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An exploratory study of correlates of allostatic load in older people living with HIV

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Abstract

Background: Older people living with HIV (PLWH) experience poorer outcomes than seronegative counterparts. Allostatic load (AL) markers have shown utility as indicators of cumulative wear-and-tear of stress on biological systems. However, little is known about correlates of AL in PLWH.

Methods: Ninety-six PLWH aged 50+ completed a comprehensive neurobehavioral assessment and blood draw. Select AL markers (i.e., 10 blood markers) were available for a subset (n=75) of seronegative controls. AL was operationalized as a sum of markers in the highest risk quartile for: cortisol, DHEA, IL-6, TNF-alpha, C-reactive protein, glucose, total cholesterol, HDL cholesterol, triglycerides, albumin, systolic and diastolic blood pressure, and BMI.

Results: PLWH had higher risk levels than seronegatives with small-medium effect sizes for several biomarkers. Among HIV+ African Americans (84% of PLWH), higher AL was associated with lower psychological resilience (rho=−0.27, p=0.02), less physical activity (rho=−0.29, p<0.01), poorer neurocognitive functioning (rho=−0.26, p=0.02), greater basic activity of daily living (BADL) complaints (p<0.01), and diabetes (p<0.01). Multivariable regressions within African American PLWH for significant AL-outcome associations (i.e., neurocognitive function, BADL complaints, diabetes) showed that associations with AL remained significant when adjusting for relevant covariates. Mediation analysis suggested that the association between SES and neurocognitive function was mediated by AL.

Conclusion: These exploratory findings are consistent with the larger aging literature, suggesting that lower AL may serve as a pathway to better health and functional outcomes, particularly in African American PLWH. Further, resilience and physical activity may reduce AL in this population.

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Keywords

weathering; allostasis; HIV/AIDS; aging; neurocognition

Introduction

People living with HIV (PLWH) are aging and reaching longer lifespans than historically experienced. Despite evidence of successful aging endpoints in PLWH[1–3], there is mounting evidence on the deleterious effects of age and HIV on physical, psychosocial, emotional, functional and cognitive health[4–12]. While recent work has shifted to focus on protective factors to promote better outcomes in people aging with HIV, such as diet, exercise, and other lifestyle factors[13–17], there is still much that is not understood about the pathways to poorer outcomes in people aging with HIV.

In the larger aging field, the theories of allostatic load[18,19] and weathering[20] posit that early life events and adverse conditions, as well as cumulative day to day stressors, set the stage for long term morbidity and mortality. These stressors and adverse conditions include factors such as low socioeconomic status (SES), abuse, stigma and discrimination, many of which are more pronounced in racial and ethnic minorities. The allostatic load model posits that stress impacts health via cumulative, multi-system wear and tear, including neuroendocrine, immune, metabolic, and cardiovascular systems[18,19]. Briefly, stress activates the hypothalamic-pituitary (HPA) axis, signaling secretion of stress hormones and inflammatory markers, leading to downstream dysfunction of cardiovascular, metabolic and immune systems[21]. These repeated processes of dysregulation in response to adaptation to stress ultimately lead to pathological tertiary endpoints, namely morbidity and mortality. Simply stated, allostatic load can be viewed as the “biological cost of adapting to stressors”. In addition to these direct pathways, stress also has indirect effects on disease markers and endpoints via health behaviors, such as lower physical activity and poorer sleep quality[22,23]. The allostatic load model has particular relevance to aging with HIV, as older HIV+ adults are at combined risk for adverse effects of age, HIV, and stress on biological functioning.

Studies in aging populations have shown many predictors and outcomes associated with allostatic load. Older age and lower SES have been shown to predict higher allostatic load[24,25]. African Americans have been shown to have higher allostatic load scores across the lifespan, which is not fully explained by poverty[26], suggesting a complex set of adverse consequences due to coping with deeply engrained early life disadvantage and living in a society that marginalizes African Americans[27]. Higher allostatic load scores have been shown to predict poorer cognitive and physical functioning as well as cardiovascular disease, above and beyond SES and health status[19]. This suggests multi-system biological pathways whereby SES ultimately impacts health outcomes. Allostatic load scores have also been shown to predict mortality differences between high and low SES adults, while individual components of allostatic load themselves were not associated, supporting the summary measure of biological risk[28,29].

