Fall Risk is Not Black and White

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Abstract

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Design: Prospective cohort

Setting: Community

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Measurements: Falls were prospectively reported using monthly fall calendars. The location of each fall and fall-related injuries were asked during telephone interviews. At baseline, we assessed risk factors for falls, including sociodemographic characteristics, physiologic risk factors, physical activity, and community-level characteristics.

Results: Over the mean follow-up of 1,048 days, 1,539 falls occurred (incidence: 806/1,000 person-years). Whites were more likely than Blacks to experience any falls (867 versus 504 falls per 1,000 person-years; RR [95% CI]: 1.77 [1.33, 2.36]), outdoor falls (418 versus 178 falls per 1,000 person-years; 1.78 [1.08, 2.92]), indoor falls (434 versus 320 falls per 1,000 person-years; 1.44 [1.02, 2.05]), and injurious falls (367 versus 205 falls per 1,000 person-years; 1.79 [1.30, 2.46]). With exception of injurious falls, higher fall rates in Whites than Blacks were substantially attenuated with adjustment for risk factors and community-level characteristics: any fall (1.24 [0.81, 1.89]), outdoor fall (1.57 [0.86, 2.88]), indoor fall (1.08 [0.64, 1.81]), and injurious fall (1.77 [1.14, 2.74]).

Conclusion: Our findings suggest that the racial differences in fall rates may be largely due to confounding by individual-level and community-level characteristics.

Keywords

geriatrics; gerontology; race; falls; health disparities; risk groups; epidemiology

Cover Page Footnote

We thank the participants, staff, and investigators of the MOBILIZE Boston Study who made this study possible. The work was supported by the National Institute on Aging grants R01-AG041525 (Leveille), R01-AG041785 (Lipsitz), 5R01-AG028738 (Li), T32-AG023480 (Gross; PI: Lipsitz), and KL2 Medical Research Investigator Training award (Kim) from Harvard Catalyst / The Harvard Clinical and Translational Science Center (a National Institutes of Health award 1KL2 TR001100-01). Dr. Lipsitz holds the Irving and Edyth S. Usen and Family Chair in Geriatric Medicine.

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Keywords: falls; racial difference; elderly; race; health disparities; socioeconomic factors; risk groups; aged, epidemiology

INTRODUCTION

Falls are a common and dangerous health problem among older adults. Approximately 40% of older (≥65 years) community-living adults fall at least annually.(Rubenstein, 2006) Falls are responsible for two-thirds of injury-related deaths, which is the fifth leading cause of death among older persons. Fall-related injuries account for 6% of all medical expenditures for older adults in the US.("Guideline for the prevention of falls in older persons. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention,"2001) approximately 3-5% of older persons are hospitalized as a result of falling (Bezon, Echevarria, & Smith, 1999; Guideline for the prevention of falls in older persons. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention," 2001; Rubenstein, 2006) and fall-related hospital stays are nearly twice as long as stays for other reasons.(Dunn, Rudberg, Furner, & Cassel, 1992; Fuller, 2000) Therefore, it is critically important to identify people who are at risk of falling in order to target preventive interventions.

Despite efforts to minimize health disparities, there appear to be racial differences in various health outcomes.(Blanco, Verghese, Lipton, Putterman, & Derby, 2012; Sondik, Huang, Klein, & Satcher, 2010) Previous research suggests that White adults are more likely to fall than non-White adults, particularly Blacks.(de Rekeneire et al., 2003; Faulkner et al., 2005; Friedman, Munoz, West, Rubin, & Fried, 2002; Hanlon, Landerman, Fillenbaum, & Studenski, 2002; Kelsey et al., 2010; Means, O'Sullivan, & Rodell, 2000; Nevitt, Cummings, Kidd, & Black, 1989; Yamashita, Noe, & Bailer, 2012) Many of these studies assessed falls by recall, thus limiting causal inferences by introducing potential recall bias. Moreover, studies that reported racial differences in fall rates may not have adequately adjusted for important confounders, particularly types of physical activities and community-level factors. Thus, it is unknown whether racial differences in rates of falls are due to differences in inherent characteristics of race, or to individual characteristics, behaviors, and particular environmental characteristics of their communities. Furthermore, several studies (Bath & Morgan, 1999; Bergland, Jarnlo, & Laake, 2003; Kelsey, et al., 2010; O'Loughlin, Boivin, Robitaille, & Suissa, 1994) suggest that fall risk factors differ by location (e.g., indoor versus outdoor). Whether racial differences exist for indoor or outdoor falls has not been adequately studied.

