Racial and Educational Disparities in Mobility Limitation Among Older Women: What Is the Role of Modifiable Risk Factors?

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Objectives. This research explores whether modifiable risk factors (MRFs) are potential mediators and/or moderators of racial/ethnic and educational mobility limitation disparities among older women.

Method. Utilizing Waves 2–9 (1994–2008) of the Health and Retirement Study (HRS), discrete-time event history models with multiple competing events were estimated using multinomial logistic regression.

Results. Black women were more likely to develop mobility limitation relative to White women. This disparity was partially mediated by body mass index. Educational disparities were also observed, yet MRFs did not appreciably influence this disparity. The effect of vigorous physical activity on mobility limitation onset varied by race: physical activity was not as protective for Black women compared with White women. Being overweight appeared to weaken the benefit of additional years of education.

Discussion. These results reiterate the importance of health promotion via MRFs; however, they also illustrate that the effect of MRFs on mobility limitation varies by race and education among older women, which has implications for health professionals interested in functional health interventions. Future recommendations include the development of interventions and health promotion aimed at increasing participation in positive health behaviors that address salient social factors among at-risk older women.

Key Words: Health and Retirement Study—Mobility disparities—Mobility limitation—Risk factors.

The consequences of mobility limitation, defined as difficulty walking, climbing, or standing, in later life have been well documented. Mobility limitation is linked to increased risk of self-care disability (i.e., instrumental/activities of daily living impairment), mortality, and institutionalization as well as increased health care expenditures (Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1995; Melzer, Lan, & Guralnik, 2003; Newman et al., 2006; Tinetti et al., 1995). Furthermore, individuals with mobility limitation often report diminished well being and mental health including increased feelings of fear and depression (Iezzoni, 2003). It is clear that the corollaries of mobility limitation are grave, and, unfortunately, mobility limitation is prevalent among older adults. To illustrate, in 2003, it was estimated that more than 15 million Medicare beneficiaries reported difficulty walking a quarter of a mile (Hardy, McGurl, Studenski, & Degenholtz, 2010). Important mobility limitation disparities have also been identified. Women, racial minorities, and individuals with low socioeconomic status (SES) are at an increased risk of mobility limitation (Freedman & Martin, 1998; Stuck et al., 1999). Given the consequences of mobility limitation, these disparities have a large affect on overall health disparities in later life; therefore, it is vital to gain a better understanding of the processes leading to mobility limitation disparities—especially potentially modifiable mechanisms such as health behaviors that allow for increased health promotion.

It is well established that modifiable risk factors (MRFs; e.g., physical activity, tobacco smoking status, and body mass index [BMI]) are strong and consistent predictors of functional impairment such as disability and functional limitation (Hubert et al., 2002; Penninx et al., 2001; Vita, Terry, Hubert, & Fries, 1998). Although previous studies suggest that racial and educational health disparities persist after adjusting for MRFs, there is evidence that MRFs contribute to these disparities and function as important mediators (Lantz et al., 1998). Yet, relatively few studies have explored potential heterogeneous effects of MRFs in relation to race/ethnicity and education and mobility limitation onset.

Thus, this research utilizes detailed prospective panel data of a late midlife cohort to assess the role of MRFs on mobility limitation onset. More specifically, this study is interested in potential racial/ethnic and educational mobility limitation disparities and how these disparities are shaped by MRFs (i.e., whether MRFs mediate or moderate mobility limitation disparities) among late midlife women. Although understanding mobility limitation disparities is important for both men and women, this research focuses on women because women are at a greater risk of mobility limitation due to higher prevalence of disabling chronic...
conditions (Dunlop, Manheim, Sohn, Liu, & Chang, 2002). It also appears that men and women have divergent functional health trajectories with women experiencing earlier onset and more accelerated impairment (Liang et al., 2008), which suggests that men and women’s development of mobility impairment over the life course may need to be assessed separately.

**Mobility Limitation, Disability, and the Disablement Process**

In some cases, mobility limitation (particularly severe mobility limitation) is viewed as a disability, but more often it is treated as a functional limitation. According to the Disablement Process (Verbrugge & Jette, 1994), functional limitation refers to “restrictions in performing fundamental physical and mental actions,” whereas disability is the “experienced difficulty doing activities in any domain of life due to health or physical problems” (p. 3–4). This distinction between functional limitation and disability is important because functional limitation reflects an earlier stage of the disabling process. In other words, functional limitation is a precursor to disability onset, which is supported by a large body of empirical evidence (see Kelly-Hayes, Jette, Wolf, D’Agostino, & Odell, 1992; Lawrence & Jette 1996; Rantanen et al., 1999).