Despite the aging of the HIV population, the high burden of HIV in those of socioeconomic disadvantage and minority status, particularly in the South[30], and the unique stressors

associated with living with a stigmatized condition, virtually no studies have examined allostatic load in PLWH. In contrast, there is a large body of work in PLWH supporting the role of stressful events, trauma, adverse life conditions, and stigma with poorer outcomes, including depression and anxiety[31,32], quality of life[31,32], substance use[31], treatment adherence[31,33,34], disease progression[34], and cognitive impairment[35,36]. The one study that examined allostatic load in HIV showed that PLWH who had experienced 4 or more adverse childhood experiences had on average higher allostatic load in adulthood compared to those who experienced fewer, and this association was not mediated by smoking or alcohol use, suggesting direct mechanisms of stress on biological functioning[37]. While no other studies have examined allostatic load in PLWH, several studies have examined associations between individual components of allostatic load and outcomes. Higher levels of interleukin 6 (IL-6) and lower levels of dehydroepiandrosterone (DHEA) have been associated with cardio-metabolic morbidities (atherosclerosis, lipodystrophy) and mortality[38–40]. Higher levels of tumor necrosis factor-alpha (TNF-alpha), IL-6, total cholesterol, and low-density lipoprotein (LDL) cholesterol have been associated with neurocognitive impairment[41,42], while higher high-density lipoprotein (HDL) cholesterol attenuated decline[42]. In terms of protective factors, exercise has shown a lowering effect on IL-6[43], while sleep and exercise are associated with lower C-reactive protein and IL-6 [44]. Stressful events have shown associations with lower DHEA and higher cortisol[45]. Thus, given the strong evidence of the effects of stress on poorer outcomes in PLWH as well as the utlitiy of several allostatic load biomarkers as indicators of potential pathways whereby stressors affect outcomes, further disentangling associations between allostatic load, morbidity, health behaviors, and functional outcomes in PLWH is warranted.

The purpose of this cross-sectional exploratory study was to examine correlates of allostatic load scores in a sample of adults with HIV aged 50 and older in the Deep South, of whom a majority were African American. We examined both conceptually relevant putative demographic (e.g., SES), psychological (e.g., resilience), and health behavior (e.g., physical activity) antecedents to allostatic load as well as health and functional outcomes (e.g., neurocognitive functioning). We hypothesized that higher levels of risk factors would be associated with higher allostatic load scores, and further, that higher allostatic load scores would be associated with poorer functional and health outcomes in PLWH.

Materials and Method

Participants and Procedure

The current study included a subsample of 101 PLWH enrolled in a larger NIH-funded observational parent study (N=279, n=174 HIV+ and n=105 HIV- controls). HIV+ patients were recruited from a university HIV/AIDS clinic while seronegative participants were recruited via flyers in the community and an online advertisement for university studies. Exclusion criteria (determined via self-report telephone screen) for the parent study included: absence of major comorbid conditions (e.g., dementia, head injury, current chemo or radiation therapy) and sensory impairment. The only difference in inclusion for HIV+ vs. seronegative participants was the age cutoff for HIV+ was 40+ while for seronegatives it was 50+ (due to focus on accelerated aging in PLWH in the parent study). For the current study,

biomarker assays were conducted for allostatic load variables for the 101 PLWH from the parent study who were aged 50+. The final sample size included 96 HIV+ participants who had available data for all allostatic load markers (i.e., 5 participants missing blood pressure and BMI data). Data for all serum allostatic load biomarkers were available for a subset of 75 HIV-seronegative control participants who had completed the parent study at the time these assays were conducted (these 75 controls did not differ on sociodemographic or clinical variables from the 30 controls who completed the study later). However these control participants did not have blood pressure or BMI data. Thus, given the focus of this paper, the relatively smaller sample size of and lack of all allostatic load markers for the seronegative sample, the seronegative sample was only included for initial comparisons by serostatus on the individual blood allostatic load biomarkers. After completing an IRB-approved consent form, participants underwent a comprehensive research battery that included clinico-demographic, psychological, health behavior, and functional measures. Descriptive statistics for relevant study variables for the 96 HIV+ participants are in Table 1 and the 75 HIV- controls are in Table 2.

Measures

Clinico-demographic: Sociodemographics were determined via a self-report questionnaire and included: age, sex, race, years of education, and yearly household income (i.e., 1 = $0-$10,000 to 11 = $100,001 and above). Given the conceptual and statistical (average Pearson's rho = 0.54) overlap between education and income, an SES composite was created as the sample-based Z-score for both indices for use in subsequent analyses, with higher values reflecting higher SES. A study-developed health questionnaire was used to determine self-report for a lifetime diagnosis of diabetes and hypertension. All participants provided urine samples for toxicology (TransMed®) for the following substances: THC, amphetamines, methamphetamine, opiates, and cocaine. Estimated duration of HIV infection and HIV disease markers (i.e., CD4 T-lymphocyte count [current and nadir] and plasma viral load [detectable >20 copies/milliliters vs undetectable ≤20 copies/milliliters]) were extracted from clinic records and included data collected from clinic visits closest to the current study visit (i.e., within 3-months prior or 1-month after, whichever was closest to current study visit).

