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Risk Factors for Falls, Falls with Injury, and Falls with Fracture Among Older Men with or at Risk for HIV Infection

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Abstract

Background: Falls and fall risk factors are common among people living with HIV (PLWH). We sought to identify fall risk factors among men with and without HIV.

Methods: Men aged 50–75 with (n=279) and without HIV (n=379) from the Bone Strength Substudy of the MACS were included. Multinomial logistic regression models identified risk factors associated with falling.

Results: 114 (41%) PLWH and 149 (39%) of uninfected men had ≥1 fall; 54 (20%) PLWH and 66 (17%) of uninfected men experienced ≥2 falls over 2 years. Five and 3% of PLWH and uninfected men, respectively, had a fall-related fracture (p=0.34). In multivariate models, the odds of ≥2 falls were greater among men reporting illicit drug use, taking diabetes or depression medications, and with peripheral neuropathy; obesity was associated with a lower risk (all p<0.05). In models restricted to PLWH, detectable plasma HIV-1 RNA, current use of efavirenz or diabetes medications, illicit drug use, and peripheral neuropathy were associated with a greater odds of having ≥2 falls (p<0.05). Current efavirenz use was associated with increased odds of an injurious fall; longer duration of antiretroviral therapy was protective (both p<0.05). Greater physical activity was associated with lower risk of falls with fracture (p<0.05).

Conclusions: Identified risk factors for recurrent falls or fall with fracture included low physical activity, detectable HIV-1 RNA, use of efavirenz, or use of medications to treat diabetes and depression. Fall risk reduction should prioritize interventions targeting modifiable risk factors including increased physical activity, ART adherence, and transition off efavirenz.

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Background

Among older adults, falls are the leading cause of injury-related morbidity and mortality[1]. Falls contribute to hospitalizations, and lead to limitations in activity as a consequence of fear of future falls[2,3]. Multiple factors can contribute to an increased risk for falls including multimorbidity, polypharmacy, neuropathy, cognitive impairment, impaired balance, and frailty[4,5]. Since aging people living with HIV (PLWH) have a higher burden of many of these risk factors for falls[6,7], it is not surprising that the rate of falls among middle-aged PLWH (45–65 years old) is similar to the rate (25–30% per year) reported for all U.S. adults aged 65 and older[4]. Moreover, these rates appear to increase with age among older PLWH, with over 46% of 60–80 year old PLWH having experienced at least one fall in the prior year[8]. The frequency of falls in cohorts of demographically similar adults both with and without HIV (specifically the Multicenter AIDS Cohort Study [MACS] and the Women's Interagency HIV Study [WIHS]) is similar to or higher than that of older adults in the general population[9,10] Within the MACS and WIHS, falls have not been significantly higher among PLWH[9,10]. Participants in these prior analyses, however, were primarily middle-aged, with a mean age less than 50[9,11]. Whether fall risks differ by HIV serostatus or effective HIV suppression among older adults is not known.

In prior studies of PLWH, falls were collected retrospectively which may underestimate the actual number of falls, may be more biased towards more severe falls, and may be less likely to capture details regarding the circumstances surrounding the fall compared to real-time reporting[12,13]. Identification of the circumstances surrounding a fall can distinguish between falls with high risk for a poor outcome (such as an indoor fall), or falls that are more likely the result of being active (i.e. while hiking or jogging) and less predictive of future functional status[14]. Collecting real-time fall characteristics can identify high p riority areas for interventions in falls-risk reduction.

Although any fall should trigger a clinical evaluation for modifiable risks, a major goal in fall reduction is reducing falls that result in a fracture. Impaired physical function and low bone density (a marker of fracture risk) are both associated with self-reported falls among PLWH[4,15]. Thus older adults with physical function impairments are likely at the greatest risk for both sustaining a fall and experiencing a fracture following a fall[16]. Whether these associations differ by HIV serostatus, particularly with the potential effects of antiretroviral therapy (ART), immunosuppression, and age on bone and muscle, are unknown.

The goals of this analysis were to identify common and unique fall risk factors (including physical function and balance measures) among older PLWH and men without HIV infection through prospective collection of falls, and to further explore the risk factors associated with fall complications.

Methods

Study Population

Men with and without HIV who participated in the Bone Strength Substudy (BOSS) of the MACS were included in this analysis. The MACS is an ongoing study of men who have sex with men, with or at risk for HIV infection at four sites in the United States: Los Angeles, CA; Pittsburgh, PA; Baltimore, MD/Washington D.C; and Chicago, IL. MACS participants return semi-annually for a standardized interview, clinical evaluation and laboratory tests. The BOSS Substudy included 658 MACS participants aged 50–79 years with a plasma HIV-1 RNA <200 copies/mL within 6 months of enrollment, and was initiated to investigate the contributions of aging, chronic HIV infection, and ART use on both skeletal and non-skeletal risk factors for fracture. The substudy was conducted between September 2012 and April 2015, with "baseline" in this analysis referring to the baseline BOSS assessment. Additional details have been previously published[17]. The institutional review boards at each site approved the study, and each participant provided written informed consent.

Outcome: Falls

A fall was defined as an event, including a slip or trip, in which a participant lost their balance and landed on the floor or ground or lower level, or hit an object like a table or chair. Participants were asked to report each fall in real-time (within 24 hours) for two years. After a fall, participants were instructed to call their MACS site (phone number provided on a wallet card) where site staff used a standardized fall reporting tool to gather information about the fall, including a description of the fall and whether it was due to external force, a seizure or loss of consciousness, its relation to consumption of alcohol, sleep medications or illicit substance use, whether the fall was attributed to low light, slippery conditions, uneven surface or obstacle, fatigue or weakness. Participants also reported whether they received medical care following the fall (fall with injury), and whether the fall resulted in a fracture. Participants were reminded by email, text, or phone every two months to report falls and were asked about any falls they may not have reported at semi-annual study visits. Two reviewers (KME and TTB) independently reviewed all reported falls and determined fall relationship to a pet, snow/ice, or a curb/step. Duplicate falls, falls that occurred when a participant was not on his feet (i.e., off a bicycle), and falls due to loss of consciousness or overwhelming force were excluded. For this analysis, we characterized types of falls and people who did or did not fall, with participants categorized as having 0, 1 (single faller), or ≥2 falls (recurrent faller) during the two-years.