Mobility limitation is one of the most common types of functional limitations among older adults (Guralnik et al., 1995; Melzer, Lan, & Guralnik, 2003; Newman et al., 2006; Tinetti et al., 1995). Risk of mobility limitation increases with age; however, prior research has estimated that the mean age of mobility limitation onset ranges from 59 to 67 years (Iezzoni, McCarthy, Davis, & Siebens, 2001). This research suggests that onset of mobility limitation most often occurs in late midlife. Given the theoretical and empirical evidence, mobility limitation can be conceptualized as an important pathway for the development of disability that occurs predominantly in late midlife. This research capitalizes on this notion by following a late midlife cohort of women (aged 53–63 years) over a period of 14 years.

**Mobility Disparities Among Older Adults**

Prior research has demonstrated that women are more likely to develop mobility limitation compared with men over the life course (Federal Interagency Forum on Aging, 2004; Freedman & Martin, 1998; Hardy, Mc Gurl, Studenski, & Degenholtz, 2010; Shumway-Cook, Ciol, Yorkston, Hoffman, & Chan, 2005). According to estimates from the National Health and Nutrition Examination Survey, 34% of women, compared with 24% of men, aged 60 years or older reported difficulty with walking a quarter mile (Ervin, 2006). Even more remarkable, using the same study, it was estimated that nearly half of women 60 years or older reported difficulty standing for 2 hr (Ervin, 2006). Similar to mobility limitation, women are more likely to experience instrumental/activities of daily living disability. Jagger et al. (2007) observed that women aged 65 years could expect to spend 57% of their lives free of disability, whereas men aged 65 years could expect to spend 79% of their lives free of disability. It has been hypothesized that sex differences in mobility and functional health, more generally, stem from variation in prevalence of chronic disabling conditions such as arthritis and osteoporosis and life expectancy between men and women. Women are more likely to experience musculoskeletal problems as well as longer life expectancies (Dunlop et al., 2002; Leveille et al., 2000; Murtagh & Hubert, 2004). Although sex disparities in mobility limitation are most certainly due to a combination of biological and social factors, sex may uniquely influence functional health trajectories due to variation in biological susceptibility of chronic disabling and life-threatening conditions.

Unlike sex disparities in mobility limitation, racial/ethnic and educational disparities are thought to be influenced predominantly through social factors (see Link & Phelan, 1995 or Marmot & Wilkinson, 2006) due to lack of resources including knowledge, money, or power as well as stress associated with marginalized social statuses. These inequalities often reflect varying access to resources throughout the life course, which have long-ranging implications for health in later life (Ferraro & Shippee, 2009; Melzer, Izmirlian, Leveille, & Guralnik, 2001; Wadsworth, 1997). For example, lower levels of educational attainment are consistently associated with greater risk of developing mobility limitation for both men and women (Freedman & Martin, 1998; Hardy et al., 2010; Shumway-Cook et al., 2005). Among older women, educational attainment is particularly sensitive predictor of mobility limitation. To illustrate, Gregory et al. (2011) documented an association between education and preclinical mobility disability among high-functioning older women, even after adjusting for income, marital status, morbidity, and self-efficacy.

There is evidence to suggest that education, relative to income, is a better predictor of onset of functional impairment such as mobility limitation because educational attainment tends to occur early in the life course and influences adult economic opportunities (Herd, Goesling, & House, 2007; Zimmer & House, 2003). Moreover, education may impact onset of mobility limitation due to its ability to shape psychosocial resources that are intrinsically related to better functional health. For example, higher levels of educational attainment are associated with greater sense of personal control (e.g., self-efficacy or mastery) and life satisfaction, which promotes reduced stress and participation in positive health behaviors (Herd et al., 2007; Kubzansky, Berkman, Glass, & Seeman, 1998).

In relation to race and ethnicity, compared with Whites, Blacks are more likely to develop mobility limitation and disability (Ervin, 2006; Freedman & Martin, 1998; Hardy et al., 2010), but the evidence for other racial/ethnic
minorities is mixed. Although prior research suggests that SES explains much of the racial variation in functional health status among older adults, there is also evidence that race and ethnicity may independently influence functional health disparities, net of SES (Kelley-Moore & Ferraro, 2004; Kington & Smith, 1997). Race and ethnicity may distinctively influence mobility limitation onset over the life course through variations in exposure to stress and environmental hazards due to discrimination and residential segregation patterns in the United States (Williams, 1999). Previous research exploring Black–White differences in mobility limitation among older women underscores the importance of understanding mobility and disability across the life course. Black–White functional health disparities peak in late midlife (i.e., 50–69 years); however, racial disparities in functional health (i.e., functional limitations and disability) are evident from childhood to late life (Nuru-Jeter, Thorpe, & Fuller-Thomson, 2011).

