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Biopsychosocial Predictors of Fall Events among Older African Americans

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Abstract

This study identifies risk and protective factors for falls among older, community-dwelling African Americans. Drawing upon the biopsychosocial perspective (Engel, 1997), we conducted a series of sex- and age-adjusted multinomial logistic regression analyses to identify the correlates of fall events among older African Americans. Our sample consisted of 1,442 community-dwelling African Americans aged 65 and older, participating in the 2010-12 rounds of the Health and Retirement Study. Biophysical characteristics associated with greater relative risk of experiencing single and/or multiple falls included greater functional limitations, poorer self-rated health, poorer self-rated vision, chronic illnesses (high blood pressure, diabetes, cancer, lung disease, heart problems, stroke, and arthritis), greater chronic illness comorbidity, older age, and female sex. Physical activity was negatively associated with recurrent falls. Among the examined psychosocial characteristics, greater depressive symptoms were associated with greater relative risk of experiencing single and multiple fall events. Implications for clinicians and future studies are discussed.

Keywords

Falls; African American; biopsychosocial model; risk and protective factors; aging in place

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Declaration of Conflicting Interests

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Introduction

An estimated 1 in 3 adults aged 65 and older experience one or more falls per year (Lord et al., 2007). Falls are major causes of hospitalization, nursing home admission, and mortality among older adults in the United States (Centers for Disease Control and Prevention [CDC], 2006). Fall-related injuries can result in activity restrictions and loss of independence, which could limit opportunities for older adults to age in place. This pattern can be self-perpetuating, as activity avoidance due to fear of falling contributes to further physical deconditioning (Boyd & Stevens, 2009; Rubenstein, 2006).

Extensive research examines and identifies risk and protective factors of falls; however, most of these studies were conducted with population-based, primarily non-Hispanic white populations, or among smaller samples of seniors living in nursing homes or long-term care facilities. Although some studies have investigated racial/ethnic differences in fall risk (Hanlon et al., 2002; Nicklett & Taylor, 2014), very few specifically examine risk and protective factors for falls among older African Americans (e.g., Andresen et al., 2006). Consequently, there is a paucity of evidence on fall events and associated risk factors among African Americans. The goal of this paper is to provide a comprehensive examination of the risk and protective factors involved in falls among older African Americans.

Research on fall risk informs clinical practice, screening tools, and fall-prevention programs (American Geriatrics Society [AGS], 2001; Stevens & Sogolow, 2008), which can substantially reduce the risk of incident and recurrent falls among older adults (Chang et al., 2004; Stevens & Sogolow, 2008; Tinetti, Speechley, & Ginter, 1988). Further research is needed that characterizes fall risk among African Americans to inform clinical guidelines and evidence-based practice, programs, and policies targeted toward improving the health and well-being of diverse older adult populations.

Literature Review: Using the biopsychosocial model to examine risk factors for falls

Research comparing fall risk among older adults by race/ethnicity has generally found that African Americans report fewer falls than non-Hispanic whites (e.g., Hanlon et al., 2002; Nevitt et al., 1989; Mertz et al., 2010; Nicklett & Taylor, 2014; Sun et al., 2016; Vieira et al., 2015). However, clinical guidelines for fall risk—which are used in practice and in fall-prevention programs—have identified older African Americans to be at heightened risk of experiencing falls (AGS, 2001; Ellis et al., 2013). This discrepancy could be due to the heightened prevalence of some fall-associated risk factors among older African American adults, such as chronic disease burden (Fillenbaum et al., 2000; Sloan & Wang, 2005), disability (Dunlop et al., 2007; Sloan & Wang, 2005), and fewer socioeconomic resources (Ellis et al., 2013; AGS, 2001; Gill, Taylor, & Pengelly, 2005). In contrast, other psychosocial factors, such as lower prevalence of depressive symptoms (Aranda et al., 2012; Lincoln et al., 2010; Woodward et al., 2013), could also serve as protective factors for falls among African Americans. As the prevalence of risks and protective factors both differ across and among population subgroups, further research is needed to identify the correlates of fall events among diverse older adult populations.

In the present study we draw upon the biopsychosocial model (Engel, 1997) to examine predictors of fall events specifically among older, community-residing African Americans. The biopsychosocial model stresses the importance of interpersonal, relational, and contextual factors in shaping health and disease experiences and outcomes (Borrell-Carrio, Suchman, & Epstein, 2004; Engel, 1997), and will therefore guide this study's examination and characterization of risk and protective factors for falls among African American older adults.