Baseline risk factors

Physical function outcomes included a modified version of the Short Physical Performance Battery (mSPPB)[18], functional reach, frailty, and the Activities-Specific Balance Confidence (ABC) survey. The mSPPB battery has been shown to improve discrimination of physical function at the higher end of the functional spectrum by using 10 repeat chair stands (increased from 5), a 4-m timed walk at usual speed, and a standing balance test for 30 seconds (increased from 10), with the addition of a single leg stand. The functional reach measured the distance a participant could extend his arm forward from a standing position without shifting his weight on his feet[19]. Frailty was assessed using criteria established by Fried, et al[20], as previously used in the MACS Cohort[7]. Participants were considered non-frail if they met no components, pre-frail if 1 or 2 components were met, and frail if ≥3 components were met. The ABC survey assessed confidence in completing 16 tasks without losing balance or becoming unsteady. An average of balance confidence on each measure was calculated, with 100% indicating complete confidence[21]. Six items were also examined separately in a short-form (ABC-6)[22]. Two-cut points were examined, i.e. >80% and >90% confidence[23,24].

Body mass index (BMI) categories included underweight/normal (<25.0 kg/m^2), overweight (25.0–29.9 kg/m^2), obese (≥30 kg/m^2). Depressive symptoms were defined by a score of ≥16 on the Center for Epidemiological Studies-Depression (CES-D) questionnaire; hepatitis B virus (HBV) infection by positive HBV surface antigen, and hepatitis C virus (HCV) by presence of serum viral RNA; liver disease by serum aspartate or alanine transaminase >150 u/L; diabetes mellitus as a fasting glucose ≥126 mg/dL or the self-reported diagnosis of diabetes with use of medications for glucose control; kidney disease by estimated glomerular filtration rate (GFR) <60mL/min/1.73 m^2 body surface area using the Modification of Diet in Renal Disease[25] equation; and hypertension as systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥ 90 mm Hg, or self-reported diagnosis of hypertension with use of anti-hypertensive medications. Polypharmacy was defined as 5 or more non -ART medications; use of controlled pain medications (i.e., opioids) or benzodiazepines were also considered. Neuroimpairment was defined as performing two standard deviations worse than HIV-uninfected age-, sex- and education-matched persons on two of three screening tests including Trails A, Trails B, and the Symbol Digit Modality Test[26]. Peripheral neuropathy was defined as <10 seconds perception of vibration at either great toe using a 120-Hz tuning fork[27]. HIV-specific factors included current CD4$^+$ T-lymphocyte count/mm^3 (CD4), plasma HIV-1 RNA level with suppression defined as <50 copies/mL, CD4 nadir, cumulative years of ART use, and any years of use of the following specific antiretroviral classes or agents: stavudine (D4T); didanosine (DDI); protease inhibitors (PI); tenofovir disoproxil fumarate (TDF); and efavirenz (EFV). We also calculated HIV RNA viral copy-years[28], as a construct of viral load burden over the two-year fall data collection period, and dichotomized this distribution at the 75th percentile to classify men with high or low viral-copy years. Physical activity level was self-reported as low, moderate, or high, and measured using the International Physical Activity Questionnaire (IPAQ)[29].

Statistical Analysis

Continuous and categorical data were reported as median with interquartile ranges (IQR) and frequency with column percentage, respectively. The distributions of demographics, behaviors, and morbidities by HIV serostatus were compared using Wilcoxon rank sum or Chi-square tests. Characteristics associated with the faller status (0, 1, 2+) was considered the primary outcome; characteristics associated with a fall, and characteristics associated with faller status with injury, or faller with fracture were secondary outcomes. Fall characteristics are described overall, and compared by HIV serostatus using Chi-square tests. Analyses exploring falls by curb/stairs or pets were post-hoc, and therefore information on pet ownership was not available for all men.

We used multinomial logistic regression to model faller status; demographics (age, race, site, and enrollment period), HIV serostatus, and BMI were included in the model. IIlicit drug use, peripheral neuropathy, and use of medications to treat depression, diabetes, and hypertension were risk factors selected for inclusion the final model by employing a stepwise, backward selection procedure (with p-value ≤0.2) for each the primary and secondary outcomes.

The faller with injury or fracture was modelled in a similar way using logistic regression, with the exception of no separate models by HIV serostatus for fallers with fracture due to small numbers. HIV factors were explored in models with PLWH only.

Associations of physical function measures (mSPPB and its components, functional reach, frailty, and ABC) with faller status were analyzed in separate models using multinomial logistic regression. A p-value of <0.05 was used to guide statistical interpretation. All analyses were completed using SAS v9.4 (SAS Institute, Cary, NC).

Results

Prospective falls over a two-year period were collected on 279 PLWH and 379 men without HIV. Baseline characteristics of these men are shown in Table 1. PLWH tended to be younger, black, to have a lower BMI and greater prevalence of diabetes and depression medication use, and differed by study site. Of 709 reported falls, 526 falls among 263 men met the study definition (exclusions were due to duplicate reporting, loss of consciousness, overwhelming external force, not being on feet at time of fall, or occurring outside of the reporting window).

Fall Characteristics

Of PLWH, 114 (41%) reported at least one fall compared to 149 (39%) of uninfected men during the two-year study. Twenty-two (10%) falls among PLWH and 32 (11%) falls among men without HIV (p=0.56) were complicated by an injury leading to medical evaluation. Falls were complicated by fracture in 5% PLWH and 3% of men without HIV (p=0.34). Falls occurred more commonly in the winter, and were commonly attributed to an uneven or slippery surface and stairs or a curb. Falls were more likely to involve illicit substance use among men without HIV, and more likely related to a pet among PLWH. Other fall circumstances did not differ by HIV serostatus (Table 2).

