

**Postural instability in individuals living with HIV infection:
Relations with thalamic nuclei volumes, peripheral neuropathy, age, and falls**

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Abstract

Background

Postural stability diminishes with age, is associated with falls liability, and is disrupted in people with HIV (PWH). The thalamus, which is also affected in HIV, plays a role in balance through its reciprocal connections with cortical, subcortical, and cerebellar structures. Here, we tested postural stability in PWH and sought factors, including thalamic nuclear volumes, peripheral neuropathy, falls history, HIV-related disease, and age that may contribute to instability in PWH.

Methods

Participants included 58 PWH and 95 people without HIV (PWOH). Postural stability was assessed with the Fregly-Graybiel ataxia test battery. Volumes for nine thalamic nuclei were derived using THalamus Optimized Multi-Atlas Segmentation (THOMAS). Peripheral neuropathy, subjective pain, and number of falls were also quantified.

Results

PWH were impaired across all postural balance tasks compared with PWOH. Poorer postural balance scores with eyes open correlated with smaller ventral posterior lateral nuclei volumes in PWH. Higher neuropathy scores in PWH correlated with poorer performance on two balance tests with eyes closed. Higher viral load was associated with greater difficulty standing on one leg with eyes closed. Even when normal aging effects were taken into account, older age in PWH related to greater difficulty standing on one leg with eyes open.

Conclusions

PWH consistently demonstrated balance deficits compared to PWOH, and these deficits were greater in individuals with smaller ventral thalamic nuclei. Older age, self-reported neuropathy, and measurable viral load were also associated with greater balance instability. Thus, balance instability should be monitored and PWH should be informed about balance safety as they age, especially in those who report symptoms of neuropathy or have detectable viral load.

Introduction

With continuing advancements in pharmacological treatment, people with HIV (PWH) can be expected to have an average or near-average life expectancy, living into their 70s (<https://www.cdc.gov/mmwr/volumes/69/wr/mm6946a1.htm#print>) (Bosh et al., 2020). With aging, postural stability diminishes and may be especially affected in PWH (cf., Berner et al., 2017; Sakabumi et al., 2019; Sullivan et al., 2023; Sullivan et al., 2024). Indeed, postural instability, which is a multifaceted process, has predicted increased liability for falls in PWH 50 years of age and older (Erlandson et al., 2012).

Postural instability in PWH has been associated with multiple factors including central and peripheral nervous system dysfunction (Bauer et al., 2005; Sullivan et al., 2011; Sullivan et al., 2023; Zahr et al., 2019). Neuroanatomical correlates of motor processes that are relevant to postural stability include structures of the thalamocortical and thalamocerebellar pathways (Sullivan et al., 2011; Surgent et al., 2019; Zahr et al., 2019). Structural MRI studies examining thalamic volume without respect to its nuclear divisions report shrinkage in HIV infection (Fama et al., 2024; Ortega et al., 2013; Pfefferbaum et al., 2012; Pfefferbaum et al., 2024; Wade et al., 2015). Thalamic dysfunction has also been observed in PWH in functional imaging studies. Using FDG-PET imaging, Hammoud and colleagues (Hammoud et al., 2018) reported significant hypometabolism in the thalamus of treated PWH compared with seronegative participants.

Postural instability has also been associated with distal sensory peripheral neuropathy (Sakabumi et al., 2019), estimated to affect nearly 50% of PWH (Anastasi & Pakhomova, 2020). The constellation of age (Valcour et al., 2008), history of AIDS (Ramachandran et al., 1997), and certain antiretroviral medications (Sacktor et al., 2003) has been associated with

extrapyramidal dysfunction in HIV (Prabhakar et al., 2020; Shorer et al., 2025; Tierney et al., 2019; Valcour et al., 2008), which in turn can increase balance instability. Thus, with age, PWH are at heightened risk for postural instability, which puts them at greater risk for falling given the combination of age-related and disease-related degradation of physiological mechanisms supporting postural stability.