Biophysical characteristics—Prior research identifies several biophysical factors associated with fall events. Falls are more prevalent among older adults with worse self-reported health (Shumway-Cook et al., 2009), visual impairments (Nevitt et al., 1989; Coleman et al., 2007), and functional impairments (Nevitt et al., 1989; Schwartz et al., 2002). Prior studies also found that chronic illness comorbidity (Shumway-Cook et al., 2009) and memory problems/cognitive impairment (Rubenstein, 2006) are positively associated with fall events. The relationship between chronic illness and falls can operate through multiple pathways, including associated complications, medication use, and physical activity (Hanlon et al., 2002; Schwartz et al., 2002).

Psychological characteristics—Psychological characteristics can affect fall risk in multiple ways. Depression is a potential risk factor for falls (Iaboni & Flint, 2013; Deandrea et al., 2010; Koski et al., 1998). Depression and falls could have a bidirectional relationship (Iaboni & Flint, 2013), with depressive symptomology, including weight loss, cognitive deficits, greater fear of falls, and avoidance of physical activity, all of which may increase one's risk of falling and sustaining related injuries (Andresen et al., 2006; Kosma, 2014).

Studies have generally found lower prevalence of depression among African American adults (CDC, 2004; Kessler et al., 2005; Williams et al., 2007), including among older African Americans specifically (Aranda et al., 2012; Lincoln et al., 2010; Woodward et al., 2013). However, depression could lead to falls through different pathways for different racial or ethnic groups. In a study of late middle-aged African Americans, the most consistent association for all fall outcomes was depressive symptoms, as assessed by CES-D 11 (Andresen et al., 2006). Those with a CES-D score of 9 or greater were at greater risk for any fall in the prior two years (1.77 OR), any injurious fall in the prior two years (1.71 OR), any fear of falling at baseline (1.76 OR), low falls efficacy at baseline (1.68 OR), and any fall at 2-year follow-up (1.50 OR).

Socio-demographic characteristics—Female sex (Deandrea et al., 2010; Shumway-Cook et al., 2009; Stahl & Albert, 2015; de Rekeneire et al., 2003) and older age (Deandrea et al., 2010; AGS, 2001) are documented risk factors for fall events. Some studies have found that higher socioeconomic status—measured as higher incomes (Ellis et al., 2013) or as more years of formal education (AGS, 2001; Gill, Taylor, & Pengelly, 2005)—was associated with a lower risk of falls. Higher socioeconomic status entails health advantages, including—but not limited to—health literacy, patient-provider communication, access to care, financial resources for health care and health promotion, and walkable or accessible neighborhood environments.

The relationship between falls and marital status has also been documented in prior studies. In studies using majority non-Hispanic white samples, single persons were more likely to experience falls (Schiller et al., 2007; Stevens et al., 2008; Shumway-Cook et al., 2009; Koski et al., 1998; Deandrea et al., 2010).

Marital status could operate differently as a risk or protective factor for falls among non-Hispanic white and African American older adults. Generally, older adults who are married benefit from greater financial security, social integration, social support, and tangible assistance (Tucker et al., 1993)—each of which can be protective against falls. African American adults are less likely to be married than older non-Hispanic white adults (35% versus 56%) due to higher rates of widowhood, divorce, and a larger proportion of individuals who were never married (U.S. Census Bureau, 2014). However, the pathways between marital status and fall risk might operate differently by race/ethnicity. African American adults could receive tangible support or assistance from non-kin or from multi-generational households (Himes, Hogan, & Eggebeen, 1996; Waite & Hughes, 1999).

There is an accumulating body of research which shows that religious involvement is associated with better physical health (George, Ellison, & Larson, 2002). Frequent service attendance has been associated with mental health, physical health, and mortality (George, Ellison & Larson, 2002). Since falls are strongly associated with poor health, there may be an association between service attendance and falls among older African Americans. Conversely, since many African Americans will attend religious services even when they have severe physical problems, service attendance may not be associated with fewer falls (Taylor, Chatters, & Levin 2004).

As noted in this literature review, the vast majority of research on falls has been conducted with non-Hispanic white samples. A small but emerging body of research examines racial differences in falls (Hanlon et al., 2002; Nicklett & Taylor, 2014). This comparative research is highly informative about differences between racial groups, but it does relatively little to advance understanding of specific factors associated with falls among African Americans. The goal of this study is to address this limitation by examining within-group differences in falls among older African Americans. Research findings from studies focused on within-group differences among African Americans will inform clinical practice, aid in the development of program interventions addressing falls, and guide future studies on fall-associated characteristics among racially and ethnically diverse older adult populations, including African Americans.