It is clear that education and race impact older women’s functional health, yet there is still some debate as to whether racial disparities in functional health simply stem from socioeconomic disadvantage. A particularly illuminating study conducted by Thorpe et al. (2008) explored mobility disparities among older women and documented variations in mobility by race and poverty. Poor White women were more likely to exhibit worse mobility function than nonpoor White women—this association was not found among Black women. However, among nonpoor respondents, Black women were more likely to experience poorer mobility function (Thorpe et al., 2008). Thorpe and colleagues’ research highlights the complexity of racial and socioeconomic disparities in relation to functional health, and suggests that both race and socioeconomic disadvantage shape mobility limitation among older women.

MRFs as Predictors of Mobility Limitation

MRFs are associated with lifestyle choices such as physical activity and smoking status. One of the most robust findings in regard to MRFs and mobility limitation is physical activity; physical activity is associated with lower likelihood of mobility limitation onset (Hubert et al., 2002; LaCroix, Guralnik, Berkman, Wallace, & Satterfield, 1993; Mänty et al., 2009; Penninx et al., 2001; Vita et al., 1998). Furthermore, Leveille, Guralnik, Ferrucci, and Langlois (1999) found that the likelihood of dying without limitation or disability was two times higher for those who participated in vigorous activity than those who were not physically active. Smoking status (i.e., tobacco) is another important risk factor, and both former and current smokers are at a greater risk of mobility limitation (Ferrucci et al., 1999; Hubert et al., 2002; LaCroix et al., 1993; Patel et al., 2006; Sainio, Martelin, Koskinen, & Heliovaaara, 2007; Vita et al., 1998). Obesity has also garnered much attention with respect to mobility limitation. Where physical activity and smoking are health risk behaviors, obesity is a health risk that is often a product of lifestyle choices or a combination of several health risk behaviors. Compared with a healthy (normal) weight, overweight and obese individuals are at a greater risk of mobility limitation (Davison, Ford, Cogswell, & Dietz, 2002; LaCroix et al., 1993; Sainio et al., 2007; Stenholm et al., 2007). However, previous literature has also found a link between being underweight (or weight loss at older ages) and higher risk of mortality and mobility decline (Losonczy et al., 1995), which suggests the relationship is not linear.

Race/Ethnicity, Education, and MRFs

Generally, individuals with fewer resources such as racial/ethnic minorities and those with lower educational attainment are less likely to participate in positive health behaviors. This association is believed to be influenced by numerous psychosocial factors and highly sensitive to an individual’s social environment (Lynch, Kaplan, & Salonen, 1997). To illustrate, although smoking has been declining over the past few decades, the rates are not declining at the same rate for all groups. Smoking rates among the less-educated and Black adults remain much higher (Kent, 2011). Among racial and ethnic minorities, Blacks are less likely to be physically active, and more likely to be smokers and overweight/obese (Adams & Schoenborn, 2006; Federal Interagency Forum on Aging, 2004; Kent, 2011), whereas Hispanics are more likely to be overweight/obese compared with Whites (Adams & Schoenborn, 2006). Among older women, specifically, minority women tend to be the least active (Brownson et al., 2000) and have the highest prevalence of obesity (Wang & Beydoun, 2007) when compared with White women. Finally, higher levels of education are linked with lower rates of obesity and smoking, and higher rates of physical activity (Adams & Schoenborn, 2006; DiPietro, 2001).

Given that the prevalence of MRFs vary across different social statuses, it is vital to understand how these relationships may influence mobility limitation disparities. Although there is prior research assessing the impact of MRFs on mobility limitation, this research sets out to comprehensively examine to what extent MRFs mediate racial/ethnic and education disparities in mobility limitations. This research also aims to identify the most salient MRF mediator(s), which may hold important information for health professionals. Based on prior obesity and functional health research, it is anticipated that BMI will be the most salient mediator.

Additionally, this research adds to the extant literature by investigating potential heterogeneous effects of MRFs across different subpopulations, which is understudied. Previous research has identified MRFs as powerful determinants of mobility impairment, but it is possible that the effects of MRFs vary among at-risk groups. For example,
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vigorous physical activity may not have the same protective effect among disadvantaged older women because the types of physical activity that dis/advantage women are exposed to (e.g., repetitive motions due to physical labor or heavy housework vs leisure sports/exercise) may not be as beneficial to functional health. Addressing potential heterogeneous effects of MRFS may lead to the development of more successful functional health interventions because clinicians will be able to adapt practices to fit various risk profiles among vulnerable subpopulations.