Psychological: The Connor-Davidson Resilience Scale-10 (CDRS) was used to measure psychological resilience[46]. Responses for this 10-item measure are summed for a total score, with higher scores reflecting greater levels of resilience. Depressive symptoms over the past week were measured by the 20-item Center for Epidemiological Studies Depression Scale (CESD)[47], with higher scores reflecting greater levels of depressive symptoms.

Health Behaviors: The International Physical Activity Questionnaire (IPAQ) Long Form[48] was used to assess self-reported physical activity. Participants were queried about frequency (i.e., number of days) and duration (i.e., minutes per day) in walking, moderate-intensity activity, and vigorous-intensity activity, over the past seven days across the following domains: leisure time, domestic activities, work-related activities, and transport-related activities. Using established guidelines, total minutes per week continuous scores were derived, which factored in metabolic equivalent (MET) values for activity level (i.e.,

walking: 3.3; moderate: 4.0; vigorous: 8.0), for use in the current study, with higher IPAQ scores reflecting greater engagement in physical activity. The MIND Diet Questionnaire[49,50] was used to assess self-reported adherence to a hybrid of the Mediterranean and Dietary Approach to Stop Hypertension (DASH) diets over a typical week. This measure includes 15 dietary components (10 brain healthy food groups [green leafy vegetables, other vegetables, nuts, berries, beans, whole grains, fish, poultry, olive oil and wine] and 5 unhealthy food groups [red meats, butter and stick margarine, cheese, pastries and sweets, and fried/fast food]). The total MIND diet score was computed by summing adherence to each of the 15 components, with higher scores reflecting greater adherence to the MIND diet. The Pittsburg Sleep Quality Index (PSQI)[51] was used to assess self-reported sleep quality over the past month. Components include subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medications, and daytime dysfunction. The Global PSQI score was used, with higher scores reflecting poorer sleep quality.

Health and Functional Outcomes: The following health and functional outcomes were examined: diabetes and hypertension status, neurocognitive functioning, and everyday functioning. Diabetes and hypertension status were ascertained via the self-report health questionnaire described above.

Neurocognitive functioning was assessed via a comprehensive seven-domain (verbal fluency, executive function, speed of information processing, learning, recall, working memory, motor) battery commonly used in neuroAIDS research[52]. Raw test scores were corrected for age, education, gender, and race/ethnicity using published normative data when available and then used to calculate global T-scores, which were used in analyses. The following individual measures were used in each domain: verbal fluency (Controlled Oral Word Association Test and Animals and Action Fluency), executive functioning (Wisconsin Card Sorting Test, Trail Making Test B), learning and delayed recall (two domains) (Hopkins Verbal Learning Test and Brief Visuospatial Memory Test), speed of information processing (Trail Making Test A, Digit Symbol Task, Symbol Search), attention/working memory (Letter Number Sequencing, Paced Auditory Serial Addition Test), and motor skills (Grooved Pegboard Test dominant and non-dominant hands).

Everyday functioning was assessed via a self-report questionnaire commonly used in HIV[52–54]. Specifically the revised version of the Lawton and Brody[55] everyday functioning questionnaire[52,53] was used to derive instrumental activities of daily living (IADL) (e.g., managing finances, managing medications) and basic activities of daily living (BADL) (e.g., bathing, dressing) declines. Total scores for each reflect the number of domains in which participants rated their current functioning as worse than their prior functioning, and also endorsed a need for assistance in each activity. In contrast to IADL complaints (sample range 0 to 10), the distribution for BADL complaints was narrow (0 to 4, with 78% of the sample having 0), therefore we examined this outcome as a binary variable in analyses (0 vs 1 or more BADL complaints).

Allostatic load: Allostatic load was determined via blood samples as well as clinical data. Specifically blood pressure (systolic and diastolic blood) and BMI were extracted from HIV + participants' clinic records in the same manner described above for HIV characteristics.

Blood samples were collected and then processed by a research nurse the morning of the current study visit (at approximately 9am) and plasma and serum were frozen in a −80C freezer for future use. The following 10 serum markers were examined: neuroendocrine (cortisol, DHEA), immune (IL-6, TNF-alpha, C-reactive protein), metablolic **(**glucose, total cholesterol, HDL cholesterol, triglycerides, albumin). Consistent with other studies of allostatic load[26,37,56], an allostatic load composite was created based on the sum of biomarkers measured in the highest risk quartile (< 25th percentile for high density lipoprotein, albumin, and DHEA, and > 75th percentile for all others) based on the distributions in the HIV+ sample[1].