The thalamus plays a known role in balance and gait by way of its reciprocal connections to cortical, subcortical, and cerebellar regions (Middleton & Strick, 2000). Although the ventral thalamus has been specifically implicated in thalamic-related motor processes (Bosch-Bouju et al., 2013), little is known about relations between specific thalamic nuclei and postural instability in PWH. Accordingly, we tested whether PWH would exhibit balance instability on an ataxia battery relative to a control group and whether the extent of instability would correlate with central, peripheral, or HIV-related measures. Specifically, we hypothesized that compared with controls PWH would demonstrate balance deficits and that select thalamic nuclei, namely the ventral thalamic nuclei, would be associated with their balance instability. Further, we examined relations among postural stability and peripheral neuropathy, falls, and HIV-related disease metrics (time since HIV infection diagnosis, CD4 cell count, CD4 nadir, viral suppression, and presence of AIDS diagnosis) and hypothesized that longer duration of HIV infection and older age would be associated with greater balance instability.

Methods

Participants

Participants were aged 21 to 86 years and included 58 PWH (15 women, 43 men) and 95 people without HIV infection (PWOH) comprising a control group (46 women, 49 men). PWH

were recruited by referral from community physicians and from HIV treatment facilities. PWOH were recruited from the local community. The median years since HIV diagnosis was 18.9 years (quartile 11.1 years, 25.8 years). The median CD4+ T-cell count was 559 cells/mm³ (quartiles = 416 cells/mm³, 797 cells/mm³), and the median CD4+ T-cell nadir count was 185 cell/mm³ (quartiles = 47 cells/mm³, 275 cells/mm³). Of the 58 PWH, 31 (53%) had an AIDS-defining event of a CD4+ T-cell count of <200 cells/mm³ at some timepoint since their HIV diagnosis. The PWH participants who met criteria for AIDS did not report a longer disease duration than those without an AIDS diagnosis. Detectable viral load was evidenced in 13 of 52 of the PWH and was not related to age.

Exclusion criteria included a significant history of medical or neurological illness or trauma potentially affecting the central nervous system (e.g., epilepsy, stroke, multiple sclerosis, Parkinson's disease, uncontrolled diabetes, loss of consciousness > 30 minutes, age-related dementing condition, or psychosurgery). Any individual with a lifetime history of schizophrenia or bipolar I disorder determined from the Structured Clinical Interview for DSM-IV-TR and DSM-5 (SCID) (American Psychiatric Association, 2013; First et al., 1998) administered by calibrated research clinicians was also excluded. An additional exclusion criterion for PWOH was a lifetime history of any DSM-IV-TR or DSM-5 disorder (e.g., major depression, eating, or anxiety disorders). Severity of depressive symptoms was assessed with the Beck Depression Inventory-II (BDI-II) (Beck et al., 1996). A semi-structured timeline follow-back interview quantified lifetime alcohol consumption (Skinner, 1982; Skinner & Sheu, 1982).

This research protocol was approved by the Institutional Review Boards of Stanford University School of Medicine (FWA0000935) and SRI International (FWA00007933) and was

carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). Written informed consent was obtained from all participants prior to testing.

Measures of Sensory Status, Pain, and Falls

Peripheral neuropathy was assessed with a quantitative test of 2-point discrimination of the left and right foot and by a self-report rating of characteristic neuropathy symptoms. Two-point discrimination was measured by touching the sole of each foot (one at a time) with 1 or 2 points of a 3-point aesthesiometer and asking the participant to say whether they felt one or two points. The examiner avoided touching calloused skin and proceeded with descending limits starting at 50 mm between points. The threshold score was the shortest distance on which fewer than 3 errors were made (Corkin et al., 1970).

Neuropathy-related symptoms were assessed by asking participants to rate discomfort in feet or legs that might be symptomatic of peripheral neuropathy (Zahr et al., 2019).

Participants were asked if they experienced (a) pain, aching, or burning, (b) pins and needles, and (c) numbness. Each symptom category was rated on a scale of 0-10: 0 for no symptoms of peripheral neuropathy; 1-3 for mild symptoms; 4-6 for moderate symptoms; and 7-10 for severe symptoms.

Participants answered a health-related quality of life questionnaire used specifically in HIV/AIDS research (Bozzette et al., 1995). Score from the pain subscale was based on 2 questions: (a) how much bodily pain they experienced over the past 4 weeks (e.g., headaches, muscle pain, back pain, stomach pain), ranging from none to very severe (5-point scale) and (b) degree of interference with daily activities because of this physical pain, ranging from not at all

to extreme (6-point scale). Raw scores were transformed to a 0-100 scale, where a score of 100 indicated no pain and score of 0 indicated maximum pain.

Participants were also asked about the number of falls they had over the past year (scale 0-6 falls). A fall was classified as unintentionally falling to the ground.