Men who had fallen were stratified by HIV serostatus and, among PLWH, by baseline virologic suppression. Among the 23 men with detectable baseline HIV-1 RNA, the majority (65%) had an HIV-1 RNA between 50–200 copies/mL, 3 (13%) had a viral load 200–500 copies/mL, and 5 (22%) had an HIV-1 RNA of >500 copies/mL (4 with VL >10,000 copies/mL). Ninety-three men (33%) had a detectable HIV-1 RNA at any point during the 2 years of follow-up. PLWH with suppressed HIV-1 RNA and men without HIV experienced similar rates of falls. Although PLWH with a detectable HIV-1 RNA tended to have more falls and falls with injury or fracture, these differences did not reach statistical significance (all p>0.13).

Characteristics Associated with Single or Recurrent Fallers

The unadjusted odds of having fallen among all men or PLWH only are shown in Tables 3a and 3b. The odds of sustaining a single fall differed across study sites and enrollment cohorts, and were associated with diabetes, use of diabetes medications, and peripheral neuropathy. Men with recurrent falls were also more likely to have diabetes and use diabetes medications; in addition, men with recurrent falls were more likely to use depression medications, have peripheral neuropathy, and use illicit substances. In an exploratory analysis, we also examined the effect of insulin (versus other diabetes medications or non-diabetes), and diabetes control (HgbA1C ≥ versus <7.5%). Poorly controlled diabetes was associated with a single fall (OR 3.95; 95% CI 1.44, 10.84; p=0.008) among all participants; insulin use (OR 3.59; 95% CI 1.23, 10.48; p=0.019) and controlled diabetes (OR 2.07; 95% CI 1.13, 3.81; p=0.019) were associated with recurrent falls. Other diabetes medications were not significantly associated with falls.

In multivariate models (Figures 1a and 1b), the odds of experiencing a single fall remained greater among men taking diabetes medication and with peripheral neuropathy. The odds of experiencing recurrent falls were greater among men reporting illicit drug use, taking diabetes or depression medications, and with peripheral neuropathy, while obesity was protective. The effect of diabetes medication with a high-risk for hypoglycemia (insulin and sulfonylureas) was greater than that of other lower-risk diabetes medications (OR 5.78; 95% CI 1.49, 22.43; p=0.01 vs OR 1.34; 95% CI 0.14, 12.8; p=0.79). In separate multivariate sensitivity analyses, poorly controlled diabetes was associated with a single fall (OR 3.75; 95% CI 1.27, 11.11; p=0.017) and insulin use was associated with recurrent falls (OR 4.00; 95% CI 1.20, 13.38; 0.024).

In univariate models restricted to PLWH, odds of a single fall were greater among men with depressive symptoms and peripheral neuropathy; odds of experiencing recurrent falls differed by study site, and was greater among those with lower physical activity, with illicit substance use, and efavirenz use. In separate sensitivity analyses, insulin was associated with recurrent falls (OR 5.49; 1.26, 23.91; p=0.023); other diabetes medications and diabetes control were not associated with single or recurrent falls. In adjusted models restricted to PLWH, only peripheral neuropathy was associated with a single fall; detectable HIV-1 RNA, use of efavirenz or diabetes medications, illicit drug use, and peripheral neuropathy were associated with a greater odds of experiencing recurrent falls. In separate sensitivity analyses, insulin remained associated with a significantly greater risk of recurrent falls (OR 7.40; 95% CI 1.37, 39.98; p=0.020).

To further investigate the HIV-1 RNA findings, we compared men with lower versus higher (>75th percentile) HIV-1 RNA copy-years, corresponding to $\log_{10}$(viral copy-years) of 2.07, or 119 copy-years/mL. PLWH in the upper quartile of HIV-1 RNA remained at significantly increased odds of recurrent falls (OR 2.70; 95% CI 1.22, 5.99, p= 0.014), although the effect was attenuated. To evaluate the effect of low-level of HIV-1 viremia, we next excluded participants with a baseline HIV-1 RNA > 500 copies/mL (n=4). The odds of recurrent falls among PLWH and low level baseline HIV-1 viremia (50–500 copies/mL) remained significant (OR 5.45; 95% CI 1.6, 18.5; p=0.007). Lastly, we assessed the effect of any subsequent HIV-1 RNA above detection over the 2-year study follow-up period (n=93). In contrast to the association with viral copy years and baseline HIV-RNA, the odds of recurrent falls with any detectable HIV-1 RNA during the study follow-up was no longer significant (OR 1.89; 95% CI 0.88, 4.05, p=0.101).

Lastly, we investigated the impact of medications often associated with falls (anxiolytics and opioids) and the effect of polypharmacy on the risk of single and recurrent falls when added to the current models. Seven percent of men with HIV and 5% of men without HIV utilized pain medications, 33% of men with and 29% of men without HIV used anxiolytics, with 61% of the men with and 58% of men without HIV taking 5 or more non-ART medications. In the univariate analysis for all men, polypharmacy (5 or more non-ART medications) was associated with recurrent falls (OR=1.79, P=0.008); this association was no longer seen in the fully adjusted model (OR=1.53, P=0.127). The association with pain medications or anxiolytics was not significant in univariate models. Among men with HIV, polypharmacy, anxiolytics, and opioids were not significantly associated with falls in univariate models.

Characteristics Associated with Fall-Related Injury or Fracture

Among all men, the odds of having an injurious fall was greater among men with peripheral neuropathy (OR 2.12 [2.09, 4.12]. p=0.026). In models restricted to PLWH, current efavirenz use was associated with increased odds of having an injurious fall (OR 5.44 [1.36, 21.8], p=0.003) while longer duration of ART (OR 0.41 [0.23, 0.74], p=0.014) was protective; peripheral neuropathy (OR 2.61 [0.85, 8.01], p=0.093) and detectable HIV-1 RNA (3.61 [0.80, 16.38], p=0.096) were non-significantly associated with a higher risk of an injurious fall. Detectable HIV-1 RNA (OR 4.48, [0.77, 25.99], p=0.094) and diabetes medications (OR 3.19 [0.94, 10.88], p=0.064) were also associated with increased risk of having a fall resulting in fracture, but did not reach statistical significance; higher self-reported physical activity was the only factor independently associated with a protective effect on risk of having a fall with a fracture (OR 0.23, [0.08, 0.72], p=0.011).