Statistical Analyses

To examine whether the individual allostatic load blood markers differed by serostatus, we conducted independent samples t-tests between the full HIV+ sample (N=101) and the subset of 75 HIV- negative controls who had available data for all markers except blood pressure and BMI. Given the exploratory nature of this pilot study, bivariate tests examining associations between allostatic load and the study variables among HIV+ participants were the main analyses. Spearman's rho correlations were conducted between continuous variables while independent samples t-tests were conducted between continuous and binary variables. Given the small sample size of this study, effect sizes were primarily examined (e.g., correlation coefficients, Cohen's ds). Lastly, given the evidence in aging literature on the particular relevance of allostatic load in African Americans, and given that our sample was largely African American, associations were also examined seperately within this racial group. All analyses conducted were two-tailed. We applied the Benjamini-Hochberg procedure using a false discovery rate (FDR) of 10% to adjust for multiple comparisons to each set of analyses (i.e., serostatus differences on allostatic load plasma markers, associations between study variables and allostatic load in the full HIV+ sample, and associations between study variables and allostatic load in the African American HIV+ subsample).

Results

HIV+ participants had significantly higher ($p<0.05$) values than HIV- negative controls for TNF-alpha ($p=0.02$), and trends emerged ($p<0.10$) for higher risk values for HDL ($p=0.06$) and triglycerides ($p=0.05$) in the expected direction. However when applying the FDR procedure no differences were significant. Table 3 contains means, standard deviations, p-values and effect sizes for serum biomarker differences by serostatus. The HIV+ participants were significantly ($p<0.05$) younger, more likely to be African American and male, had lower SES composite scores, but did not differ on urine toxicology positivity. Characteristics for relevant study variables for HIV+ and HIV- controls can be found in Tables 1 and 2.

[1]We examined whether findings differed if risk cut-offs were based upon quartiles from the HIV-negative sample as well as the whole sample (HIV+ and HIV-negative combined), and in general the pattern of results was very similar. These three allostatic load composites were also highly correlated (average Pearson's r =0.94). The means and SDs were also similar (original based on HIV+ distributions= 4.21[2.01], based on full sample distributions = 4.13 [2.08], based on HIV-negative only distributions = 4.38[2.10]).

We then examined associations within the HIV+ sample between the allostatic load composite and several sociodemographic, clinical (i.e., HIV characteritsics and urine toxicology status), psychological, and health behavior variables, as well as several health and functional outcomes (i.e., diabetes status, hypertension status, neurocognitive functioning, and everyday functioning). In the overall HIV+ sample, no significant associations emerged between allostatic load and: age, SES, urine toxicology positivity, sex, race, diet, sleep, depression, BADL/IADL complaints, neurocognitive functioning, physical activity, estimated duration of infection, current or nadir CD4, or viral load detectability. Higher allostatic load scores were significantly associated with lower resilience (rho=−0.20, p=0.0486) and with diabetes (t[93]=5.54, p<0.01) and hypertension (t[93]=2.27, p=0.03) diagnoses. However when applying the FDR procedure, only diabetes was significant.

We then examined the aforementioned associations within HIV+ African American PLWH only. Similar to the overall HIV+ sample, no associations emerged in African American participants between allostatic load and: age, SES, urine toxicology positivity, sex, diet, sleep, depression, IADL complaints, estimated duration of infection, current or nadir CD4, or viral load detectability, as well as hypertension status. Higher allostatic load was associated with lower resilience (rho=−0.27, p=0.02), less physical activity (rho=−0.29, p<0.01), poorer neurocognitive functioning (rho=−0.26, p=0.02), greater BADL complaints (t[78]=−2.74, p<0.01), and diabetes (t[78]=4.05, p<0.01). We further examined associations between allostatic load and the individual seven cognitive domain T scores, and found that speed of information processing was the domain with the strongest association with allostatic load (rho=−0.31, p<0.01). When the FDR procedure was applied to these asociations within the African American HIV+ subsample, they all remained significant. Correlations between study variables, allostatic load componsite, and individual markers among African American PLWH are in Table 4, while scatterplots for significant associations in this subsample are in Figure 1.