The objective of this study was to determine whether previously reported racial differences in fall rates exist in community-living older adults in the MOBILIZE (Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly) Boston Study (MBS). Prospective measurement of a large number of novel and traditional risk factors for falls and adjudication of fall events in MBS offers a unique opportunity to address these unanswered questions. Specifically, we hypothesized that Whites are more likely to fall than Blacks, and that this discrepancy is largely explained by differences in known or hypothesized risk factors. We also examined the racial difference in fall rates by location (indoor and outdoor) and type of fall (any fall and injurious falls).

METHODS

Study Sample

The MBS is a prospective observational study of novel and traditional risk factors for falls in a representative sample of older individuals living in the greater Boston area. Details of the study design and procedures have been previously described.(Leveille et al., 2008; Samelson et al., 2008) Probability sampling was used to recruit older persons who were living within a 5-mile

radius of Hebrew Senior Life and met the following criteria: age ≥70 years, ability to speak and understand English, ability to walk across a room, visual ability to read written material, Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975) score ≥18, and the expectation that participants would be living in the area for at least 2 years. Spouses or companions ≥64 years old living with a participant were also recruited if they were otherwise eligible. Enrollment took place from September, 2005 to January, 2008.

Of 765 participants who had a baseline home interview and clinic examination, 699 self-identified as being White or Black/African American and had at least 6 months of follow-up. Because participants with missing data on several covariates were likely to differ systematically from those with fewer covariates missing, we excluded 33 (4.7%) who had missing data on ≥5 covariates of interest (range of missing data: 0-28) and finally included 666 in this analysis. The Institutional Review Board of Hebrew SeniorLife approved the MBS, as well as this ancillary study.

Fall Assessment

The completion rate of falls calendars was 83% for Whites and 68% for Blacks. Participants were instructed to complete and return monthly falls calendar postcards designed to be posted on a refrigerator. Research staff monitored the return of the calendars and on any given month, approximately one-third of participants were called for ascertainment of missing or incomplete calendars.

A fall was defined as unintentionally coming to rest on the ground or other lower level not as a result a major intrinsic event (e.g. myocardial infarction, stroke, seizure or an overwhelming external hazard, such as being hit by a vehicle).("The prevention of falls in later life. A report of the Kellogg International Work Group on the Prevention of Falls by the Elderly," 1987) fall events that could not be unambiguously classified according to this definition were reviewed individually by an adjudication panel. After a participant reported a fall, a structured telephone interview was conducted to determine the circumstances, including the location of the fall and whether the fall was injurious. An indoor fall was defined as one that occurred inside a structure (e.g., home, building, etc.) and an outdoor fall was defined as occurring anywhere outside a structure. An injurious fall was ascertained from the question: "Did you hurt yourself in any way when you fell?"

Fall Risk Factors

Based on published studies and clinical expertise, we classified potential risk factors for falls into the following 4 categories.