Methods

Data and Sample

The Health and Retirement Study (HRS) is a population-based tracking study of older adults, with replacement, that began in the early 1990s. The HRS has maintained high response rates among surviving participants, ranging from 85% to 93% across survey waves (Kapteyn et al., 2006). Data collection efforts are ongoing by telephone, in person, and/or through the analysis of biometric indicators, according to study protocols (Juster & Suzman, 1995). The HRS has given researchers the opportunity to examine within-group differences

of health- and aging-related outcomes of older adults. The HRS over-sampled African American participants at baseline, following participants into middle age and older adulthood. Further details about the HRS study methods and sampling design have been published elsewhere (Juster & Suzman, 1995; HRS, 2011).

The HRS analytic sample was comprised of African Americans living in community (non-institutional) settings. Of the 3,945 African American participants in the 2010 and 2012 HRS rounds, 1,685 (43%) were asked questions regarding fall events over the preceding 2 years. Of those participants, 243 (6%) did not answer (a) whether or not they has fallen in the preceding 2 years (n=134 missing, 8%) and/or did not answer (b) the number of times they had fallen in the preceding 2 years (n=109 missing, 6%). The resulting sample size was then 1,442 African American participants. This subsample did not have significantly different mortality risk or chronic disease comorbidity when compared to age-matched African American participants for whom falls data were not available. The research was approved by the institutional review board at the University of Michigan.

Variables and Measurement

The selection of biophysical and psychosocial characteristics was guided by results from published studies on risk and protective factors for fall events. To establish temporal precedence, we examined the relationship between 2010 biophysical and psychosocial risk factor data with subsequent (2012) falls data. Further details on variables, including measurement and role in statistical analyses, are included in Table 1.

Fall Events (outcome variable)—We examined the relationship between biopsychosocial characteristics and the dependent variable, the relative risk ratio (RRR) of experiencing a single fall or multiple falls (compared to experiencing no falls). Single and multiple fall events were examined separately in order to identify characteristics associated with different types of fall risk (AGS, 2001; Schiller et al., 2007). This strategy identifies risk factors for providers to target interventions accordingly.

Falls were assessed according to self-report (e.g., de Rekeneire et al., 2003; Hanlon et al., 2002; Nicklett & Taylor, 2014) in the 2012 round of the HRS. Participants were asked whether or not they had fallen in the preceding 2 years, i.e., since the prior interview round (2010). Participants reporting such fall events then reported the number of falls during those two years. Fall events were then recoded into a categorical ordinal variable: 0 = No falls (reference group); 1 = 1 fall; and 2 = 2 or more falls.

Biophysical measures—We examined the relationship between specific characteristics and fall events using 2010 HRS data: functional limitations, health and vision, chronic illness burden, physical activity, medication use, sex, and age. We categorized the sample according to the following age groups: 65-69, 70-74, 75-79, 80-84, and 85 or older. Functional limitations were examined separately according to mean values for Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) scales. The ADL scale ranges from 0 to 5 and measures the number of ADL activities with which participants had any difficulty, including bathing, dressing, eating, walking across a room, or getting out of bed. The IADL scale ranges from 0 to 5 and measures the number of IADL activities with

which participants had any difficulty, including using a telephone, taking medications, handling money, shopping, and preparing meals. Health status was measured using a Likert scale of self-rated health. Participants were asked how they would describe their health: excellent, very good, good, fair, or poor (Idler & Benyamini, 1997). Vision was also measured using a Likert scale; participants were asked how they would describe their eyesight: excellent, very good, good, fair, poor, or legally blind (poor and legally blind were subsequently collapsed).

Eight chronic illnesses were separately examined: high blood pressure, diabetes, cancer of any kind, lung disease, heart problems, stroke, arthritis, and memory problems. Disease status was based on self-reported diagnosis and was examined using indicator variables. Comorbidity was assessed according to the number of the 8 chronic illnesses above with which the participant had been diagnosed (recoded as 0, 1, 2, or 3+). The dichotomous measure of physical activity participation was constructed to indicate whether or not participants regularly (once per week or more) engaged in physical activity of a light, moderate, or vigorous nature. Medication use was assessed by self-report.

Psychosocial measures—Depressive symptoms were assessed using the CES-D scale (Radloff, 1977). Marital status was assessed as a dichotomous measure, with participants indicating they were married (1) as opposed to never married, separated, divorced, or widowed (0). Education was examined categorically (less than high school, high school/GED completion, some college, or college or more). Total household income (from all sources) and total household wealth (minus total debts) was examined in thousand-dollar increments using 2010 RAND income and wealth imputation data¹. Frequency of religious service attendance was examined categorically: not at all, once per year, 1-3 times per month, once per week, or more than once per week.

Analytic Approach

We first examined relationships between fall event (no falls, single fall, or multiple falls) using descriptive statistics. We then examined the independent relationships between biopsychosocial characteristics and falls in a series of age- and sex-adjusted multinomial logistic analyses. This strategy examined the association between examined characteristics and risks of those who experienced single and/or multiple fall events, compared to those who experienced no falls. The analytic approach draws upon the biopsychosocial model (Engel, 1997), which stresses the importance of understanding how characteristics independently and interdependently relate to health outcomes.