Physical Function and Balance in Fall Risk

Lower balance confidence on the ABC survey was associated with recurrent falls; the strength of this association was attenuated but similar with the ABC-6 survey. Slower time to complete 10 chair rises was the only objective physical function measure associated with recurrent falls (Table 4).

Discussion

In this prospective study of falls among older (ages 50–79) PLWH and men without HIV, nearly half of men sustained at least one fall over 2 years, with approximately 10% of falls leading to injury and almost 5% resulting in a fracture. Similar to prior findings from demographically comparable populations, we did not find that PLWH were more likely to fall than men without HIV. We did however detect a significant association of recurrent falls with detectable baseline HIV-1 RNA or greater burden of HIV-1 RNA over the study period. Consonant with these associations is the protective effect seen with longer duration of ART on injurious falls. Not surprisingly with the well-established link to neurological side effects including dizziness[30], efavirenz use was associated with an increased risk of falls. Although we are limited in our ability to draw conclusions from our findings regarding incomplete HIV-1 RNA suppression and fall risk because of the small number of men with detectable HIV-1 RNA, our results support a growing body of literature underscoring the importance of consistent virologic suppression to decrease risk for multiple non-HIV outcomes[31].

Similar to prior studies in populations with and without HIV, other fall risk factors included neuropathy, use of diabetes and depression medications, and illicit substance use[4,11,32]. The association between diabetes and fall or fracture risk is likely multifactorial: older adults with diabetes may have neuropathy, poor muscle quality, and multimorbidity. Further, fall risk tended to be greatest with use of diabetes medications with the highest potential for hypoglycemia. The extent to which risk for falls is directly attributable to diabetes, medications, and intensity of diabetes management, however, is difficult to parse. In a meta-analysis of nearly 15,000 older adults without HIV, diabetes was associated with increased falls (relative risk 1.64), but the risk was primarily seen among insulin-treated vs non-insulin treated adults (RR 1.94 vs 1.27)[33]. Furthermore, intensive management of blood glucose and blood pressure among older adults with diabetes did not increase fall risk in the ACCORD trial[34,35]. In summary, although diabetes may be a risk for falls, the existing literature does not suggest that less aggressive glucose control lowers fall risk.

Associations between falls and physical activity, slow chair rise time, and poor balance confidence highlight potentially modifiable risks for improvement of fall risk in our population. Both chair stand time and poor balance confidence or fear of falling were strong predictors of falls, are easy to assess in the clinical setting, and are amenable to improvement with exercise. In contrast to prior studies[4,5], we surprisingly did not find an association between falls and other measures of physical function including balance impairment despite the relatively high portion of participants with difficulties by tandem stand (45% of men with HIV). Perhaps our men were more fit, as suggested by a similar proportion of SPPB impairment (13% with SPPB <10) despite a median age that was 10 years younger[10]. The US Preventive Services Task Force and other fall reduction programs emphasize exercise interventions to prevent falls among older at-risk adults, with additional interventions based on clinical judgement[3637–39,40]. The best type of exercise for fall reduction among older PLWH has not been investigated.

Our detailed falls reporting tool resulted in a few additional notable findings. First, PLWH were more likely to report a fall in relation to a pet. The CDC previously reported that pet-related injuries most commonly involved dogs, were described as tripping over or being pulled by the dog (52%), and most commonly occurred while walking a dog (26%)[41]. Thirty percent of both dog- and cat-related injuries were fractures, and the highest rates of fractures occurred among older adults. As our finding was a post-hoc observation, we did not collect information on pet ownership and were unable to determine if PLWH were simply more likely to own a pet. We also noted high rates of falls associated with steps/curbs and snow/ice. Evaluation for impairment in visual depth perception in addition to counseling regarding safety around pets, built and natural environmental factors, appropriate footwear in the winter, lighting in home stairwells, and avoidance of distractions while walking could be incorporated into routine falls assessment for older adults both with and without HIV[1,42].

Several limitations of the present study should be acknowledged. First, the study population was restricted to men with or at risk for HIV. Second, men in the MACS have been routinely engaged in study participation and may be more fit and adherent than other populations, which may influence fall risk factors. Third, sites differed in fall reporting, which may have been due to differences in climate, participant briefing, or other characteristics. To control for this, all multivariate analyses adjusted for site. The large cohort of older men with a comparable HIV-uninfected control group, the use of a prospective reporting tool, ascertainment of fall risk factors prior to reported falls, and the detailed description of factors contributing to each fall are clear strengths.

In summary, the rate of falls, recurrent falls, and falls with fracture were high among older men with or at risk for HIV infection. Our novel finding that HIV-1 viremia was associated with fall risk, after accounting for common fall risk factors, further emphasizes the importance of ART adherence in non-HIV comorbidity management. Several additional factors may help identify persons at risk for falls (diabetes, neuropathy, illicit substance use) or potential targets for interventions (increasing physical activity, improving physical function, transitioning off efavirenz, and counseling regarding pets, curbs, and other potential hazards). Finally, physical activity was the only factor that was associated with (and protective for) falls complicated by fracture. Extrapolating from these findings and our prior work, we suggest that fall risk reduction among older PLWH should mirror those of the US Preventative Task Force[1] with a focus on physical activity and additional risk reduction maximized through ART adherence and transition to use of newer non-efavirenz-containing ART regimens.