1.) *Sociodemographic characteristics.*

We assessed age, gender, education (years), current annual household income (<$15,000, $15,000-24,999, $25,000-34,999, or ≥$35,000), marital status (yes/no), and social activity scale (0-8, higher scores indicate more social activity).(Stewart et al., 2001)

2.) *Physiologic Risk Factors and Health Status.*

We assessed self-reported health (excellent, very good, good, fair or poor) and pain severity via the subscale of the Brief Pain Inventory(Cleeland, 1989) quartiles (<0.5, ≥0.5 and <2.0, ≥2.0 and ≤3.75, >3.75). Medical history included number of chronic conditions,(Sangha, Stucki, Liang, Fossel, & Katz, 2003) hypertension (normotension, controlled hypertension, uncontrolled hypertension), diabetes (none, definite, probable), stroke, arthritis of the hand, knee or hip, peripheral neuropathy,(Perkins, Olaleye, Zinman, & Bril, 2001) and use of antihypertensive, antidepressant, and benzodiazepine. Physical examination included: body mass index (kg/m^2); visual acuity, assessed by distance vision at 10 feet with corrective lenses, if needed, using a Good-

Lite chart Model 600A chart; the Centers for the Epidemiologic Studies Depression Scale (CESD-R)(Eaton, Muntaner, Smith, Tien, & Ybarra, 2004; Gordon, 1972); MMSE as a measure of general cognition(Folstein, et al., 1975); Trail-making test (part B time minus part A time) as a measure of executive function(Gordon, 1972; Reitan, 1958); gait speed (meters/second) from a 4-meter walk; time to complete 5 repeated chair stands (seconds); and one-leg stand (seconds). We asked about limitations in activities of daily living (ADL) and instrumental activities of daily living (IADL).(Katz & Akpom, 1976; Lawton & Brody, 1969) Specific to the fall risk assessment, we obtained the information on falling in the previous year and use of a walking aid; and measured the Falls Efficacy Scale(Tinetti, Richman, & Powell, 1990) and the Berg Balance Scale.(Berg, Wood-Dauphinee, Williams, & Maki, 1992) Frailty status (robust, pre-frail, or frail) was defined according to previously published criteria.(Fried et al., 2001; Kiely, Cupples, & Lipsitz, 2009)

3.) Types and Amount of Physical Activity.

The Physical Activity Scale for Elderly (PASE) is a summary measure of physical activity level in the previous 7 days, with a higher score indicating more physical activity.(Washburn, Smith, Jette, & Janney, 1993) Because the chances of falling may depend on types of activities, we considered the total number of hours of physical activity as well as hours spent in sitting activity, walking outside, sport activity (light, moderate, or strenuous sport), muscle strengthening, and volunteer activity.

4.) Community-Level Characteristics.

We used the American Community Survey("American Community Survey Massachusetts,") 2005-2009 5-year census tract that matched to the MBS tract, to estimate: a) percent of households with a White head of household; b) percent of college graduates; c) percent of employed adults in the census tract holding a White collar job. These characteristics were used as surrogate measures of community-level socioeconomic status and potential environmental hazards.(Kelsey, et al., 2010; Li, Land, Zhang, Keithly, & Kelsey, 2009)

Statistical Analysis

Participant characteristics and fall risk factors were summarized by means (standard deviation) or percentages, and compared between White and Black/African American participants using t-test for continuous variables and chi-square tests for categorical variables. We first estimated the incidence rates of total falls, indoor falls, outdoor falls, and injurious falls (number per 1,000 person-years). To test our hypothesis that racial differences in fall rates are largely explained by the differences in potential risk factors for falls, we used negative binomial regression models with robust standard error to account for over-dispersion and adjust for the following groups of confounders: 1) socio-demographic characteristics; 2) physiologic risk factors and health status; 3) types and amount of physical activity; and 4) community-level characteristics. We examined how the rate ratio (RR) and 95% confidence interval (CI) comparing Whites versus Blacks changed with serial adjustments for 4 categories of confounders. Education, income, body mass index, gait speed, adjusted trail making test, vision score, CESD-R score, and community-level characteristics were grouped in quintiles to account for a potential non-linear relationship with falls.