Balance Measures

Postural stability was assessed with the Fregly-Graybiel ataxia test battery (Fregly et al., 1972), which is akin to a roadside sobriety test. The battery included standing heel-to-toe (2 trials of 60 second each, max=120 seconds), taking steps heel-to-toe on a line (2 trials of 10 steps each, max= 20 steps), and standing on one leg (2 trials of 30 seconds for each leg, max=60 seconds; left and right leg scores were then averaged). All balance tasks were conducted first with eyes open and then with eyes closed.

As expected, age and all balance scores were related; thus, balance and 2-point discrimination scores were age-corrected based on the control group and expressed as age-residualized Z-scores with an expected mean $\pm$ standard deviation=0 $\pm$ 1.

MRI Data Acquisition and Quantification

As described previously (Pfefferbaum et al., 2023), thalamic volumes were derived from automatic segmentation of standard T1-weighted MRI. T1-weighted Inversion-Recovery Prepared SPGR images were acquired on 3 Tesla GE whole body MR systems (General Electric Healthcare, Waukesha, WI) using an 8-channel phased-array head coil (TR=6.55/5.92 ms, TE=1.56/1.93 ms, TI=300/300 ms, matrix = 256x256, thick=1.25 mm, skip=0 mm, 124 slices). Drift was corrected by adjusting scanner calibration parameters when necessary to maintain spatial stability within manufacturer guidelines, and routine phantom data were used to

evaluate spatial fidelity.

Preprocessing of the T1-weighted MRI data (Adeli et al., 2019) involved noise removal (Coupe et al., 2008), correcting field inhomogeneity via N4ITK (Tustison et al., 2011), and segmenting the brain mask by majority voting (Rohlfing et al., 2004). The voting was performed with respect to the maps generated by separately applying FSL BET (Smith, 2002), AFNI 3dSkullStrip (Cox, 1996), FreeSurfer mri_gcut (Sadananthan et al., 2010), and the Robust Brain Extraction (ROBEX) method (Iglesias et al., 2011) to the bias and non-bias corrected T1-weighted MRIs.

Using a modified version of THalamus Optimized Multi-Atlas Segmentation (THOMAS) called Histogram-based polynomial synthesis (HIPS)-THOMAS (Su et al., 2019; Vidal et al., 2024), volumes for ten thalamic nuclei were derived: anterior ventral (AV), ventral lateral posterior (VLp), ventral lateral anterior, (VLa) ventral anterior (VA), ventral posterior lateral (VPL), pulvinar (Pul), medial geniculate (MGN), lateral geniculate (LGN), mediodorsal (MD), and centromedian (CM). This multi-atlas segmentation method yields reliable and valid quantification of thalamic regional volumes using standard white-matter nulled T1-weighted data (Vidal et al., 2024) by synthesizing white-matter-nulled image contrast from T1 prior to THOMAS segmentation. All thalamic volumes were adjusted for age and intracranial volume (ICV) based on linear regression functions derived from the PWOH and applied to all data; ICV adjustment attenuated volume differences due to sex. Data from the PWOH group presented here were used in an earlier study (Pfefferbaum et al., 2023).

Statistical Analysis

Data were analyzed using JMP16 (JMP 16). Composite balance scores were calculated, separately for the eyes open and eyes closed conditions, and reflect the average age-corrected Z-scores across the 3 balance tasks. Group differences were tested using parametric and non-parametric tests depending on the type of variables and the distribution characteristics of the analyzed scores. Correlations between brain-behavior scores were analyzed with Pearson correlations and Spearman's rho. A statistical correction (false discovery rate: FDR) (Benjamini & Hochberg, 1995) was employed when reporting significant balance-thalamic nuclei correlations to limit the risk of Type I errors, with significance requiring $p \leq .0056$. In all other analyses a standard $p < .05$ level was used to determine statistical significance. Multiple regression analysis examined the unique contribution of variables to balance scores when multiple factors were correlated to such scores.

Results

Group Demographic Comparisons

The PWH and PWOH groups did not differ on age (Table 1). Compared with the PWOH group, the PWH group had more men, fewer years of education, lower scores on a screening test of overall current cognitive function (Dementia Rating Scale-2) (Jurica et al., 2004), and lower estimated IQ as assessed with the National Adult Reading Test (NART) (Nelson, 1982). The PWH group also endorsed more depressive symptoms (BDI-II), reported a lower level of socioeconomic status, and had a higher lifetime alcohol consumption (kg) than the PWOH group. The median body mass index (BMI) in the PWH group was 25.3 (quartiles=23.1, 27.9)

and was not significantly different from that of the PWOH group (median=24.9; quartiles=22.1, 29.0) ($t(151)=.045$, $p=.964$).