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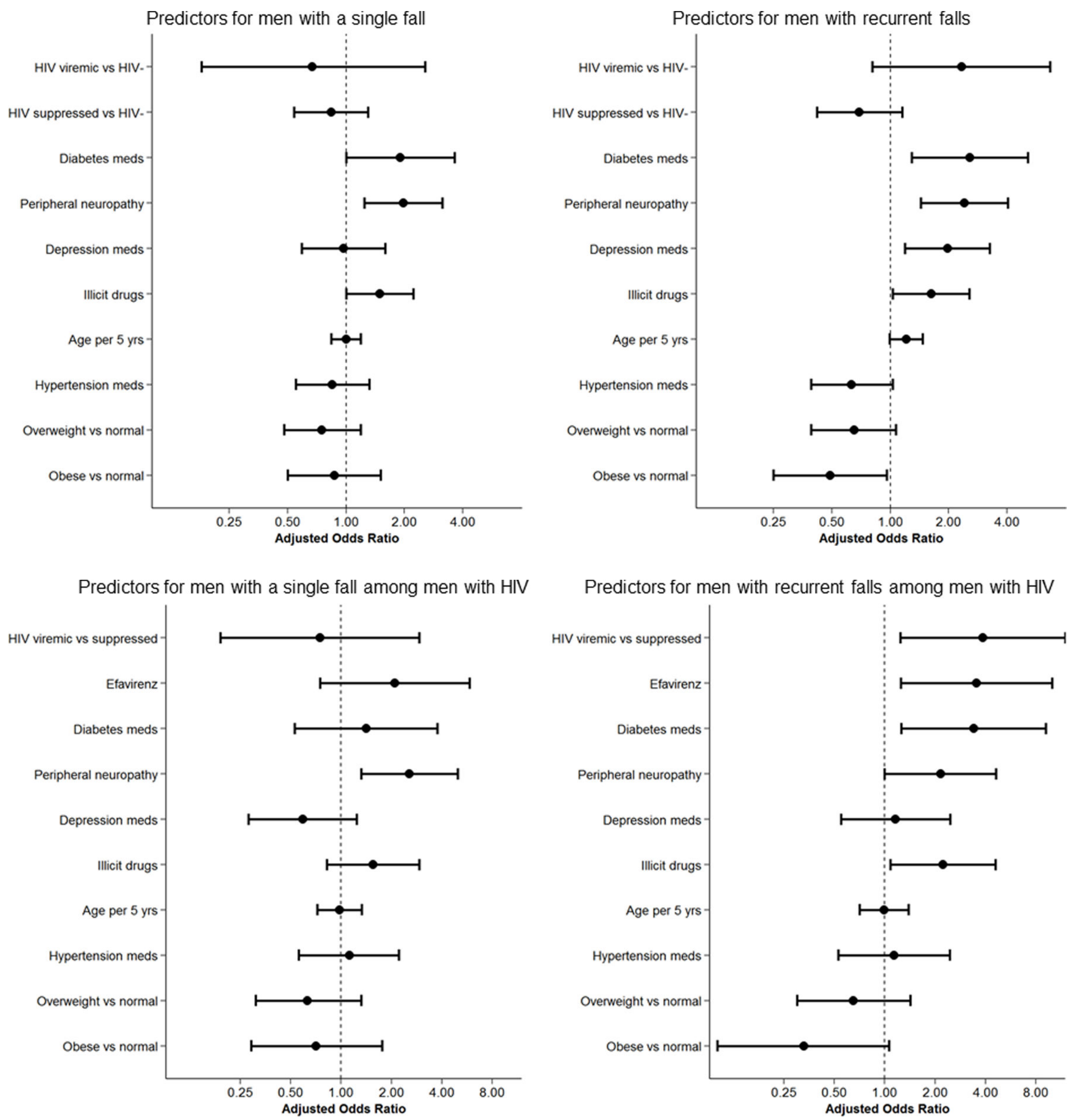

Figure 1.

Predictors of being a single or recurrent faller from multinomial logistic regression in the entire cohort (1a) or among men with HIV only (1b).

Table 1.

Baseline Characteristics of the Study Population

	Men with HIV (n=279)	Men without HIV (n=379)	P-value
Age	61.1 (55.6,64.2)	62.4 (58.5,66.8)	<0.001
Race			
White	199(71%)	312(82%)	0.001
Black	67(24%)	47(12%)	
Other	13(5%)	20(5%)	
Study Site			
Baltimore	64(23%)	93(25%)	0.005
Chicago	87(31%)	73(19%)	
Pittsburgh	64(23%)	109(29%)	
Los Angeles	64(23%)	104(27%)	
Late cohort (enrolled after 2001)	72(26%)	50(13%)	<0.001
Smoking status			
Non-smoker	78 (32%)	131 (35%)	0.57
Former smoker	143 (52%)	195 (52%)	
Current smoker	45 (16%)	51 (14%)	
Physical activity			0.77
Low	58(21%)	80(21%)	
Moderate	75(27%)	109(29%)	
High	145(52%)	185(49%)	
Body mass index	25.2(22.8,28.4)	26.1(23.5,29.9)	0.004
Diabetes	45(18%)	42(12%)	0.034
Controlled (HbA1C <7.5%)	37 (13%)	32 (9%)	
Uncontrolled (HbA1C ≥ 7.5%	7 (3%)	12 (3%)	
Diabetes medications	37(13%)	37(10%)	0.16
Non-insulin therapy	28 (10%)	28 (7%)	
Insulin	10 (4%)	10 (3%)	
Depression medications	81(30%)	67(18%)	<0.001

	Men with HIV (n=279)	Men without HIV (n=379)	P-value
Illicit drug use	130(48%)	157(42%)	0.14
Peripheral neuropathy	135(51%)	143(40%)	0.48
Neuroimpairment	15(7%)	15(5%)	0.51
HIV-1 RNA <50 copies/mL	255(91%)	-	
CD4 ≥ 500 cells/uL	201(73%)	-	
Nadir CD4 <200 cells/uL	101(36%)	-	
Current use of efavirenz	30(11%)	-	
ABC ≤ 80	25 (9%)	28 (7%)	0.48
ABC ≤ 90	66 (24%)	81 (21%)	0.51
ABC-6 ≤ 80	55 (20%)	71 (19%)	0.78
ABC-6 ≤ 90	116 (42%)	153 (41%)	0.80
Tandem Stand (unable)	126 (45%)	149 (29%)	0.13
Functional Reach	30.7 (25.5, 36.2)	31.8 (26.1, 37.0)	0.32
10-time chair rise	23.9 (19.1, 26.8)	23.1 (19.2, 27.6)	0.84
Grip Strength	37 (30, 41)	35 (30, 41)	0.24
Gait speed	3.7 (3.4, 4.2)	3.8 (3.3, 4.1)	0.15
SPPB Score <10	41 (15%)	51 (13%)	0.65
Frailty Score			0.09
Non-frail	158 (57%)	235 (62%)	
Pre-frailty	102 (37%)	131 (35%)	
Frailty	19 (7%)	13 (3%)	

ABC, activities-specific balance confidence; SPPB, short physical performance battery

Table 2.

