Severely Obese (BMI ≥ 35) at Baseline				
Black vs. White	1.27(0.82-1.97)	1.13(0.72-1.79)	1.56(1.10-2.23) *	1.58(1.09-2.28) *
Hispanic vs. White	0.91(0.45-0.84)	1.07(0.55-2.08)	1.12(0.59-2.12)	1.60(0.86-2.95)
Hispanic vs. Black	0.72(0.33-1.55)	0.94(0.45-1.97)	0.72(0.37-1.40)	1.01(0.53-1.94)

Notes.

BMI = Body Mass Index; ADL = Activities of Daily Living.

^a Onset of mobility difficulty between 1996 and 2006.

^b Onset of ADL difficulty between 1996 and 2006.

^c Model 1: controlling for socio-demographic characteristics and health behaviors.

^d Model 2: controlling for socio-demographic characteristics, health behaviors, and disease severity.

* p<0.05

** p<0.01.