In the negative binomial regression models, we used 3 different offset (exposure time) variables. For total falls, we used total person-time under observation. For outdoor and indoor falls, we estimated person-time spent outdoors and indoors by multiplying total person-time with the proportion of time spent for outdoor and indoor activities, respectively, from the Physical Activity Scale for the Elderly (PASE)(Kelsey, et al., 2010; Washburn, et al., 1993).

Missing covariates were imputed using multiple imputation by chained equation to impute missing covariates,(Rubin, 1987) based on available potential risk factors for falls, number of falls, and duration of follow-up. As a sensitivity analysis, we restricted our analysis to those without a fall in the previous year (64% of our sample) to minimize the possibility that participants' risk factors and activity levels may be altered as a result of recent falls.

Analyses were performed using Stata software version 11 (Stata Corporation, College Station, TX). A 2-sided p-value <0.05 was considered statistical significant.

RESULTS

Compared to Blacks, Whites had higher levels of education and income, and were more likely to be married and engaged in social activities (Table 1). White participants were more likely to rate their health as good or excellent; had less pain and fewer chronic diseases, including hypertension and diabetes; better cognitive and physical function; fewer ADL difficulties; and less frailty. They participated in more hours of sitting activities and sports activities than Blacks. In terms of community-level characteristics, Whites were more likely than Blacks to reside in communities with higher proportions of Whites, college graduates, and professionals.

Table 1. Fall Risk Factors for Whites and Blacks in the MOBILIZE Boston Study

	White (N=550)		**Black/African American** (N=116)		*P-value*
Characteristics	Mean or %	SD	Mean or %	SD	
Follow-up duration, years	3.4	0.9	3.4	0.9	0.86
Sociodemographic Characteristics					
Age, years	78.0	5.5	77.8	5.1	0.71
Male	38%		29%		0.07
Education, years	14.8	2.7	11.8	3.2	<0.001
Annual income					<0.001
<= $14,999	15%		53%		
$15,000 - $24,999	29%		30%		
$25,000 - $34,999	13%		9%		
>= $35,000	44%		8%		
Married	48%		25%		<0.001
Social activity scale	4.0	1.6	3.4	1.7	0.001
Physiologic Risk Factors and Health Status					
Self-rated health:					<0.001
Excellent	19%		9%		
Very good	35%		20%		
Good	36%		41%		
Fair or poor	10%		31%		
Pain severity					<0.001
1st quartile	25%		22%		
2nd quartile	28%		11%		
3rd quartile	27%		24%		
4th quartile	20%		42%		
Body mass index (kg/m^2)	27.1	6.9	28.7	5.6	<0.001
Number of chronic conditions	4.0	1.7	4.4	1.7	0.03
Hypertension	77%		91%		<0.001

Characteristics	White (N=550) Mean or %	SD	Black/African American (N=116) Mean or %	SD	*P-value*
Diabetes	5%		9%		<0.001
Stroke	9%		9%		0.99
Arthritis	37%		41%		0.42
Neuropathy	54%		59%		0.38
CES-D Revised score, points	10.7	10.8	12.2	12.5	0.20
Number of medications (used)	5.9	2.9	6.5	3.3	0.08
Antihypertensive use	68%		83%		0.001
Antidepressant use	14%		9%		0.11
Benzodiazepine use	10%		5%		0.09
Vision score	64.7	16.6	64.7	15.8	0.99
Trail making test (adjusted), seconds	79.1	58.7	138.4	76.7	<0.001
MMSE	27.7	2.1	24.7	3.1	<0.001
Any ADL difficulty	18%		29%		0.008
Any IADL difficulty	37%		45%		0.14
Fall in the previous year	37%		29%		0.10
Ambulates with a walking aid	12%		24%		<0.001
Falls efficacy scale	96.8	7.4	94.8	9.8	0.01
Gait speed, meters/second	1.0	0.2	0.9	0.3	<0.001
Repeated chair stand, seconds	13.4	4.2	14.7	4.7	0.002
One-leg stand, seconds	8.4	7.3	6.9	6.7	0.04
Balance (Berg scale)	50.5	5.6	48.8	7.0	0.003
Frailty	6%		15%		0.007
Types of Physical Activity					
Sitting activity, hours/week	18.1	8.8	16.0	9.9	0.02
Walking outside, hours/week	5.6	5.9	6.0	7.4	0.49
Total sport activity, hours/week	3.4	8.2	1.0	2.6	0.002
Light sport activity	1.3	3.8	0.6	2.0	0.06
Moderate sport activity	1.0	3.5	0.1	0.5	0.007
Strenuous sport activity	1.1	3.1	0.3	1.0	0.008
Muscle strengthening, hours/week	0.7	1.9	0.5	1.5	0.46
Volunteer activity, hours/week	4.1	10.0	3.5	9.3	0.55
Community-Level Characteristics					
Proportion of Whites	77.7	17.4	19.0	21.1	<0.001
Proportion of college graduates	62.8	19.9	23.7	15.7	<0.001
Proportion of professional occupation	17.4	5.8	11.1	4.3	<0.001