Age and sex were included as control variables as these characteristics could confound (e.g., Andresen et al., 2006) or modify (e.g., Hanlon et al., 2002; de Rekeneire et al., 2003) the relationship between biopsychosocial predictors and falls. Slight adjustments were made in some models. The model examining age group did not adjust for age, while the model examining sex controlled for age only. The model examining comorbidity adjusted for the number of 8 specified health conditions for which data were missing. Household income and

¹For more information on RAND contributions to HRS data, including income and wealth imputations, see: http://hrsonline.isr.umich.edu/modules/meta/rand/randhrso/rnd_Odd.pdf

household wealth adjusted for whether the household was considered single or coupled. Relative risk ratios (RRRs) and 95% confidence intervals (CIs) are reported. Relative risk ratios estimate the ratio of the probability of (a) one fall event and/or (b) multiple fall events over the probability of no fall events. All analyses were conducted using Stata version 13.1.

Results

Descriptive Statistics

Descriptive statistics of biopsychosocial characteristics and fall event categories are shown in Table 2.

Participants were aged 65-103 (mean age, 75 years). Approximately 28% of participants reported falling one time or more over the preceding two years; 11% of participants reported a single fall event, while 17% of participants reported multiple falls. Among those who reported a fall, the majority (59%) fell more than once.

Chronic disease comorbidities were highly prevalent in the sample: high blood pressure (80% of participants), diabetes (33%), cancer (15%), lung disease (79%), heart problems (22%), stroke (9%), arthritis (67%), and memory problems (3% of participants). Only 7% of the sample reported no chronic illness comorbidities. The remaining participants were diagnosed with 1 condition (18%), 2 conditions (32%), or 3 or more conditions (44%). Regular physical activity (81%) and regular medication use (88%) were examined as potential biophysical predictors of falls among older African American adults.

Multinomial Logistic Analyses

As shown in Table 3, participants reporting greater ADL limitations were more likely to report multiple falls (RRR: 1.40, CI: 1.26, 1.55). Participants reporting greater IADL limitations were also more likely to report multiple falls (RRR: 1.36, CI: 1.23, 1.51) as well as single fall events (RRR: 1.15, CI: 1.00, 1.32). Participants who described their overall health as “fair” were more likely to report multiple falls compared to those who described their overall health as “excellent” (RRR: 5.39, CI: 1.64, 17.74). Participants who described their health as “poor” were more likely to experience a single fall (RRR: 2.93, CI: 1.03, 8.30) and multiple falls (RRR: 9.23, CI: 2.70, 31.59), compared to participants who rated their health as “excellent.” Participants who rated their overall vision as “poor” or “legally blind” were more likely to report multiple falls (RRR: 3.31, CI: 1.37, 8.04) compared to participants who rated their vision described as “excellent.”

Participants who had been diagnosed with the following chronic illnesses were more likely to report single and multiple fall events, compared to no falls: diabetes (single fall RRR: 1.70, CI: 1.21, 2.38; multiple falls RRR: 1.62, CI: 1.21, 2.16), heart problems (single fall RRR: 1.79, CI: 1.25, 2.56; multiple falls RRR: 1.94, CI: 1.44, 2.63), stroke (single fall RRR: 1.65, CI: 1.01, 2.69; multiple falls RRR: 2.24, CI: 1.52, 3.29), and arthritis (single fall RRR: 1.62, CI: 1.08, 2.43; multiple falls RRR: 2.34, CI: 1.61, 3.39). High blood pressure was associated with a higher risk of experiencing a single fall (RRR: 1.98, CI: 1.18, 3.32), while cancer (RRR: 1.57, CI: 1.09, 2.24) and lung disease (RRR: 1.68, CI: 1.08, 2.61) were

associated with a higher risk of experiencing multiple falls among participants, compared to no falls.

Compared to those with no chronic illness comorbidity, participants with three or more comorbidities were more likely to experience single falls (RRR: 4.60, CI: 1.41, 14.98) and multiple falls (RRR: 3.75, CI: 1.59, 8.86). Regular physical activity was associated with lower risk of multiple falls (RRR: 0.64, CI: 0.46, 0.89). Participants with greater depressive symptoms were more likely to report single falls (RRR: 1.09, CI: 1.00, 1.19) and multiple falls (RRR: 1.23, CI: 1.15, 1.32). Women were more likely than men to experience a single fall (RRR: 1.63, CI: 1.13, 2.34) and to report multiple falls (RRR: 1.35, CI: 1.00, 1.55) compared to no falls.