**METHOD**

**Data**

To complete this research, Waves 2 through 9 (1994–2008) of the Health and Retirement Study (HRS) were used, which is sponsored by the National Institute of Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan (HRS, 2008). The HRS is an ongoing nationally representative longitudinal survey that uses a multistage, clustered probability frame. It is primarily focused on the health, finances, and employment history of a late midlife cohort (between 1931 and 1941). The first interviews were conducted as structured face-to-face interviews in 1992, and then, two-year follow-up telephone surveys have been used. The initial sample size was approximately 12,654 people (including age-eligible respondents and their spouses). Additionally, to assist in the data management and analysis of this project, the most recent RAND HRS Data file (version K) was used; the RAND HRS Data file is a user friendly, longitudinal data set created from original HRS data by the National Institute on Aging and the Social Security Administration (Chien et al., 2011). Because of modifications in the functional health measures from Wave 1 to Wave 2, the baseline for these analyses was established at Wave 2 (1994). A subset of the original sample was created comprising of age-eligible (i.e., 53–63 years) women in 1994 (N = 5,031).

**Measures**

Mobility limitation was self-reported and comprised of five questions (i.e., “Because of a health problem do you have any difficulty with … ?:) (a) walking across the room; (b) walking one block; (c) walking several blocks; (d) walking up one flight of stairs; and (e) walking up several flights of stairs. The answer categories included the following: “yes,” “no,” “can’t do,” or “don’t do.” A summary index was created for respondents reporting difficulty completing the task; it ranged from 0 to 5, where 0 was having no difficulty with any of the mobility limitation measures and 5 was having some difficulty with all five measures. The summary index was collapsed into a dichotomous measure (no difficulty vs any difficulty). Mobility limitation onset was defined as having no limitation (no difficulty) prior and then reporting limitation (any difficulty) in the subsequent wave.

This analysis was interested in exploring racial/ethnic and education disparities in mobility limitation onset. A three-category dummy variable was created for race and ethnicity with White (reference), Black, and Hispanic as the categories. It is important to note that respondents who did not identify as White, Black, or Hispanic, approximately 1% of the sample, were omitted from the analyses because there were too few cases to sufficiently test interactions between race/ethnicity and MRFS. Education was measured as the number of years of formal education. Race/ethnicity and education were treated as time-fixed variables. Additional sociodemographic covariates were included (i.e., age and marital status) in the analysis. Age was treated as a time-fixed measure (i.e., relative age within sample) and measured at Wave 2 (baseline), whereas marital status was treated as a time-varying variable. A four-category dummy variable was created for marital status with married/partnered (reference), divorced/separated, widowed, and never married as the categories.

There were three MRFS measures included in the analysis: vigorous physical activity, smoking status, and BMI. Physical activity was measured as participating in vigorous exercise or sports, heavy housework, or physical labor multiple times per week. In Waves 3–6, respondents were asked whether they participated in vigorous activity 3 or more times per week. Beginning in Wave 7, the respondents were asked how often they participated in vigorous activity. Those reporting more than once a week were considered physically active. The physical activity measure was treated as a dichotomous variable, where physically active = 1. Smoking status was measured as a three-category dummy variable with never smoked, former smoker, and current smoker as the categories. Never smoked was the reference group. The smoking status measure was constructed from two questions: (a) “Have you ever smoked cigarettes?” and (b) “Do you smoke cigarettes now?” Respondents who reported having ever smoked cigarettes but also reported currently being a nonsmoker were classified as former smokers. A categorical measure of BMI was constructed from self-reported weight and height measures; the categories were based on the Centers for Disease Control and Prevention’s BMI guidelines (Centers for Disease Control and Prevention, 2011) and included underweight (<18.5), healthy weight (normal: 18.5–24.9), overweight (25–29.9), and obese (30). All MRFS were treated as time-varying measures and assessed at the beginning of each interval.

In addition to sociodemographic characteristics and MRFS, two measures of morbidity status were included in the analyses as controls in the main effects models. The number of chronic conditions and a measure of self-rated health were utilized as measures of morbidity. The number of chronic conditions was measured using an index physician-diagnosed self-reports of conditions. The index
ranged from 0 to 7 conditions and included information about arthritis, cancer, diabetes, heart problems, high blood pressure, lung disease, stroke, and psychiatric problems. Self-rated health was measured continuously on a five-point Likert scale with 1 (poor health) and 5 (excellent health). Both measures of morbidity status were treated as time-varying measures and assessed at the beginning of the interval.