Characteristics of the Falls Among Fallers with and without HIV

	Total number of Falls (n=526)	Falls among Men with HIV (n=234)	Falls among Men without HIV (n=292)	P-value
Fall with injury	54 (10.3%)	22(9.4%)	32(11%)	0.56
Fall with fracture	20 (3.8%)	11(4.7%)	9(3.1%)	0.34
Winter	160 (30.4%)	71(30.3%)	89(30.5%)	0.97
Fall during usual activities	151 (28.7%)	74(31.6%)	77(26.4%)	0.19
Mentioned pet	33 (6.3%)	22(9.4%)	11(3.8%)	0.008
Mentioned stairs/curb	123 (23.4%)	56(23.9%)	67(22.9%)	0.79
Mentioned snow or ice	77 (14.6%)	40(17.1%)	37(12.7%)	0.15
Attributed to lack of lighting	60 (11.7%)	29(12.8%)	31(10.9%)	0.51
Attributed to a slippery surface	141 (27.5%)	64(28.2%)	77(27%)	0.77
Attribute to an uneven surface	174 (33.7%)	79(34.5%)	95(33.1%)	0.74
Attribute to an obstacle	93 (18.1%)	45(19.7%)	48(16.8%)	0.39
Attributed to fatigue	50 (9.8%)	26(11.5%)	24(8.4%)	0.25
Attributed to alcohol	20 (3.9%)	8(3.5%)	12(4.2%)	0.69
Attributed to sleep medications	97 (18.4%)	47 (20.9%)	50 (17.4%)	0.31
Attributed to illicit substance	10 (2%)	1(0.4%)	9(3.2%)	0.03
Attributed to weakness	91 (17.8%)	44(19.4%)	47(16.5%)	0.40

Table 3a.

Characteristics Associated with Increased Odds of Single or Recurrent Falls, Unadjusted, Among Entire Cohort

Variables	1 faller/ non-faller vs reference group	OR for 1 faller	P-value	2+ faller/non-faller vs reference group	OR for 2+ faller	P-value
HIV suppressed (vs negative)	56/153 vs 83/230	1.01(0.68,1.51)	0.944	47/153 vs 66/230	1.07(0.7,1.64)	0.754
HIV with viremia (≥50 vs <50 copies/mL)	3/12 vs 83/230	0.69(0.19,2.52)	0.577	8/12 vs 66/230	2.32(0.91,5.92)	0.077
Age per 5 yrs	NA	1.03(0.88,1.2)	0.743	NA	1.18(1,1.39)	0.057
Black (vs white)	22/65 vs 112/308	0.93(0.55,1.58)	0.791	27/65 vs 91/308	1.41(0.85,2.33)	0.187
Other race (vs white)	8/22 vs 112/308	1(0.43,2.31)	1.000	3/22 vs 91/308	0.46(0.14,1.58)	0.217
Chicago (vs Baltimore)	40/72 vs 37/107	1.61(0.94,2.75)	0.084	48/72 vs 13/107	5.49(2.77,10.85)	0.000
Pittsburgh (vs Baltimore)	31/98 vs 37/107	0.91(0.53,1.59)	0.751	44/98 vs 13/107	3.69(1.88,7.27)	0.000
Los Angeles (vs Baltimore)	34/118 vs 37/107	0.83(0.49,1.42)	0.503	16/118 vs 13/107	1.12(0.51,2.43)	0.782
Enrollment after 2001 (vs before 2001)	25/66 vs 117/329	1.07(0.64,1.77)	0.807	31/66 vs 90/329	1.72(1.06,2.79)	0.029
Former smoker (vs non-smoker)	79/209 vs 47/131	1.05(0.69,1.61)	0.809	50/209 vs 42/131	0.75(0.47,1.19)	0.217
Current smoker (vs non-smoker)	15/53 vs 47/131	0.79(0.41,1.53)	0.483	28/53 vs 42/131	1.65(0.93,2.93)	0.089
Heavy alcohol use (yes vs no)	10/40 vs 131/353	0.67(0.33,1.39)	0.284	13/40 vs 107/353	1.07(0.55,2.08)	0.837
Moderate physical activity (vs low)	32/119 vs 32/77	0.65(0.37,1.14)	0.133	34/119 vs 32/77	0.69(0.39,1.21)	0.191
High physical activity (vs low)	78/199 vs 32/77	0.94(0.58,1.54)	0.814	55/199 vs 32/77	0.66(0.4,1.11)	0.116
Overweight (BMI 25–30 kg/m^2) (vs normal)	45/152 vs 63/160	0.75(0.48,1.17)	0.206	41/152 vs 58/160	0.74(0.47,1.18)	0.205
Obese (BMI≥ 30 kg/m^2) (vs normal)	34/83 vs 63/160	1.04(0.63,1.71)	0.875	22/83 vs 58/160	0.73(0.42,1.28)	0.271
Hypertension (vs no)	85/238 vs 57/156	0.98(0.66,1.45)	0.909	71/238 vs 49/156	0.95(0.63,1.44)	0.808
Diabetes (vs no)	26/40 vs 115/354	2(1.17,3.42)	0.011	22/40 vs 98/354	1.99(1.13,3.5)	0.018
Dyslipidemia (vs no)	105/310 vs 36/84	0.79(0.5,1.24)	0.304	88/310 vs 32/84	0.75(0.47,1.19)	0.221
Liver disease (vs no)	0/3 vs 142/392	NA		1/3 vs 120/392	1.09(0.11,10.57)	0.941
Renal impairment	15/38 vs 127/357	1.11(0.59,2.09)	0.747	14/38 vs 107/357	1.23(0.64,2.35)	0.534
Hepatitis C infection (vs no)	7/21 vs 135/374	0.92(0.38,2.22)	0.859	7/21 vs 114/374	1.09(0.45,2.64)	0.842
CESD≥16 (vs<16)	30/64 vs 112/331	1.39(0.85,2.25)	0.187	26/64 vs 95/331	1.42(0.85,2.36)	0.182
Diabetes medication (vs no)	21/34 vs 121/360	1.84(1.03,3.29)	0.040	21/34 vs 100/360	2.22(1.24,4)	0.008
Hypertension medication (vs no)	66/180 vs 76/214	1.03(0.7,1.52)	0.871	56/180 vs 65/214	1.02(0.68,1.54)	0.908
Cholesterol lowering medication (vs no)	62/193 vs 80/201	0.81(0.55,1.19)	0.277	61/193 vs 60/201	1.06(0.7,1.59)	0.783