Abbreviations: ADL, Activities of daily living; CES-D, Center for Epidemiologic Studies Depression Scale; IADL, Instrumental activities of daily living; MMSE, Mini Mental State Examination; SD, standard deviation

The follow-up time ranged from 195 to 1,577 days (mean: 1,048 days) and was similar between Whites and Blacks (Table 1). The total number of falls per person during follow-up ranged from 0 to 51 (median: 1 fall). There were 1,539 falls during the follow-up period, corresponding to 806 falls per 1000 person-years. The incidence rate was greater among Whites than Blacks for any falls (867 falls per 1000 person-years versus 504 falls per 1000 person-years), outdoor falls (418 falls per 1000 person-years versus 178 falls per 1000 person-years),

indoor falls (434 falls per 1000 person-years versus 320 falls per 1000 person-years) and injurious falls (367 falls per 1000 person-years versus 205 falls per 1000 person-years) (Figure 1)

FIGURE LEGENDS

Figure 1 . Incidence Rates of Total, Outdoor, Indoor, Injurious Falls by Race*

***** Fall rates were statistically significantly higher in Whites than in Blacks for total, outdoor, indoor, and injuirous falls ($p<0.05$ for all comparisons).

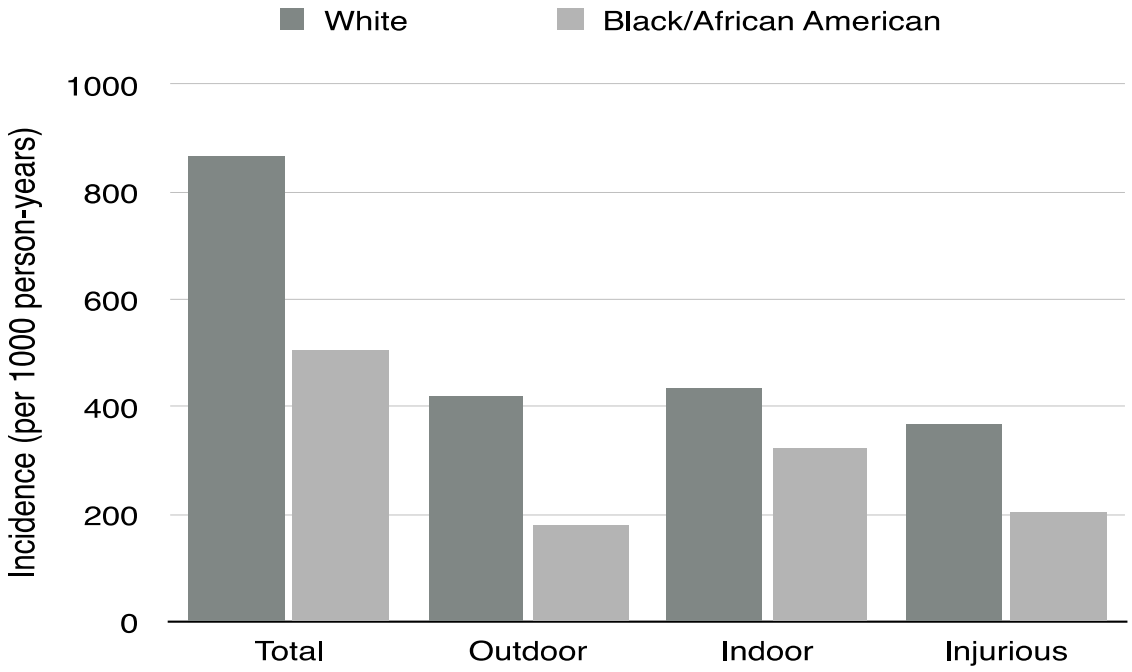

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Table 2. Crude and Adjusted Rate Ratios of Falls Comparing Whites and Blacks

	Total Falls				Outdoor Falls				Indoor Falls				Injurious Falls			
Confounding Adjustment*	**RR**	**95% CI**		***P***	**RR**	**95% CI**		***P***	**RR**	**95% CI**		***P***	**RR**	**95% CI**		***P***
A. Unadjusted	1.77	1.33	2.36	<0.001	1.78	1.08	2.92	0.02	1.44	1.02	2.05	0.04	1.79	1.30	2.46	<0.001
B. A + sociodemographic	1.51	1.10	2.07	0.01	1.72	1.01	2.94	0.05	1.32	0.89	1.97	0.17	1.75	1.24	2.47	0.001
C. B + physiologic risk factors	1.33	0.96	1.83	0.09	1.51	0.86	2.66	0.15	1.26	0.84	1.90	0.26	1.77	1.25	2.51	0.001
D. C + types of physical activity	1.29	0.93	1.78	0.12	1.45	0.92	2.30	0.11	1.21	0.81	1.80	0.35	1.65	1.18	2.32	0.004