Analytic Strategy

Discrete-time event history modeling with repeated multiple competing events was estimated using multinomial logistic regression. The risk group at the beginning of each interval was respondents without any mobility limitation and possible outcomes included: no limitation (stable), any limitation (onset), death, or attrited (i.e., lost to follow-up). The risk group was refreshed; therefore, respondents were able to reenter the risk group if they experienced recovery. The observation intervals were stacked to create a person-interval data set. Analyses were run using both a categorical measure (i.e., a series of dummy variables with Interval 1 as the reference) and a continuous measure of the observation intervals. Not only was a general linear trend observed using a categorical measure, but the continuous measure of the observation intervals improved model fit; therefore, the continuous measure of observation intervals was chosen as the most parsimonious parameterization. On average, respondents contributed 3.6 intervals (~7 years) out of a total of 7 intervals (14 years). Although death and attrition were explicitly modeled, the results are not presented, but are available upon request from the author. Both death and attrition represented a small proportion of the potential outcomes with less than 1% of the sample experiencing death and approximately 5% of the sample attriting during the observation period. A series of multiple logistic regression models were created to ascertain the parameter estimates of the logged odds of mobility limitation onset. The analyses were weighted, and robust standard errors were employed to adjust for clustering at the individual level from repeated observations.

Because this research was concerned with both the mediating and moderating effects of MRFs on mobility limitation disparities, the analysis was completed in two main steps as follows: (a) a series of main effects models were created to observe potential mediating effects of MRFs on mobility limitation disparities and (b) a series of interaction effects models were created to observe potential moderating effects. For Step 1, Model 1 included only sociodemographic characteristics: race/ethnicity, education, age, and marital status as well as the observational interval measure. In Model 2, only MRFs: physical activity, smoking status, and BMI were included. Models 3–5 introduced each individual MRF into the model so that the impact of physical activity, smoking status, and BMI on race/ethnicity and education could be assessed separately. In Model 6, sociodemographic characteristics and MRFs as a group were included in the model. Finally, in Model 7 (full model), morbidity status was introduced to evaluate the effect of MRFs, net of morbidity. In Step 2, interaction effects were tested for each MRF in relation to race/ethnicity and education. The results presented include only the models where the interaction terms were significant.

Results

Descriptive Statistics

Approximately 43% of the subset reported having mobility limitation at Wave 2, whereas the other 57% of women (N = 2,548) comprised the preliminary at-risk group (i.e., respondents without mobility limitation at Wave 2). Table 1 presents the descriptive characteristics for the initial mobility limitation onset risk group by race and ethnicity. Both unweighted and weighted distributions are presented. For the total at-risk group, about a quarter was physically active (i.e., participated in vigorous exercise multiple times per week), and there were no significant differences among racial and ethnic groups. About one in five respondents reported being a current smoker in the total sample. Hispanic respondents were more likely to have never smoked, relative to White respondents. Only a small percentage, approximately 3% of the total at-risk sample was underweight. Being a healthy weight was the modal category for the total sample, yet nearly half of the respondents reported being overweight or obese. Black and Hispanic respondents were more likely to be overweight or obese, compared with White respondents, in the initial risk group.

Main Effects Models

Table 2 displays a summary of the findings acquired from multinomial logistic regression analyses for mobility limitation onset by sociodemographic characteristics, MRFs, and duration for women. Log odds parameter estimates are presented. The likelihood ratios and intercepts for all models were statistically significant at an α level of less than 0.001. In Model 1, race (i.e., Black) and education were statistically significant. Compared with White respondents, Black respondents were at an increased risk of mobility limitation onset with a log odds of 0.34 (odds ratio [OR] = 1.40; 95% confidence interval [CI] = 1.21, 1.64). Education (OR = 0.92; 95% CI = 0.90, 0.94) had a protective effect on the onset of mobility limitation. Additionally, older respondents were more likely to experience mobility limitation decline with log odds of 0.02 (OR = 1.02; 95% CI = 1.00, 1.04). Model 2 examined MRFs as a group. Vigorous physical activity (OR = 0.66; 95% CI = 0.60, 0.73) reduced the odds of mobility limitation onset, whereas former smokers (OR = 1.15; 95% CI = 1.02, 1.30) and current smokers (OR = 1.50; 95%
CI = 1.29, 1.74) were at a greater risk of onset. All BMI measures were significant predictors with underweight, overweight, and obese respondents being more likely to experience mobility limitation onset relative to healthy weight respondents. The association between obesity and mobility limitation was particularly pronounced among women, with a log odds of 1.01 or an odds ratio estimate of 2.75 (95% CI = 2.39, 3.17).