Given the demonstrated importance of examining AL in the context of SES in prior studies, we conducted posthoc multivariable regressions analyses to determine whether any of the significant aforementioned associations with allostatic load and outcomes (i.e., diabetes status in the full HIV+ sample; neurocognitive function, BADL complaints, diabetes status in African American HIV+ subsample) were independent of SES. We also considered other potential demographic and HIV covariates that may be related to the outcomes and thus warrant inclusion in the analyses, and the only association found was that within the African American HIV+ subsample, women were more likely to have diabetes. Predictors were entered in the model simultaneously. In the full HIV+ sample, in the model predicting diabetes status (χ^2=21.90, DF=2, R^2=0.25, p<0.001), allostatic load (B=−0.67, p<0.01) was a significant predictor while SES was not (B=0.04, p=0.89). The following results were in the African American HIV+ subsample. In the model predicting BADL complaints (χ^2=7.17, DF=2, R^2=0.09, p=0.03), allostatic load (B=0.33, p=0.02) was a significant predictor while SES was not (B=−0.24, p=0.40). In the model predicting diabetes (χ^2=15.44, DF=3, R^2=0.26, p<0.001), allostatic load (B=−0.50, p<0.01) was a significant predictor while SES (B=0.27, p=0.53) and sex (B=0.77, p=0.07) were not. In the model predicting neurocognitive functioning (F(2,78)=6.21, R^2=0.14, p<0.001), both SES (B=0.81, p=0.02) and allostatic load (B=−0.62, p=0.04) were significant predictors.

A follow-up mediation model was conducted to examine the mediating role of allostatic load in the association between SES and neurocognitive functioning among African American PLWH using the PROCESS procedure for SPSS with 95% percentile confidence intervals (CIs) and 2000 bootstrap samples. The indirect effect is considered significant if the CI does not include zero[57]. As seen Figure 2, the direct effect of SES on neurocognitive functioning was significant (B=1.12, SE=0.41, p=0.008). Further, SES was significantly associated with allostatic load (B=−0.31, SE=0.15, p=0.046) and allostatic load in turn was significantly associated with neurocognitive functioning (B=−0.63, SE=0.29, p=0.035). Importantly, the indirect effect of SES on neurocognitive functioning through allostatic load was significant, suggesting mediation (B=0.19, SE=0.12, 95% CI [.002, .485]).

Discussion

The current study is the first to examine correlates of allostatic load in older PLWH. We found that PLWH had worse values than seronegative controls on several individual components of allostatic load, however none of these associations were statistically significant. Nonetheless, small-to-medium effect sizes in the expected direction were found for TNF-alpha, IL-6, HDL cholesterol, and trigylcerides. When further exploring correlates of allostatic load in PLWH, we found several interesting univariate associations between allostatic load and potential precursors as well as outcomes within African American PLWH. Higher allostatic load was associated with lower physical activity, lower resilience, poorer neurocognitive functioning (both global functioning and speed of information processing), greater BADL impairment, and greater likelihood of diabetes in African American PLWH. Surprisingly, we did not find significant associations with age and allostatic load, which may have been due to the age 50+ cutoff truncating the age range of the sample. While our low number of white participants (n=15) limited our ability to adequately examine racial differences in associations, the robust associations within the African American subsample supports prior literature on the particularly deleterious effects of allostatic load in this racial minority group. Interestingly, our African American and white HIV+ subjects did not differ on SES or on allostatic load itself, but again, the small number of whites in the sample may have limited the ability to detect differences. Yet, this highlights that other complex factors and stressors associated with being in a racial minority group compounded with being HIV+ may make these individuals more vulnerable to allostatic load effects, above and beyond low SES. Unfortunately we did not have data on these nuanced mechanisms (e.g., stigma, adverse childhood experiences, stress).

Nonetheless, these findings have important implications for PLWH, particularly African Americans, who are currently the most HIV-affected population in the United States. While our findings are limited by the cross-sectional design, our data support prior work suggesting that physical activity and psychological resilience are protective for promoting lower allostatic load[58–60]. However findings may be bidirectional, particularly for physical activity, such that more physical activity has downstream effects on lowering allostatic load, and the better physical functioning associated with lower allostatic load may increase the likelihood and ability to exercise. The association with higher psychological resilience and lower allostatic load was particularly interesting, as it supports theories such as the transacational model of stress and coping[61], in that those with higher resilience appraise stressful events as

less threatening (and that they have resources to handle them), and thus are less affected by these stressors[62].

Regarding functional outcomes, allostatic load was associated with poorer neurocognitive functioning and BADL complaints as well as diabetes status, above and beyond SES, which is consistent with prior work[19,63,64]. Importantly, and in line with other studies on allostatic load and weathering theories, allostatic load mediated the association between SES and neurocognitive functioning, suggesting that allostatic load is one of the pathways whereby low SES negatively impacts brain health throughout the lifespan, presumably via the negative experiences of low SES contexts (e.g., of stressful and adverse events, health behaviors). While we did not have nuanced data to examine these underlying mechanisms, this findings warrant further investigation in larger samples with historical data.