Although the risk of single fall events did not differ by age group, participants aged 80-84 (RRR: 1.81, CI: 1.09, 2.99) and 85+ (RRR: 2.88, CI: 1.75, 4.72) were more likely to report multiple falls than relatively younger (65-69 years) participants.

Discussion

This study examined whether or not selected biological, psychological, and social characteristics were associated with single and multiple falls among community-dwelling African American older adults. Drawing from the biopsychosocial framework (Engel, 1997), we examined biophysical (health- and illness-associated conditions), psychological (depressive symptoms), and social (socio-demographic characteristics, religious service attendance) characteristics. As one of the few studies to examine correlates of falls among older African Americans, this research contributes to a larger literature on falls among older adults. The findings of this study also illustrate the need for research to further investigate the multifactorial relationships between risk factors and falls among older African Americans.

Key Findings

This study of older African Americans found both similarities and departures from prior, primarily population-based, research. Most of the examined baseline biophysical characteristics were associated with higher risk of subsequent falls, including self-rated health, functional limitations, vision problems, chronic conditions (including high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, and arthritis) and comorbidity, regular physical activity, older age, and female sex. These findings are consistent with research using primarily non-Hispanic white samples. Among psychosocial characteristics examined, greater levels of baseline depressive symptoms were significantly associated with subsequent falls. In this study, memory problems and regular medication use were not significantly associated with fall events.

In this study of older African American adults, female sex and older age operated as risk factors for single and multiple fall events, respectively. These relationships were consistent when age and sex were operationalized as control variables in separate multinomial logistic analyses. In every sex-adjusted multivariate logistic analysis, female sex was significantly associated with the risk of experiencing single falls compared to no falls. Correspondingly,

older age was significantly associated with higher risk of experiencing multiple fall events in every age-adjusted multivariate logistic analysis.

Our study departs from findings of some prior studies that examined the fall-associated characteristics, including memory problems such as dementia / Alzheimer's disease (Rubenstein, 2006), polypharmacy (Kojima et al., 2011), and certain medications, such as diuretics, sedatives, anticonvulsants, and antidepressants (Ensrud et al., 2002; Lawlor, Patel, & Ebrahim, 2003; Tinetti et al., 1988). Our findings also differ from findings in prior studies reporting positive associations between marital status and falls (Schiller et al., 2007; Stevens et al., 2008; Shumway-Cook et al., 2009; Koski et al., 1998; Deandrea et al., 2010). Socioeconomic status was also not associated with fall risk in this study, in contrast to prior population-based studies (AGS, 2001; Gill, Taylor, & Pengelly, 2005) and studies of older African Americans specifically (Hanlon et al., 2002). Collectively these findings reinforce the importance of investigating within group differences in fall events among African Americans.

Limitations and Directions for Future Research

This study has several limitations that should be considered when interpreting the results. Several key measures were based on self-reported data; retrospective accounts of fall events tend to underestimate the occurrence and frequency of fall events (Cummings, Nevitt, & Kidd, 1988). Data on key measures were collected in close temporal proximity. Sample size limitations might have limited the strength of some statistical tests, which could result in overly conservative analyses. Finally, the models could be subject to residual confounding due to measurement error and/or incomplete characterization of the model. These reservations aside, this study makes contributions for clinical practice and future research concerning falls among older African American adults.

As noted previously, there is extremely little research on falls and the risk factors for falls among African Americans. Our study was not able to include all important risk factors for falls. Future research should investigate fall history (AGS, 2001; Ganz et al., 2007; Nicklett & Taylor, 2014; Studenski et al., 1994), which could differ by race/ethnicity (Ellis et al., 2013). Fall history could lead to activity avoidance and physical deconditioning, and subsequently, increased vulnerability to falls (Boyd & Stevens, 2009; Rubenstein, 2006). Future research should also consider how fall risk differs according to the social and environmental contexts in which falls occur. Research has found that African Americans are more likely to fall inside the home and non-Hispanic whites are more likely to fall outdoors (Faulkner et al., 2005). Thus, it is important to investigate factors that could affect fall risk inside (Lord, Menz, & Sherrington, 2006) and outside the home (Balfour & Kaplan, 2002; Li et al., 2006). In addition, the pathways through which certain characteristics affect fall risk among older African Americans should be further examined in biophysical (specific medication use), psychological (e.g., motivation and control), social (household composition, social support and interaction), and environmental domains.