E. D + community characteristics	1.24	0.81	1.89	0.32	1.57	0.86	2.88	0.14	1.08	0.64	1.81	0.78	1.77	1.14	2.74	0.01

Abbreviations: CI, confidence interval; RR, rate ratio.
*Adjustment is cumulative. Rate ratios derived from crude and adjusted negative binomial regression models. Confounders included in each category were: 1) socio-demographic risk factors: age, gender, education, income, marital status; 2) physiologic risk factors: gait speed, one-leg stand, previous history of falls, activity of daily living disability, mini-mental state examination score, adjusted trail making test, body mass index, systolic blood pressure, pain severity, depressive symptoms, psychoactive drug use, and antihypertensive drug use; 3) types of physical activity: hours of light-, moderate-, and strenuous-intensity sports, walking outside, sitting, muscle strengthening, volunteer activities; 4) community-level characteristics: proportion of Whites, proportion of college graduates, and proportion of professional occupation.

DISCUSSION

In this representative cohort of community-living older adults, we found that Whites are more likely than Blacks to have any falls, outdoor falls, indoor falls, and injurious falls. However, after adjusting for a wide range of risk factors, this difference in fall risk, except for injurious falls, diminished. These findings suggest that racial differences in fall rates may in large part, be due to confounding by the difference in prevalence of risk factors, rather than inherent characteristics of race.

In addition, we examined the location of falls and injurious falls. Though differences in the magnitude of the risk for the indoor and outdoor unadjusted analyses suggest that the association between race and falls differs by the location of falls,(Bath & Morgan, 1999; Bergland, et al., 2003; Kelsey, et al., 2010; O'Loughlin, et al., 1994) the RRs were substantially attenuated with adjustment for confounding factors and there was no longer evidence of racial differences in fall risk according to the location.