In Models 3–5, the individual MRFs were added. In Model 3, vigorous physical activity was introduced. With the addition of physical activity, race remained significantly associated with mobility limitation. Black respondents were more likely to report mobility limitation onset, relative to White respondents. Similarly, more years of education continued to be linked to lower risk of mobility limitation onset. Model 4 included smoking status. Black respondents continued to be more at risk of mobility limitation onset, whereas more educated respondents continued to be associated with lower risk. Age also continued to be positively associated with mobility limitation onset. In Model 4, both former and current smokers were more likely to experience onset. With the introduction of smoking status, the strength of the association between Black race and mobility limitation increased marginally—indicating a potential suppressor effect. With the introduction of BMI (Model 5), once again, being Black was significantly associated with increased risk of mobility limitation, whereas education was associated with decreased risk. Being underweight, overweight, or obese were all strong predictors of onset in Model 5. Compared with Model 1, the association between Black race and mobility limitation onset was attenuated, which suggests that BMI is a partial mediator in this relationship.

Model 6 included both sociodemographic characteristics and all MRFs. From Model 1 to Model 6, the strength of the association between Black race and mobility limitation onset was diminished. It appears that MRFs, as a group, partially mediated the original association between race (i.e., Black) and mobility limitation; however, from Model 5 to Model 6, the magnitude of the association remained relatively stable, which suggests that BMI was the most salient mediator. To formally test whether BMI was a partial mediator, an adjusted Sobel test (see MacKinnon & Dwyer, 1993) of mediation was conducted. Being obese (z-score = 7.48) or overweight (z-score = 2.38) were significant partial mediators at an α-level of less than 0.05. Education remained relatively stable across all of the models. In Model 6, all of the MRFs measures were significant. Once more, physical activity was associated with lower risk of mobility limitation onset. Former smokers and current smokers were more likely to experience mobility decline. Being underweight, overweight, or obese, relative to a healthy weight, continued to be associated with greater risk of mobility limitation onset.

### Table 1. Descriptive Statistics for Mobility Limitation Onset Initial Risk Group by Race and Ethnicity (N = 2,548)

<table>
<thead>
<tr>
<th>Race and ethnicity</th>
<th>Total (N = 2,548)</th>
<th>White (N = 1,959)</th>
<th>Black (N = 409)</th>
<th>Hispanic (N = 180)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unweighted</td>
<td>Weighted</td>
<td>Unweighted</td>
<td>Weighted</td>
</tr>
<tr>
<td>Education (years)</td>
<td>12.5 (3.1)</td>
<td>57.4 (2.8)</td>
<td>12.9 (2.2)</td>
<td>57.4 (2.9)</td>
</tr>
<tr>
<td>Race</td>
<td>7.1</td>
<td>4.7</td>
<td>7.1</td>
<td>4.7</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smoked</td>
<td>49.0</td>
<td>48.4</td>
<td>50.1</td>
<td>49.0</td>
</tr>
<tr>
<td>Former smoker</td>
<td>31.1</td>
<td>31.6</td>
<td>30.6</td>
<td>31.2</td>
</tr>
<tr>
<td>Current smoker</td>
<td>19.9</td>
<td>20.0</td>
<td>19.3</td>
<td>19.7</td>
</tr>
<tr>
<td>Body mass index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>3.2</td>
<td>3.0</td>
<td>2.2</td>
<td>2.0</td>
</tr>
<tr>
<td>Healthy weight</td>
<td>46.0</td>
<td>48.3</td>
<td>22.0</td>
<td>22.0</td>
</tr>
<tr>
<td>Overweight</td>
<td>34.4</td>
<td>33.1</td>
<td>46.5</td>
<td>46.4</td>
</tr>
<tr>
<td>Obese</td>
<td>16.4</td>
<td>15.5</td>
<td>29.3</td>
<td>29.6</td>
</tr>
<tr>
<td>Morbidity status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of chronic conditions</td>
<td>0.9 (0.9)</td>
<td>0.9 (0.8)</td>
<td>0.8 (0.9)</td>
<td>0.8 (0.8)</td>
</tr>
<tr>
<td>Self-rated health</td>
<td>3.8 (0.9)</td>
<td>3.8 (0.8)</td>
<td>3.9 (0.9)</td>
<td>3.9 (0.8)</td>
</tr>
</tbody>
</table>

**Notes:** *Percentages shown for categorical variables; mean and (standard deviation) shown for continuous variables.

*Bolded items indicate significant (p < .05) distributional differences, relative to White respondents.*

CI = confidence interval, MRF = modifiable risk factor.
Model 7 introduced morbidity status. Both measures of morbidity status were significantly associated with mobility limitation onset, where more chronic conditions increased the risk of onset and higher ratings of health decreased risk of onset. With the introduction of number of chronic conditions and self-rated health, Black respondents were no longer at a greater risk of mobility limitation onset. From Model 6 to Model 7, most associations, with the exception of race, remained significant—although attenuated. Net of sociodemographic characteristics and morbidity status, MRFs continued to be reliable predictors of mobility limitation onset. Finally, in all six models, the duration measure showed increasing risk of mobility limitation onset over the study period.