Variables	1 faller/ non-faller vs reference group	OR for 1 faller	P-value	2+ faller/non-faller vs reference group	OR for 2+ faller	P-value
Depression medication (vs no)	29/83 vs 113/310	0.96(0.6,1.54)	0.861	42/83 vs 79/310	1.99(1.27,3.1)	0.003
Illicit drug (vs no)	71/162 vs 70/231	1.45(0.98,2.13)	0.061	62/162 vs 58/231	1.52(1.01,2.3)	0.044
Stimulants (vs no)	10/28 vs 131/365	1(0.47,2.1)	0.990	14/28 vs 106/365	1.72(0.87,3.39)	0.116
Peripheral neuropathy (vs no)	45/78 vs 96/314	1.89(1.22,2.91)	0.004	41/78 vs 79/314	2.09(1.33,3.28)	0.001
Neurological impairment (vs no)	7/30 vs 135/362	0.63(0.27,1.46)	0.277	12/30 vs 109/362	1.33(0.66,2.68)	0.428

Table 3b.

Characteristics Associated with Increased Odds of Single or Recurrent Falls, Unadjusted, Among Men with HIV Only

Variables	1 faller/ non-faller vs reference group	OR for 1 faller	P-value	2+ faller/non-faller vs reference group	OR for 2+ faller	P-value
HIV with viremia (≥50 vs <50 copies/mL)	3/12 vs 56/153	0.68 (0.19, 2.51)	0.566	8/12 vs 47/153	2.17 (0.84, 5.63)	0.111
Age per 5 yrs	NA	1.11 (0.86, 1.43)	0.426	NA	1.07 (0.82, 1.39)	0.607
Black (vs white)	13/40 vs 44/117	0.86 (0.42, 1.77)	0.689	14/40 vs 38/117	1.08 (0.53, 2.19)	0.837
Other race (vs white)	2/8 vs 44/117	0.67 (0.14, 3.25)	0.615	3/8 vs 38/117	1.15 (0.29, 4.57)	0.838
Chicago (vs Baltimore)	21/38 vs 14/45	1.78 (0.80, 3.96)	0.160	28/38 vs 5/45	6.63 (2.33, 18.9)	<0.001
Pittsburgh (vs Baltimore)	11/35 vs 14/45	1.01 (0.41, 2.50)	0.982	18/35 vs 5/45	4.63 (1.56, 13.7)	0.006
Los Angeles (vs Baltimore)	13/47 vs 14/45	0.89 (0.38,2.10)	0.788	4/47 vs 5/45	0.77 (0.19, 3.04)	0.704
Enrollment after 2001 (vs before 2001)	13/39 vs 46/126	0.91 (0.45,1.86)	0.802	20/39 vs 35/126	1.85 (0.96, 3.56)	0.067
Former smoker (vs non-smoker)	30/87 vs 19/52	0.94 (0.48, 1.84)	0.865	26/87 vs 18/52	0.86 (0.43, 1.73)	0.677
Current smoker (vs non-smoker)	10/24 vs 19/52	1.14 (0.46, 2.82)	0.776	11/24 vs 18/52	1.32 (0.54, 3.23)	0.537
Heavy alcohol use (vs no)	4/15 vs 55/148	0.72 (0.23, 2.26)	0.570	4/15 vs 51/148	0.77 (0.25, 2.44)	0.662
Moderate physical activity (vs low)	13/44 vs 14/29	0.61 (0.25, 1.49)	0.279	18/44 vs 16/29	0.74 (0.33, 1.68)	0.475
High physical activity (vs low)	32/92 vs 14/29	0.72 (0.34, 1.53)	0.394	21/92 vs 16/29	0.41 (0.19, 0.90)	0.025
Overweight (BMI 25–30) (vs normal)	17/65 vs 32/71	0.58 (0.29, 1.14)	0.116	19/65 vs 29/71	0.72 (0.37, 1.40)	0.327
Obese (BMI ≥ 30) (vs normal)	10/29 vs 32/71	0.77 (0.33, 1.76)	0.528	7/29 vs 29/71	0.59 (0.23, 1.50)	0.269
Hypertension (vs no)	41/99 vs 18/65	1.50 (0.79, 2.83)	0.215	37/99 vs 18/65	1.35 (0.71, 2.57)	0.362
Diabetes (vs no)	11/22 vs 48/142	1.48 (0.67, 3.27)	0.334	11/22 vs 44/142	1.61 (0.73, 3.59)	0.240
Dyslipidemia (vs no)	46/137 vs 13/28	0.72 (0.35, 1.51)	0.389	46/137 vs 9/28	1.04 (0.46, 2.38)	0.917
Liver disease (vs no)	0/1 vs 59/164	NA		1/1 vs 54/164	3.04 (0.19, 49.4)	0.435
eGFR<60 (vs ≥60)	7/28 vs 52/137	0.66 (0.27, 1.60)	0.357	8/28 vs 47/137	0.83 (0.35, 1.95)	0.674
HCV infection (vs no)	6/11 vs 53/154	1.59 (0.56, 4.50)	0.386	5/11 vs 50/154	1.40 (0.46, 4.22)	0.550
CESD≥16 (vs<16)	18/28 vs 41/137	2.15 (1.08, 4.27)	0.029	9/28 vs 46/137	0.96 (0.42, 2.18)	0.917
Diabetes medication (vs no)	8/19 vs 51/145	1.20 (0.49, 2.90)	0.690	11/19 vs 44/145	1.91 (0.84, 4.31)	0.121
Hypertension medication (vs no)	30/78 vs 29/86	1.14 (0.63, 2.07)	0.665	32/78 vs 23/86	1.53 (0.83, 2.84)	0.174
Cholesterol lowering medication (vs no)	29/91 vs 30/73	0.78 (0.43, 1.41)	0.403	32/91 vs 23/73	1.12 (0.60, 2.07)	0.728
Depression medication (vs no)	14/52 vs 45/112	0.67 (0.34, 1.33)	0.252	20/52 vs 35/112	1.23 (0.65, 2.33)	0.525
Illicit drug (vs no)	31/71 vs 28/92	1.43 (0.79, 2.61)	0.236	33/71 vs 22/92	1.94 (1.04, 3.62)	0.036