Conclusions and Implications

This is the first study to examine biophysical, psychological, and social correlates of fall events among a population-based sample of older African American adults. These findings can inform providers and interventionists with strategies to identify and screen African American clients at heightened risk of falls (shown in Table 3). In most cases, these fall-associated characteristics can be identified or screened, including visual and functional limitations, chronic illness and comorbidity, older age, and female sex. Other characteristics identified as protective factors against falls—such as depressive symptoms or physical activity participation—provide opportunities for health professionals to collaborate in health-promotion and fall-reduction strategies for older African American adults. Identification of the pathways through which risk factors could relate to falls draws upon the knowledge, expertise, and practice of multiple disciplines, including providers in mental health, medical care, health promotion, and community-based long-term services.

The findings of this study also illustrate the need for future research to examine the fall risk among minority older adult populations. Fall events are influenced by multiple interacting causes and contributing factors, and these factors can relate to one another in complex and sometimes compounding ways. Future studies should examine the multiple pathways through which biophysical, psychological, and social factors interact to affect fall risk. This research can inform home- and community-based interventions to prevent incident and recurrent falls among older adults.

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Table 1

Description of Study Measures, Health and Retirement Study 2010-2012

Measure	Characteristic	Analytic role	Variable type	Measurement	Description
Fall events	Fall events in the past 2 years	Dependent variable	Categorical (ordinal)	0=No fall*; 1=1 fall; 2=Multiple (2+ falls)	Self-reported falls events and self-reported number of falls in the past 2 years. Fall events were recoded as: no falls; single falls; or multiple (2 or more) falls.
ADL limitations	Activities of Daily Living (ADL)	Biophysical predictor	Integer	0-5	The number of ADL activities with which participants had any difficulty (bathing, eating, dressing, walking across a room, and getting out of bed)
IADL limitations	Instrumental Activities of Daily Living (IADL)	Biophysical predictor	Integer	0-5	The number of ADL activities with which participants had any difficulty (using a telephone, taking medication, handling money, shopping, and preparing meals)
Overall health	Self-rated health	Biophysical predictor	Categorical (ordinal)	1=Excellent*; 2=Very good; 3=Good; 4=Fair; 5=Poor	Self-reported health: excellent; very good; good; fair; or poor
Overall vision	Self-rated vision	Biophysical predictor	Categorical (ordinal)	1=Excellent*; 2=Very good; 3=Good; 4=Fair; 5=Poor/legally blind	Self-reported eyesight: excellent; very good; good; fair; or poor/legally blind (poor and legally blind were collapsed into a single response category)
Chronic illness diagnoses	Specific chronic illness diagnoses	Biophysical predictor	Nominal (binary indicator)	0=Not diagnosed with condition*; 1=Diagnosed with condition	Self-reported chronic illness (according to clinical diagnosis): high blood pressure; diabetes; cancer of any kind; lung disease; heart problems; stroke; arthritis; or memory problems
Comorbidity	Chronic illness comorbidity	Biophysical predictor	Categorical (ordinal)	0=No chronic illness*; 1=1 condition; 2=2 conditions; 3=3 or more conditions	Whether or not participants had been diagnosed with 0, 1, 2,

Measure	Characteristic	Analytic role	Variable type	Measurement	Description
					or 3+ of eight specific chronic illnesses examined
Physical activity	Regular physical activity	Biophysical predictor	Nominal (binary indicator)	0=No regular physical activity; 1=Regular physical activity	Self-reported regular physical activity (once per week or more), whether light, moderate, or vigorous
Medications	Medication use	Biophysical predictor	Nominal (binary indicator)	0=No regular medication use; 1=Regular medication use	Self-reported regular medication use
Age	Age Group: Age (in years)	Age Group: Biophysical predictor Age: Covariate	Age Group: Categorical (ordinal) Age: Integer	Age Group: 1=65-69*; 2=70-74; 3=75-79; 4=80-84; 5=85+; Age: 65-103	Self-reported age, recoded (into age groups)
Sex	Sex	Biophysical predictor	Nominal (binary)	0=Male*; 1=Female	Self-reported sex
Depressive symptoms	CES-D value	Psychological predictor	Integer	0-8	Evaluated according to the CES-D scale (Radloff, 1977)
Marital status	Married and/or partnered	Social predictor	Nominal (binary indicator)	0=Not married/partnered; 1=Married/partnered	Recoded from married (1) or single, separated, divorced, or widowed (0)
Education	Highest level of completed education	Social predictor	Categorical (ordinal)	1=Less than high school*; 2=High school / GED; 3=Some college; 4=College or more	Highest level of education completed, recoded into 4 categories (high school and GED completion were collapsed into a single category)
Income	Household income	Social predictor	Integer	Mean (in \$1000s)	Total household income from all sources, in thousand
Wealth	Household wealth	Social predictor	Integer	Mean (in \$1000s)	Total household wealth minus total debts, in thousands
Religious service attendance	Frequency of religious service attendance	Social predictor	Categorical (ordinal)	1=Not at all*; 2=1+/year (but less than once/month); 3=1-3 times/month; 4=Once/week; 5=More than once/week	Participants were asked how frequently they attended religious services

Note: An asterisk (*) indicates reference category in multivariate analyses.