**Interaction Effects Models**

Table 3 presents the significant moderating effects of race/ethnicity*MRFs and education*MRFs. The likelihood ratios and intercepts for all models were statistically significant at an α-level of less than 0.001.

In Model 1, Black*physical activity was significantly associated with mobility limitation onset. The interaction term coefficient for Black*physical activity was positive, which suggested that physical activity was not as protective for Black respondents compared with physically active White respondents. Predicted probabilities demonstrate the racial heterogeneity among vigorously active and inactive older women. Among physically inactive women, the predicted probability of mobility limitation onset was nearly identical for both groups. The predicted probability for Black and White respondents was 0.76 and 0.74 for Black respondents and White respondents, respectively. Among physically active women, the predicted probability for Black respondents was 0.74, whereas the predicted probability for White respondents was 0.66.

In Model 2, Black*overweight and Black*obese were negatively associated with mobility limitation onset. The negative coefficient indicates that Black overweight or obese women were less likely to experience mobility limitation onset compared with White overweight or obese women. However, the predicted probabilities illustrate that the risk of mobility limitation onset was nearly identical for both groups. The predicted probability for overweight Black and White women was 0.84, whereas the predicted probability for obese Black and White was 0.90 and 0.89, respectively. Additionally, Hispanic*underweight was negatively associated with mobility limitation onset. Relative to overweight White respondents, underweight Hispanic respondents...
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were less likely to develop mobility limitation. In Model 3, education*BMI was introduced. One interaction term was significant: education*overweight. Education*overweight was associated with greater risk of mobility limitation onset; this suggested that protective effect of higher levels of education was diminished for overweight respondents.

**Discussion**

These results demonstrate the complex relationship between mobility limitation onset and MRFs. As a group, MRFs were better predictors of mobility limitation onset than sociodemographic characteristics as evidenced by the model fit (i.e., likelihood ratio) from Table 2 (i.e., Model 2 vs Model 1). These results reiterate the importance of MRFs in relation to mobility limitation onset and the need for health promotion; however, they also underscore the importance of social factors such as race and education. For example, in the main effects full model, educational disparities persist for women even after controlling for MRFs and morbidity status. Relating to the main effects of race and ethnicity, Black women were more likely to experience mobility limitation onset. Relative to White women, Hispanic women were not significantly different in relation...
to risk of mobility limitation onset. Prior research has documented Black–White differences for mobility, but similar to these results, findings for Hispanics have been equivocal.

BMI index appeared to be a particularly salient mediator for race and mobility limitation onset. This parallels previous research exploring race, obesity, and functional health. Ferraro and Kelley-Moore (2003) documented a robust association between chronic obesity and lower body disability among older adults; their findings suggest that long-term obesity has a “scarring effect” that shapes mobility over the life course. Black women, compared with White women, are more likely to be overweight or obese at every stage of the life course, and among Black women over the age of 40 years more than half are obese (Wang & Beydoun, 2007). The excess burden of higher levels of BMI among older Black women—often reflecting long-term obesity—partially accounted for the increased risk of mobility limitation onset among this sample of late midlife women. However, there were interesting interaction effects that suggest the interplay between race and MRFs is even more dynamic regarding mobility in later life.

Among the interaction effects models, there were several significant relationships. The protective effect of physical activity was not as great for Black women as White women. In addition, Black women who were overweight or obese were marginally less likely to experience mobility limitation onset. Underweight Hispanic women were less likely to experience mobility limitation onset, relative to White women. Being overweight appeared to weaken the benefit of additional years of education. These results illustrate that MRFs are potential sources of heterogeneous risk for mobility limitation by race and sex, which has implications for health professionals interested in health promotion and functional health interventions. For example, Black women appear to be a vulnerable group for mobility limitation onset, and BMI was an influential mediator in Black–White disparities in mobility limitation onset. This suggests that older Black women would most likely benefit from greater participation in positive health behaviors that lower BMIs, yet vigorous physical activity—an often acclaimed health promotion technique—is not as protective for Black women compared with White women.