Variables	1 faller/ non-faller vs reference group	OR for 1 faller	P-value	2+ faller/non-faller vs reference group	OR for 2+ faller	P-value
Stimulants (vs no)	7/15 vs 52/148	1.33 (0.51, 3.44)	0.559	9/15 vs 46/148	1.93 (0.79, 4.70)	0.148
Peripheral neuropathy (vs no)	27/45 vs 32/118	2.21 (1.19, 4.10)	0.012	2¼5 vs 34/118	1.62 (0.85, 3.08)	0.142
Neurological impairment (vs no)	4/14 vs 55/149	0.77 (0.24, 2.45)	0.663	6/14 vs 49/149	1.30 (0.47, 3.58)	0.607
History of AIDS	13/28 vs 46/137	1.38 (0.66, 2.89)	0.389	7/28 vs 48/137	0.71 (0.29, 1.74)	0.458
CD4<200 (vs ≥500) cells/uL	1/6 vs 42/119	0.47 (0.06, 4.04)	0.493	0/6 vs 42/119	NA	0.982
CD4 200–499 (vs ≥500) cells/uL	16/37 vs 42/119	1.23 (0.62, 2.43)	0.560	13/37 vs 42/119	1.00 (0.48, 2.05)	0.990
Nadir CD4<200 (vs ≥500) cells/uL	17/66 vs 7/18	0.66 (0.24, 1.84)	0.430	18/66 vs 5/18	0.98 (0.32, 3.01)	0.974
Nadir CD4 200–499 (vs ≥500) cells/uL	35/81 vs 7/18	1.11 (0.43, 2.90)	0.829	30/81 vs 5/18	1.33 (0.45, 3.91)	0.600
Current efavirenz use (vs no)	8/12 vs 51/150	1.96 (0.76, 5.07)	0.164	10/12 vs 45/150	2.78 (1.13, 6.85)	0.027
Ever stavudine use (vs no)	41/94 vs 18/68	1.65 (0.87, 3.11)	0.124	29/94 vs 26/68	0.81 (0.44, 1.49)	0.494
Ever didanosine use (vs no)	30/64 vs 29/98	1.58 (0.87, 2.89)	0.133	20/64 vs 35/98	0.87 (0.46, 1.65)	0.679
Current integrase use (vs no)	15/43 vs 44/119	0.94 (0.48, 1.87)	0.867	12/43 vs 43/119	0.77 (0.37, 1.60)	0.487
Current protein inhibitor use (vs no)	25/86 vs 34/76	0.65 (0.36, 1.19)	0.160	26/86 vs 29/76	0.79 (0.43, 1.46)	0.456
On HAART (vs no)	53/155 vs 6/7	0.40 (0.13, 1.24)	0.112	53/155 vs 2/7	1.20 (0.24, 5.94)	0.826
Duration of any protease inhibitor use	NA	0.99 (0.94, 1.04)	0.754	NA	1.00 (0.95, 1.05)	0.900
Duration of HAART	NA	1.00 (0.93, 1.07)	0.937	NA	1.02 (0.95, 1.09)	0.607

HAART, highly active antiretroviral therapy

Table 4.

Physical Function and Balance Characteristics Associated with Fall Risk

Characteristic	Odds (95% CI) for 1 Faller	P-value	Odds (95% CI) for 2+ Faller	P-value
ABC ≤ 80	1.67(0.82,3.39)	0.156	2.21(1.07,4.54)	0.032
ABC ≤ 90	1.62(1.01,2.58)	0.045	1.95(1.19,3.18)	0.008
ABC-6 ≤ 80	1.56(0.96,2.56)	0.075	1.94(1.15,3.26)	0.012
ABC-6 ≤ 90	1.38(0.92,2.08)	0.117	1.59(1.01,2.48)	0.044
Tandem Stand	1.21(0.8,1.83)	0.367	0.99(0.63,1.56)	0.957
Functional Reach	1.07(0.84,1.35)	0.594	0.98(0.76,1.26)	0.859
10-time chair rise	1.15(0.94,1.42)	0.177	1.26(1,1.59)	0.047
Grip Strength	0.99(0.81,1.21)	0.903	1(0.8,1.25)	0.982
Gait speed	0.97(0.79,1.21)	0.809	1.06(0.82,1.36)	0.652
SPPB Score <10	1.25(0.71,2.2)	0.434	1.22(0.64,2.32)	0.546
Pre-frailty	1.13(0.73,1.73)	0.591	1.5(0.94,2.4)	0.093
Frailty	1.35(0.54,3.35)	0.521	1.23(0.43,3.55)	0.698

ABC, activities-specific balance confidence; SPPB, short physical performance battery