Table 1 – about here

The PWH group had impaired 2-point discrimination of the feet compared with the PWOH group ($t(126)=3.92$, $p=.0001$). The PWH group reported a higher incidence of neuropathic symptoms than did the PWOH group ($Z=3.53$, $p=.0004$), with 17 of 57 PWH (29.8%) compared with 5 of the 75 PWOH (6.7%) reporting at least some degree of neuropathic symptoms, and 5 PWH and 0 PWOH experiencing severe symptoms. The PWH group also reported having more physical pain than the PWOH group ($t(143)=3.49$, $p<.0006$). No group difference was observed for reported number of falls over the past year ($Z=.007$, $p=.994$), with 44% ($n=12$) PWH reporting 0 falls, 22% ($n=6$) 1 fall, 22% ($n=6$) 2 falls, 7% ($n=2$) 3 falls, and 4% ($n=1$) 4 falls compared to 42% ($n=16$) PWOH reporting 0 falls, 29% ($n=11$) 1 fall, 18% ($n=7$) 2 falls, 5% ($n=2$) 3 falls, and 5% ($n=2$) 5 falls.

Between-group analyses

Composite balance scores, computed separately for the eyes open and eyes closed conditions, indicated a group difference between the PWH and PWOH groups (Supplemental Table 1). The PWH group was impaired across all postural balance tasks in both vision conditions compared with the PWOH group (Figure 1). No sex difference was observed for any of the balance composites in either the PWH or PWOH group.

Figure 1 - about here

Of the thalamic nuclei volumes examined, the PWH group had smaller VLp volumes than the PWOH group (Supplemental Table 2). No group difference was observed for any other nuclear volume.

Correlations within the PWH group

Employing FDR correction for multiple comparisons, poorer overall postural balance composite scores with eyes open correlated with smaller ventral posterior lateral nuclei (VPL) volumes in the PWH group ($r=.424$, $p=.0002$) (Table 2). Further, all three individual balance scores with eyes open correlated with VPL volumes in the PWH group (standing heel-to-toe $r=.277$, $p=.004$; steps on a line $r=.423$, $p=.001$; standing on one leg $r=.367$, $p=.005$) (Figure 2). Additionally, trouble standing on one leg with eyes open was correlated with smaller anterior ventral (AV) nuclei volumes ($r=.340$, $p=.010$). In the eyes closed condition, poorer scores when standing heel-to-toe correlated with smaller VPL volumes ($r=.411$, $p=.002$).

Table 2 and Figure 2 –about here

Longer duration of an HIV diagnosis significantly correlated with smaller VPL thalamic nuclei volume ($r=-.362$, $p=.005$) and was modestly correlated with centromedian (CM) thalamic nuclei volume ($r=.325$, $p=.013$) (Figure 3). Neither 2-point pedal discrimination nor number of falls over the past year correlated with any balance score in the PWH group. By contrast, higher self-reported neuropathy scores in the PWH group correlated significantly with poorer performance with eyes closed on two of the three balance tests (standing heel-to-toe: $\rho=-.360$, $p=.006$ and standing on one leg: $\rho=-.366$, $p=.006$) and the composite score ($\rho=-.387$, $p=.004$). Further, self-reported neuropathy scores were correlated with reported number of falls ($\rho=.400$, $p=.04$) and were unrelated to history of an AIDS diagnosis.

-Figure 3 about here-

Older age in the PWH group correlated with greater difficulty standing on one leg with eyes open ($\rho = -.327$, $p = .013$) even after taking into account normal aging effects. Greater self-reported physical pain correlated with greater difficulty standing on one leg with eyes closed ($\rho = .327$, $p = .014$). PWH who were not virally suppressed had significantly more difficulty with standing on one leg with eyes closed compared with those who were virally suppressed ($t = 2.41$, $p = .02$) (Supplemental Figure).

Multiple regression analysis was computed to determine the relative contribution of significant correlates (VPI volume, age) to the prediction of the eyes open composite balance score. Both VPI volume (t Ratio = 3.48, $p = .001$) and age (t Ratio = -2.37, $p = .02$) emerged as unique predictors of the composite balance score in the eyes open condition, accounting for 29.8% of the variance.