Table 2

Descriptive Statistics of Biopsychosocial Characteristics and Fall Events, 2010-2012

Characteristic	No Falls Mean/% (n/SE)	Single Fall Mean/% (n/SE)	Multiple Falls Mean/% (n/SE)
Fall Events	71% (1033)	11.23% (162)	17.13% (247)
ADLs	0.47 (0.03)	0.57 (0.09)	1.20 (0.10)
IADLs	0.44 (0.03)	0.65 (0.10)	1.09 (0.10)
Overall Health			
Excellent	5.0% (52)	3.1% (5)	1.2% (3)
Very Good	23.0% (238)	17.9% (29)	14.6% (36)
Good	39.3% (406)	35.8% (58)	31.7% (78)
Fair	25.9% (267)	30.2% (49)	35.8% (88)
Poor	6.8% (70)	13.0% (21)	16.7% (41)
Overall Vision			
Excellent	4.4% (45)	5.0% (8)	2.9% (7)
Very Good	17.3% (178)	11.2% (18)	11.0% (27)
Good	49.4% (509)	48.4% (78)	39.2% (96)
Fair	21.6% (223)	22.4% (36)	29.4% (72)
Poor/Legally Blind	7.3% (76)	13.0% (21)	17.5% (43)
Chronic Illness Diagnoses			
High Blood Pressure	79.5% (820)	88.9% (144)	85.4% (211)
Diabetes	33.2% (343)	45.7% (74)	43.3% (107)
Cancer	14.9% (154)	14.8% (24)	21.5% (53)
Lung Disease	79.4% (82)	9.3% (15)	13.0% (32)
Heart Problems	22.1% (228)	34.2% (55)	37.0% (91)
Stroke	9.3% (96)	14.4% (23)	19.5% (48)
Arthritis	66.9% (688)	78.4% (127)	83.8% (207)
Memory problems	2.5% (26)	2.5% (4)	5.3% (13)
Comorbidity			
No Chronic Illness Conditions	6.9% (71)	1.9% (3)	2.4% (6)
1 Condition	17.7% (183)	8.6% (14)	6.9% (17)
2 Conditions	31.6% (326)	29.7% (48)	23.5% (58)
3 or more Conditions	43.8% (453)	59.8% (97)	67.2% (166)
Physical Activity			
Regular Physical Activity	80.9% (835)	81.5% (132)	69.6% (172)
Medications			
Regularly Taking Medications	88.3% (911)	93.8% (152)	93.1% (230)
Age Group			
65-69	23.9% (247)	22.2% (36)	16.6% (41)

Characteristic	No Falls Mean/% (n/SE)	Single Fall Mean/% (n/SE)	Multiple Falls Mean/% (n/SE)
70-74	30.9% (319)	30.2% (49)	25.9% (64)
75-79	25.5% (263)	25.4% (41)	26.3% (65)
80-84	11.4% (118)	8.6% (14)	14.2% (35)
85+	8.3% (86)	13.6% (22)	17.0% (42)
Sex			
Female	60.6% (626)	71.6% (116)	68.0% (168)
Depressive Symptoms			
CES-D	1.37	1.73	2.28
Marital Status			
Married	45.6% (471)	46.3% (75)	40.1% (99)
Education			
Less than High School	36.6% (377)	38.9% (63)	39.3% (97)
High School/GED	32.8% (338)	27.8% (45)	33.6% (83)
Some College	18.7% (193)	21.0% (34)	18.2% (45)
College or more	11.9% (123)	12.3% (20)	8.9% (22)
Household Income			
	37.83 (1.73)	38.71 (7.92)	30.20 (2.20)
Household Wealth			
	175.08 (18.95)	152.78 (21.61)	121.27 (15.01)
Religious Service Attendance			
Not at all	14.2% (146)	15.5% (25)	15.0% (37)
1+/year (less than once/month)	11.6% (119)	15.5% (25)	19.5% (48)
1-3 times per month	17.6% (181)	11.2% (18)	14.6% (36)
Once per week	31.3% (322)	28.6% (46)	26.1% (64)
More than once per week	25.3% (262)	29.2% (47)	24.8% (61)

Note: ADLs = Activities of Daily Living; IADLs = Instrumental Activities of Daily Living

Table 3

Sex- and Age-Adjusted Multinomial Logistic Regression Analysis of Biopsychosocial Characteristics and Fall Events, 2010-2012