As mentioned, limitations of the current study include a small sample size and low power to detect racial differences. The cross-sectional design also limited conclusions regarding temporality of the associations. Further, although a comprehensive panel of markers were included in our composite, and while blood was drawn in the morning, participants were not instructed to fast, which may have influenced the values for some of the markers. While allostatic load measurement varies widely across studies, in terms of markers included and approach to calculation[21,22], with no consensus approach, and while we did have the core components, we did not have some of the commonly used markers, including hemoglobin A1C and heart rate variability. Another important limitation was our lack of measures tapping into stressors, including adverse childhood experiences, stigma and discrimination, and stressful life events. While we did have current education and income data to yield an SES composite, more nuanced data on childhood income and highest occupation held would have tapped more into lifetime SES. In addition to a need for assessing other variables (e.g., stress), future studies would benefit from objective and ecologically valid measurements of psychological and behavioral variables in future studies. For example, experience sampling method would offer an approach to capture such variables in real-time over a longer time period. Another limitation of this study is that while we did have urine toxicology data for the day of the study visit, we did not have nuanced data for substance use diagnoses, and thus were unable assess how alcohol and drug use and abuse might affect allostatic load and associations with allostatic load. Finally, given that a majority (95%) of our HIV+ sample was currently prescribed antiretroviral therapy, this limited our ability to explore whether treatment status influenced allostatic load, as well as associations between allostatic load and study variables. Indeed, treatment status and regimen may modulate biomarker levels in PLWH[65].

This study demonstrates that allostatic load may be a useful clinical tool in predicting risk for poorer outcomes among PLWH, particularly development of vascular comorbidities as well as cognitive and functional impairment. This index will be particularly important to examine as the population of PLWH continues to age. Future studies are needed using longitudinal design in larger diverse samples to better understand factors that alter allostatic load over time as well as the temporal effect of allostatic on poorer endpoints in PLWH. Furthermore, such future work should include examination of factors that may be particularly impactful to biological stress responses in PLWH, including, stigma, adverse

childhood experiences, and stressful life events. Lastly, given that there is no gold-standard for measurement of allostatic load, future studies are warranted to determine the optimal set of markers to include, with a goal of yielding the minimum set of markers needed to provide useful predictive value.

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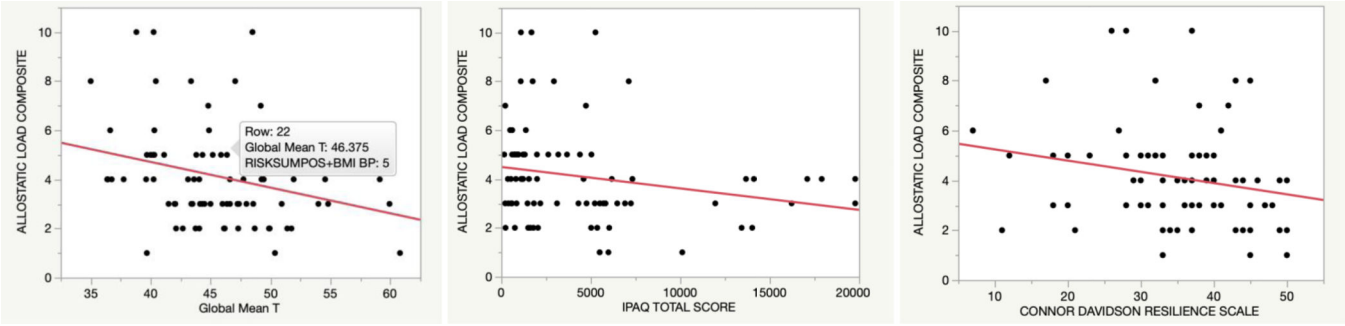

Figure 1.

Scatterplots for associations between allostatic load composite and significant correlates within HIV+ African American Subsample