Discussion

Use of a quantitative, roadside-like ataxia testing was adequately sensitive to elicit significant instability in PWH, who were impaired across all balance tasks compared to PWOH, in both the eyes open and eyes closed conditions. Selective relations were observed between these balance tasks and dissociable thalamic nuclei and demographic and disease related variables.

The present findings in HIV comport with the premise that multiple neural systems subserve motor and sensory processes relevant to control and maintenance of postural stability (Sullivan et al., 2024; Surgent et al., 2019). The VPI volume of the thalamus and age were each predictors

of the ataxia composite score for the eyes open condition. Further, these brain structure-balance relations are consistent with functional imaging studies that revealed the relevance of connectivity of the ventral posterior lateral thalamic nuclei to neural systems involved in motor functions, including the motor cortex (Hale et al., 2015), somatosensory cortex (Zhang & Li, 2017), and the cerebellum (Honnorat et al., 2021). Honnorat and colleagues (Honnorat et al., 2022) reported that weaker connectivity between the ventral posterior lateral thalamic nuclei and cerebellar regions was related to worse performance on ataxia testing performed with eyes closed in individuals with alcohol use disorder.

Despite age-correction of all ataxia scores, older age in PWH was also consistently related to poorer balance scores in the eyes open condition and was a unique predictor of composite balance score. The persistence of the effects of age in PWH may also reflect their compromised ability to use visual cues to stabilize their balance to the extent that older controls did. Older age has also been reported to be a relevant predictor of postural instability assessed with a force platform showing longer sway paths in older PWH (Sullivan et al., 2024).

The PWH and control groups did not differ on reported falls within the past year, with 69% of PWH and 72% of PWOH reporting having fallen at least once. Although PWH had attenuated 2-point pedal discrimination compared with controls, no relations were observed between 2-point discrimination and balance scores or number of reported falls. By contrast, self-reported neuropathy scores related to balance instability and more falls reported by PWH. Although compromised ataxia battery and 2-point pedal discrimination were each related to ventral lateral medial thalamic nuclei volume, these two behavioral measures were not related to one another, suggesting that these processes may rely on dissociable neural systems and that

performance on one function cannot be generalized to the other. This dissociation comports with other studies that did not observe a relation between distal neuropathy and balance in PWH (Bauer et al., 2005).

Men and women did not differ on any balance task in either the HIV or control groups. Neither CD4 cell count nor history of an AIDS-defining event correlated with any of the balance scores or thalamic volumes. By contrast, higher viral load was associated with poorer balance in one of the most challenging conditions, namely, balancing on one leg with closed eyes.

The findings in HIV comport with the premise that multiple neural systems subserve motor and sensory processes relevant to control and maintenance of postural stability with eyes open and eyes closed (Sullivan et al., 2024; Surgent et al., 2019). There is strong evidence that the thalamus is a critical structure connecting the basal ganglia and cerebellar neural systems subserving motor processes in rodents (cerebello-thalamo-cortical and basal ganglio-thalamo-cortical loops)(Hintzen et al., 2018). Our findings suggest that ventral posterior and anterior thalamic nuclei may be particularly relevant to balance-related actions subserved by these neural systems in humans.

Limitations of this study must be acknowledged. The analysis was cross-sectional, thereby precluding tracking the progression of balance instability as it relates to age or fluctuating viral load, either for better or worse. Sex differences on balance tasks may not have been observed in the HIV group due to sample size. In addition, histories of HIV therapies were not considered in analysis. Highly variable histories in our relatively small sample would preclude a formal analysis of the potential influence of selective pharmaceutical drugs on neurotoxicity, balance, and the brain. Ultimately, selectivity of the relation between imbalance and the ventral

posterior lateral nucleus of the thalamus should be tested against additional brain structures and systems.

In summary, people with HIV infection demonstrated balance deficits compared to similarly aged adults without HIV. Further, deficits in balance were greater in individuals with HIV who had smaller ventral thalamic nuclei. Additionally, age, over and above normal aging effects, self-reported symptoms of neuropathy, and measurable viral load in people with HIV infection were associated with greater balance instability. Thus, PWH should be monitored for balance instability and informed about balance safety as they age especially in those reporting neuropathic symptoms or with detectable viral load.