In contrast, the adjusted RR of injurious falls differed minimally from the unadjusted RR. Unlike the risk of all, outdoor, and indoor falls that was attenuated by confounder adjustment, the rate of injurious falls remained significantly greater for Whites than Blacks in adjusted analyses; a finding consistent with a previous study.(Nevitt, Cummings, & Hudes, 1991) It is not clear why the risk of an injurious fall is greater for Whites. Just as different cultural practices may influence fall rates,(Lipsitz et al., 1994) it may also influence the reporting of injury from a fall. The MBS question assessing injurious falls was not specific enough to distinguish a major injury from a minor one. It is possible that Whites and Blacks may have interpreted this question differently in reporting injury; perhaps both generally reported major injuries but Whites may have been more likely to report a minor injury. Additionally, it is unclear whether Whites in our sample had more severe osteoporosis which may put them at a higher risk for fractures. Finally, the lower BMI values observed among Whites in the MBS sample may offer a less protective padding-effect when a fall occurs.(De Laet et al., 2005)

In our study, falls were prospectively assessed using monthly fall calendars and telephone interviews. Uncertain falls were adjudicated by an expert panel with access to explicit details of each fall event. This approach has been well-validated for use in epidemiologic studies (Tinetti, Doucette, Claus, & Marottoli, 1995; Tinetti, Liu, & Claus, 1993) and is more accurate than a long-term recall.(Cummings, Nevitt, & Kidd, 1988) Moreover, the MBS excluded participants with severe cognitive impairment, thus reducing the failure to recall falls. (Cummings, et al., 1988) Although underreporting of falls by Blacks remains a possible explanation for higher rates of falls in Whites, our prospective assessment based on monthly calendars reduces such possibility. Furthermore, a previous prospective study(Studenski et al., 1994) reported that Whites and Blacks did not differ in their fall reporting.

Our study has several other strengths over previous research studying falls in older adults. We had an extensive list of established and novel risk factors (e.g., community-level characteristics, pain) for falls that allowed us to examine how the RR for falls changed with adjustment for categories of risk factors. Community-level characteristics we not considered in previous studies.(Faulkner, et al., 2005), (Friedman, et al., 2002), (Hanlon, et al., 2002), (Nevitt, et al., 1989), (Tinetti, Speechley, & Ginter, 1988)

A few limitations of this study deserve mentioning. We approximated the amount of time spent indoors and outdoors using relevant variables in the PASE questionnaire. The results did not differ substantially when total person-time was used as an offset in these analyses. Although we adjusted for community-level characteristics, we did not have information on the quality of

sidewalks or other physical neighborhood characteristics. The MBS question concerning injury associated with falling is very general and includes both minor injuries and those requiring medical attention and hospitalization.

Multiple pathological conditions, rather than single disease processes are likely the causal factors that underlie the development of most geriatric syndromes, including falls. Cumulative research has shown that falls are influenced by a combination of multiple individual characteristics and behaviors, environmental factors, and community characteristics, cultural practices and lifestyle differences. A substantial proportion of the heightened risk for falling observed among Whites compared to Blacks can be explained by individual-level risk factors, types of physical activity, with community characteristics adding additional influence. Based on these findings, we conclude that the previously reported racial differences in fall rates may be largely due to incomplete adjustment for potential confounding factors.

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We thank the participants, staff, and investigators of the MOBILIZE Boston Study who made this study possible. The work was supported by the National Institute on Aging grants R01-AG041525 (Leveille), R01-AG041785 (Lipsitz), 5R01-AG028738 (Li), T32-AG023480 (Gross; PI: Lipsitz), and KL2 Medical Research Investigator Training award (Kim) from Harvard Catalyst / The Harvard Clinical and Translational Science Center (a National Institutes of Health award 1KL2 TR001100-01). Dr. Lipsitz holds the Irving and Edyth S. Usen and Family Chair in Geriatric Medicine.

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