Note. IPAQ=International Physical Activity Questionnaire

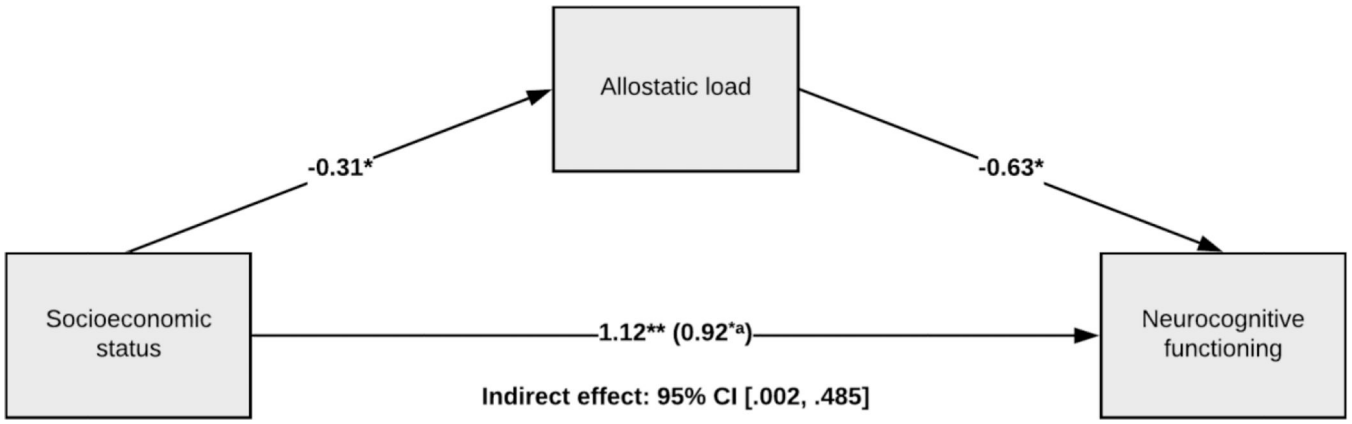

Figure 2.
Mediation Model. *p < .05, **p < .01. [a]When allostatic load is in the model

Table 1.

Descriptive statistics for all study variables for the HIV+ sample (N=96)

Variable	M (SD) or %	Range
Sociodemographics		
Age	55.81 (5.06)	50–73
Sex (% Men)	68%	n/a
Race (% African American)	84%	n/a
Education (years)	12.60 (2.21)	8–20
Income (% with annual income ≤$20,000)	85%	n/a
Primary HIV Risk Factor		
Men who have sex with men	38%	n/a
Heterosexual sex	48%	
Intravenous drug use	14%	
Clinical Variables		
Estimated Duration of Infection (years)	18.00 (8.80)	1–33
Current CD4[a] (Median [IQR])	600 (338.00–858.00)	26–1561
Nadir CD4[b] (Median [IQR])	142.5 (19.75–373.00)	2–1131
Plasma Viral Load[c] (% undetectable)	60%	n/a
Currently Prescribed Antiretroviral Therapy[d]	95%	n/a
Diabetes[e] (% with)	17%	n/a
Hypertension[e] (% with)	62%	n/a
Urine toxicology[f] (% positive for illicit drugs)	30%	n/a
Allostatic Load Sum	4.21 (2.01)	1–10
Psychological Variables		
Depression Score	17.99 (10.92)	2–49
Connor Davidson Resilience Scale	34.90 (9.54)	7–50
Health Behaviors		
Physical Activity Score (Median [IQR])	2024 [998.25–6018.75)	165–46,350
MIND Diet Score	6.78 (2.14)	2–12

Variable	M (SD) or %	Range
Sleep Quality Index[g]	8.24 (4.19)	1–17
Functional Outcomes		
Instrumental Activity of Daily Living Complaints	1.49 (2.16)	0–10
Basic Activity of Daily Living Complaints[e]	0.27 (0.61)	0–4
Global Cognitive T-Score	45.24 (5.55)	31.06–60.61
Global Neurocognitive Impairment (% with)	54%	n/a

[a] n=71

[b] n=88

[c] n=83

[d] n=91

[e] n=95

[f] n=94, substances include amphetamines, methamphetamine, opiates, and cocaine

[g] n=85.

Table 2.

Demographic and clinical characteristics of the HIV-negative controls (N=75)

Variable	M (SD) or %	Range
Sociodemographics		
Age	60.61 (7.37)	50–79
Sex (% Men)	45%	n/a
Race (% African American)	61%	n/a
Education (years)	13.96 (2.48)	8–20
Income (% with annual income ≤$20,000)	45%	n/a
Clinical Variables		
Diabetes (% with)	17%	n/a
Hypertension (% with)	60%	n/a
Urine toxicology[a] (% positive for illicit drugs)	19%	n/a

[a] n=63, substances include amphetamines, methamphetamine, opiates, and cocaine.

Table 3.

Means, standard deviations, and serostatus differences on individual serum allostatic load components