SupplementalFigure_Boxplot_ViralLoad_Revision --<https://links.lww.com/QAI/C774>

SupplementalTable_1_JAIDS_Fama_REVISED --<https://links.lww.com/QAI/C775>

Table_Supplemental_2__Revised_JAIDS --<https://links.lww.com/QAI/C776>

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Figure Legend

Figure 1: Boxplots depicting balance test scores in the eyes open and closed conditions for the PWOH (black) and PWH (green) groups.

Figure 2: Scatterplots depicting the significant relations between ventral posterior lateral and anterior ventral nuclei volumes and balance test scores in the PWOH group. Parcellation of thalamic nuclei depicting thalamic volumes quantified using a modified version of Thalamus Optimized Multiple-Atlas Segmentation (THOMAS).

Figure 3: Scatterplots depicting the significant relations between reported time (weeks) since HIV-infection diagnosis and ventral posterior lateral and centromedian thalamic nuclei volumes.

Supplemental Figure: Boxplots depicting the group difference between PWH who were virally suppressed (green) versus PWH who were not virally suppressed (red) when standing on one leg in the eyes closed condition.

Eyes Open

Eyes Closed

$t(151)=3.59, p=.0004$

$t(150)=3.28, p=.001$

$t(151)=2.77, p=.006$

$t(149)=2.59, p=.011$

$t(150)=4.20, p=.0001$

$t(149)=2.82, p=.006$

Figure 1

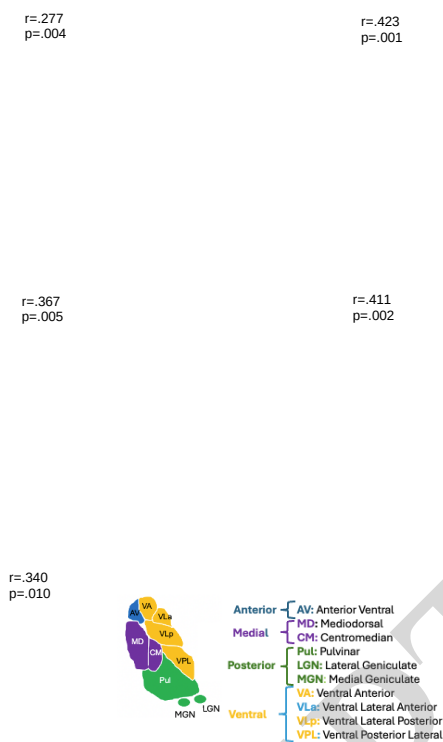


Figure 2

$r=-.362$
 $p=.005$

$r=-.325$
 $p=.013$

Figure 3

	PWH (n=58)	PWOH (n=95)	Group Differences
Sex	15F, 43M	46F, 49M	ChiSquare=7.9 $p=.005$
Age	53.5 (9.38) 28.2 to 78.3	51.7 (15.14) 21.4 to 86.1	$t=1.27$ $p=.21$
Education	13.5 (2.80) 6 to 19	16.0 (2.32) 11 to 21	$t=5.87$ $p<.0001$
NART ^a	105.0 (9.28) 90 to 123	112.8 (8.03) 92 to 126	$t=4.24$ $p<.0001$
Lifetime alcohol (kg)	79.9 (100.78) 0 to 605	26.9 (41.53) 0 to 258	$t=4.54$ $p<.0001$
BDI-II ^b	10.0 (7.91) 0 to 28	2.8 (3.71) 0 to 17	$t=7.56$ $p<.0001$
DRS-2 ^c	136.2 (5.47) 120 to 144	139.8 (2.42) 132 to 144	$t=5.15$ $p<.0001$
SES ^d	38.6	25.8	

	(15.29) 11 to 69	(12.18) 11 to 61	t=5.72 p<.0001
Body Mass Index	25.9 (4.1) 19.3 to 37.9	25.9 4.6 16.5 to 39.9	t=0.05 p=.96
CD4 cell count ^e	591 (250) 88 to 1224	na	
CD4 nadir ^f	118 (156) 0 to 600	na	
Weeks since HIV dx	976 (489) 77 to 2010	na	
2-point discrimination ^g (feet)	.989 (1.83) -1.6 to 4.9	.000 (1.01) -1.6 to 4.4	t=3.92 p=.0001
Pain score ^h	74.1 (25.2) 22.5 to 100	86.2 (16.6) 32.5 to 100	t=3.49 p=.0006
Subjective Neuropathy ⁱ (Category 0, 1, 2, 3)	n= 40/8/4/5	n=70/2/3/0	Z=3.53 p=.0004
Falls in past year ^j (0, 1, 2, 3, 4, 5, 6 - falls)	n=12/6/6/2/1/0/0	n=16/11/7/2/0/2/0	Z=.007 p=.994