	Single fall event RRR [95% CI] (ref: 0 falls)	Multiple fall events RRR [95% CI] (ref: 0 falls)
ADLs	1.05 [0.91, 1.21]	1.40 *** [1.26, 1.55]
IADLs	1.15 * [1.00, 1.32]	1.36 *** [1.23, 1.51]
Overall Health		
Very Good	1.24 [0.46, 3.35]	2.61 [0.77, 8.84]
Good	1.45 [0.55, 3.78]	3.27 [0.99, 10.76]
Fair	1.79 [0.68, 4.73]	5.39 ** [1.64, 17.74]
Poor	2.93* [1.03, 8.30]	9.23 *** [2.70, 31.59]
Overall Vision		
Very Good	0.59 [0.24, 1.44]	1.00 [0.41, 2.46]
Good	0.86 [0.39, 1.90]	1.22 [0.53, 2.80]
Fair	0.91 [0.39, 2.09]	2.04 [0.88, 4.75]
Poor/legally blind	1.52 [0.62, 3.74]	3.31 ** [1.37, 8.04]
Chronic Illness		
High Blood Pressure	1.98 ** [1.18, 3.32]	1.46 [0.99, 2.17]
Diabetes	1.70 ** [1.21, 2.38]	1.62 ** [1.21, 2.16]
Cancer	1.07 [0.66, 1.72]	1.57 ** [1.09, 2.24]
Lung Disease	1.15 [0.64, 2.05]	1.68 * [1.08, 2.61]
Heart Problems	1.79 ** [1.25, 2.56]	1.94 *** [1.44, 2.63]
Stroke	1.65 * [1.01, 2.69]	2.24 *** [1.52, 3.29]
Arthritis	1.62 * [1.08, 2.43]	2.34 *** [1.61, 3.39]
Memory Problems	0.86 [0.29, 2.54]	1.54 [0.76, 3.11]
Comorbidity ^c		
1 Chronic Condition	1.73 [0.48, 6.21]	1.04 [0.39, 2.75]
2 Chronic Conditions	3.22 [0.97, 10.66]	1.87 [0.77, 4.52]
3 or more Conditions	4.60 * [1.41, 14.98]	3.75 ** [1.59, 8.86]
Physical Activity	1.08 [0.69, 1.68]	0.64 ** [0.46, 0.89]
Medications	1.94 [0.99, 3.80]	1.58 [0.93, 2.69]
Age Group ^a		
70-74	1.06 [0.67, 1.68]	1.21 [0.79, 1.85]
75-79	1.06 [0.66, 1.72]	1.48 [0.97, 2.28]
80-84	0.83 [0.43, 1.60]	1.81 * [1.09, 2.99]

	Single fall event RRR [95% CI] (ref: 0 falls)	Multiple fall events RRR [95% CI] (ref: 0 falls)
85+	1.70 [0.94, 3.05]	2.88 *** [1.75, 4.72]
Sex^b (female)	1.63 ** [1.13, 2.34]	1.35 * [1.00, 1.82]
Depressive Symptoms	1.09 * [1.00, 1.19]	1.23 *** [1.15, 1.32]
Marital Status	1.30 [0.90, 1.88]	1.02 [0.74, 1.40]
Education		
High School/GED	0.79 [0.52, 1.20]	1.05 [0.75, 1.46]
Some College	1.06 [0.67, 1.67]	1.00 [0.67, 1.50]
College or more	0.95 [0.55, 1.65]	0.77 [0.46, 1.29]
Household Income^d	1.00 [1.00, 1.00]	1.00 [0.99, 1.00]
Household Wealth^e	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]
Religious Service Attendance		
1+/year (less than once/month)	1.20 [0.65, 2.21]	1.57 [0.95, 2.59]
1-3 times per month	0.54 [0.28, 1.04]	0.79 [0.47, 1.33]
Once per week	0.78 [0.46, 1.33]	0.79 [0.50, 1.25]
More than once per week	0.96 [0.56, 1.63]	0.94 [0.59, 1.50]

Note: Significance levels are indicated at

*
p < .05;

**
p < .01;

p < .001

Note: Only main effects are shown. The RRR coefficients reported in Table 2 control for age (continuous) and sex (male and female), unless otherwise indicated. RRR=Relative Risk Ratio; SE=Standard Error; ADLs = Activities of Daily Living; IADLs = Instrumental Activities of Daily Living.

^a Age Group: This analysis controls for sex only.

^b Sex: This analysis controls for age only.

^c Chronic Illness Comorbidity: This analysis controls for age, sex, and whether or not data were missing on chronic illness diagnoses.

^d Household Income (in thousands): This analysis controls for age, sex, and whether or not the household was considered a couple household.

^e Household Wealth (in thousands): This analysis controls for age, sex, and whether or not the household was considered a couple household.