Marker	HIV+ (n=101)	N	HIV- (n=75)	N	t-statistic	p	d
Neuroendocrine							
Cortisol (ug/dL)	10.64 (4.81)	101	10.31 (3.53)	75	0.51	0.61	0.08
DHEA (ug/dL)	98.73 (67.16)	101	115.65 (120.64)	75	−1.84	0.24	0.17
Immune/Inflammatory							
IL-6 (pg/mL)	2.94 (9.68)	101	1.50 (1.68)	75	1.27	0.21	0.21
TNF-alpha (pg/mL)	3.72 (3.60)	101	2.68 (0.88)	75	2.44	0.02	0.40
C-Reactive Protein (mg/L)	6.71 (17.85)	101	4.21 (5.72)	75	1.17	0.24	0.19
Metabolic							
Glucose (mg/dL)	118.00 (51.49)	101	116.23 (58.22)	75	0.21	0.83	0.04
Total Cholesterol (mg/dL)	189.45 (58.02)	101	197.87 (54.61)	75	−0.98	0.33	0.15
HDL (mg/dL)	60.49 (19.78)	101	65.91 (17.89)	75	−1.87	0.06	0.29
Triglycerides (mg/dL)	170.33 (140.21)	101	134.59 (87.62)	75	1.94	0.05	0.31
Albumin (g/dL)	4.39 (0.27)	101	4.37 (0.27)	75	0.54	0.59	0.07
Cardiovascular							
Systolic Blood Pressure	127.69 (17.04)	96	NA	NA		NA	
Diastolic Blood Pressure	79.58 (8.92)	96	NA	NA		NA	
Anthropomorphic			NA	NA		NA	
Body Mass Index	27.89 (7.17)	97	NA	NA		NA	

J Acquir Immune Defic Syndr. Author manuscript; available in PMC 2021 April 15.

Table 4.

Spearman's rho correlations between allostatic load individual markers and composite and other study variables in HIV+ African Americans

Variable	Age	SES	EDI	Current CD4	Nadir	CESD	CDRS	MIND Diet	IPAQ	PSQI	IADL	BADL	Global T
AL Composite	−0.05	−0.13	−0.08	−0.11	−0.11	0.12	**−0.27** *	−0.18	**−0.29** **	−0.11	0.12	**0.26** *	**−0.26** *
Cortisol	0.00	−0.08	−0.09	−0.10	−0.10	−0.18	0.10	−0.12	0.05	−0.18	−0.08	0.01	−0.03
DHEA	−0.14	0.19	−0.05	−0.14	−0.01	−0.07	0.13	**0.26** *	**0.23** *	−0.13	−0.04	−0.05	0.04
IL-6	−0.09	0.08	0.02	−0.06	−0.20	0.15	−0.16	0.03	0.01	−0.03	−0.05	0.00	−0.20
TNF-alpha	−0.12	−0.01	0.07	**−0.24** *	−0.05	−0.08	−0.15	−0.13	−0.13	**−0.28** *	−0.02	0.04	−0.18
CRP	−0.12	−0.03	−0.02	−0.05	0.05	**0.23** *	**−0.27** *	0.10	−0.01	−0.08	0.08	0.09	−0.16
Glucose	0.05	−0.12	−0.09	0.21	0.17	−0.06	−0.17	−0.09	−0.16	0.07	0.08	0.12	−0.12
Total Cholesterol	−0.12	0.02	0.03	−0.07	−0.05	0.07	−0.00	−0.03	−0.11	0.00	0.11	0.09	−0.05
HDL	−0.13	0.02	−0.14	0.07	−0.16	−0.04	0.14	−0.02	−0.04	0.11	0.14	0.06	0.02
Triglycerides	−0.02	−0.05	0.00	0.02	0.07	−0.01	−0.04	0.01	−0.13	−0.10	−0.01	**0.23** *	−0.07
Albumin	0.07	0.06	0.02	−0.07	−0.07	0.05	0.02	0.05	**−0.27** *	0.03	0.01	−0.02	0.00
Systolic BP	**0.26** *	0.12	0.05	**−0.28** *	−0.07	−0.04	−0.04	0.02	**−0.37** **	−0.08	0.14	0.12	−0.03
Diastolic BP	0.08	0.07	−0.17	**−0.29** *	−0.02	−0.01	−0.00	−0.11	**−0.33** **	−0.05	0.13	0.18	−0.02
BMI	−0.03	0.19	−0.07	**0.27** *	0.20	−0.01	0.02	0.17	−0.07	0.02	0.04	0.13	0.16

Note. AL=allostatic load, DHEA=dehydroepiandrosterone, IL-6=interleukin 6, TNF-alpha=tumor necrosis factor-alpha, CRP=C-reactive protein, BP=blood pressure, BMI=body mass index, SES=socioeconomic status, EDI=estimated duration of infection, CESD=Centers for Epidemiologic Studies Depression Score, CDRS=Connor Davidson Resilience Scale, IPAQ=International Physical Activity Questionnare, PSQI=Pittsburg Sleep Quality Index, IADL=instrumental activities of daily living complaints, BADL=basic activities of daily living complaints, Global T=global cognitive functioning T-score.

N=81 for AL composite, 84 for AL individual blood markers, 81 for blood pressure, and 82 for BMI.

* $p<0.05$

** $p<0.01$.