More generally, these results reiterate the importance of BMI for mobility limitations among multiple groups. There is a great deal of focus on the obesity epidemic, but these findings indicate that underweight women are also at risk of mobility limitation onset. Yet, underweight Hispanic women were much less likely to experience mobility limitation onset relative to underweight White women. This suggests being underweight does not influence mobility in the same manner across all racial and ethnic groups. Lastly, the pronounced influence of BMI is observed in the education and MRFs interaction models. Education is a robust predictor of mobility limitation with more years of formal education being protective; however, being overweight reduced the benefits of more education among older women.

Research Limitations

Although this research contributes to extant literature, it must be viewed in light of the research limitations. One of the main limitations of this study is the two-year interval. It cannot be established at what point during the two-year interval respondents developed mobility limitation onset or recovery. Because event history analysis examines a change in state or the occurrence of an event, the outcome variable used in this research can only capture a passing of a threshold. Another limitation of this research is the attrition due to mortality and drop-outs. In relation to MRFs, attrition may be a particularly salient form of selection bias because of healthy survivor bias, where participation in MRFs shapes mortality rates among respondents. However, attrition was included in the analysis as a competing event, which is a standard technique to account for selection bias from attrition. The results suggest that those with fewer resources and poorer health were more likely to attrite—which implies that mobility limitation onset was underestimated. Further limitations stem from the operationalization of central measures. For example, the mobility limitation measures were self-reported and did not take into account the severity of the limitation. Future research may benefit from the use of object or performance-based measures as they are more sensitive to earlier declines in functional health (Guralnik et al., 1994).

Additionally, the MRFs measures were self-reported, and many of the measures lacked sophistication. The physical activity measure only asked about vigorous exercise and question format changed starting in Wave 7; however, the types physical activity older adults participate in tend to be low intensity (DiPietro, 2001). Because of concordance issues with the physical activity measure, sensitivity analyses were completed where only Waves 3–6 were included in the analyses. These models yielded a similar pattern of results including a significant interaction between race and physical activity (note: the magnitude of the interaction term was slightly larger in these models). Physical activity and mobility limitation also have a bidirectional relationship; however, MRFs including physical activity were measured as time varying at the beginning of each interval, which takes into account some of the issues with bidirectionality. The BMI measure was also based on self-reports of weight and height, and it likely underestimates BMI. Finally, MRFs were measured at the beginning of each interval but not assessed cumulatively.

Conclusion

Mobility limitation is prevalent among older adults and has serious individual and societal consequences. Prior research has identified and acknowledged significant mobility limitation disparities for men and women including racial/ethnic and educational disparities. MRFs are thought to contribute to these disparities; however, relatively little
research has explored both the mediating and moderating effects of MRFs on these disparities. This research contributes to the extant literature by comprehensively examining MRFs and mobility limitation disparities among late midlife women. Thorpe et al. (2008) documented important race and poverty disparities among women aged 65 years and older, yet these disparities were not uniform among Whites and Blacks. Poverty appeared to have a greater influence on White women’s mobility, whereas among the nonpoor, Black women experienced worse mobility outcomes. Furthermore, neither poverty nor race appeared to impact progression of disability. In light of these prior findings, this research may speak to the variations in mobility and disability by race and SES. In particular, this research suggests that the relationship between race and mobility onset is moderated by physical activity and BMI. Further research exploring these variations may uncover important information for health professionals about racial and educational mobility disparities.

Additionally, this research not only reiterates the importance of MRFs but also recognizes that participation in health behaviors occurs within the context of social and physical environments over the life course. This research suggests that physical activity may benefit White and Black women differently. It is well documented that older Black women are less likely to participate in physical activity (see Brownson et al., 2000), relative to White women; however, these findings indicate that even among (self-reported) physically active women, mobility limitation disparities by race exist. It is possible that the types of vigorous physical activity that White and Black women participate in have a differing impact on mobility. It is also possible that the physiological benefits of physical activity such as reduced stress and improved immune and cardiovascular functioning do not offset the detrimental physiological effects of racism and discrimination. An alternative explanation may stem from sociocultural differences in self-reporting vigorous physical activity. Either way, further research into understanding how White and Black women’s mobility responds to physical activity may inform interventions. Likewise, the author recommends interventions and health promotion aimed at increasing participation in positive health behaviors that address salient social factors and heterogeneity among at-risk older women. For example, Gallant and Dorn (2001) observed that formal social integration (e.g., attending organizations, clubs, meetings, or religious services) had a considerable and unique impact on health behaviors among older Black women. Community-level interventions that address obstacles preventing positive changes in MRFs may lead to better functional health outcomes within at-risk communities.

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