PWH = people with HIV; PWOH = people without HIV;

^a NART – National Adult Reading Test [PWH: n=32; PWOH: n=62]

^b BDI-II – Beck Depression Inventory –Second Edition [PWH: n=57; PWOH: n=94]

^c DRS-2 – Dementia Rating Scale – Second Edition. [PWH: n=55; PWOH: n=82]

^d SES - lower scores reflect higher socioeconomic status

^e CD4 cell count: n=56

^f CD4 nadir: n=50

^g 2-point discrimination [PWH: n=53; PWOH: n=75]; age-corrected Z-scores with higher scores indicating worse performance

^h Pain score [PWH: n=57; PWOH: n=88]; lower number reflects more reported pain

ⁱ Subjective Neuropathy score: Categories 0/1/2/3: n=number of participants in each category [PWH: n=57; PWOH: n=75]

^j Number of participants reporting how many falls (0-6) over the past year [PWH: n=39; PWOH: n=57]

Table 2. Correlations between Balance Scores (Eyes Open and Eyes Closed) and Thalamic Nuclei Volumes

	Eyes Open		AV		VA		VL _a		VL _p		VPL		Pul		LGN		MGN		n
	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	
Stand heel-to-toe																			
PWOH	.081	.432	.119	.252	.064	.538	.133	.200	.222	.030	.009	.929	-.029	.780	.115	.267	.020	.851	95
PWH	.167	.211	.063	.639	.069	.605	.146	.276	.277	.004	.259	.049	.141	.291	.256	.053	.261	.047	58
Steps on a line																			
PWOH	.085	.412	-.116	.262	-.096	.354	-.023	.827	-.021	.842	-.062	.551	.055	.594	.217	.035	.032	.755	95
PWH	.287	.029	.136	.310	.058	.666	.274	.037	.423	.001	.309	.018	.282	.032	.267	.042	.040	.763	58
Stand on one leg																			
PWOH	.123	.235	.105	.313	-.088	.395	.154	.137	-.018	.861	.034	.746	.058	.579	.027	.796	-.012	.908	95
PWH	.340	.010	.172	.201	.197	.143	.295	.026	.367	.005	.090	.507	.210	.116	.133	.323	.009	.948	57
Composite Score																			
PWOH	.139	.179	.049	.635	-.056	.589	.125	.227	.092	.376	-.011	.919	.039	.705	.177	.086	.020	.846	95
PWH	.311	.019	.143	.287	.126	.350	.279	.355	.424	.0002	.276	.038	.250	.061	.270	.042	.141	.295	57

Eyes Closed	AV		VA		VL _a		VL _p		VPL		Pul		LGN		MGN		CM		n
	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	
Stand heel-to-toe																			
PWOH	.098	.343	-.010	.920	.005	.962	.094	.366	-.087	.403	-.090	.383	.038	.713	.137	.185	-.049	.639	95
PWH	.126	.351	-.037	.783	-.095	.481	.082	.542	.411	.002	.241	.071	.098	.469	.270	.042	.126	.350	57
Steps on a line																			
PWOH	-.065	.531	.073	.481	.089	.390	.050	.627	-.025	.808	-.035	.736	.149	.150	.021	.838	.084	.420	95
PWH	-.054	.694	-.109	.426	-.200	.140	-.142	.297	.022	.871	.012	.932	.129	.345	.094	.492	.055	.692	56
Stand on one leg																			
PWOH	.105	.316	-.098	.348	.050	.631	-.058	.580	-.043	.684	.095	.363	-.041	.697	.322	.002	.065	.531	95
PWH	.302	.022	.104	.442	-.094	.488	.193	.151	.217	.104	.204	.128	.199	.137	.356	.007	.137	.308	57
Composite Score																			
PWOH	.062	.552	-.002	.984	.068	.513	.057	.587	-.069	.510	-.016	.882	.078	.455	.227	.028	.042	.688	94
PWH	.170	.210	-.024	.863	-.177	.191	.063	.647	.318	.017	.214	.113	.195	.151	.337	.011	.153	.260	56