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Psychological grit moderates the relation between lifetime stressor exposure and functional outcomes among HIV-seropositive and HIV-seronegative adults

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Abstract

The ability to maintain functional independence throughout the lifespan may be diminished among medically compromised and chronically stressed populations. People living with HIV are more likely to demonstrate functional impairment and report greater exposure to lifetime and chronic stressors than their seronegative counterparts. It is well-known that exposure to stressors and adversity is associated with functional impairment outcomes. However, to our knowledge, no studies have examined how protective factors such as psychological grit mitigate the negative effects of lifetime and chronic stressor exposure on functional impairment, and how this association differs by HIV-status. To address this issue, we studied associations between lifetime and chronic stressor exposure, grit, and functional impairment in 176 African American and non-Hispanic White HIV-seropositive ($n = 100$) and HIV-seronegative ($n = 76$) adults, aged 24–85 ($M = 57.28$, $SD = 9.02$). As hypothesised, HIV-seropositive status and lower grit, but not lifetime stressor exposure, were independently associated with more functional impairment. Moreover, there was a significant three-way interaction between HIV-status, grit, and lifetime stressor exposure, $b = 0.07$, $p = 0.025$, 95% CI [0.009, 0.135]. Specifically, lifetime stressor exposure was related to more functional impairment for HIV-seronegative—but not HIV-seropositive—adults who reported low levels of grit. These findings suggest that the protective effects of grit may differ across populations at risk for functional impairment.

Keywords

functional impairment; functional outcomes; grit; HIV; lifetime stress

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CONFLICT OF INTEREST STATEMENT

We have no conflicts of interest to disclose.

1 | INTRODUCTION

Loss of functional independence throughout the lifespan is of clinical importance as it is an indicator of potential disability, loss of independence, and mortality (Ustün & Kennedy, 2009). Functional impairment is described by the Diagnostic and Statistical Manual for Mental Disorders, Fifth-Edition (DSM-5) as the degree of dysfunction (mild, moderate, or severe) in social, occupational, and other domains of life, and is required as a separate criterion for the diagnosis of a mental disorder (American Psychiatric Association [APA], 2013). Several studies have identified populations at risk for functional impairment, including those who have been exposed to chronic adversity as well as medically compromised populations (Kornblith et al., 2020; McIntosh & Rosselli, 2012). Adults who experience chronic exposure to stressors and adversity are at risk of developing physical and psychiatric illness (e.g., depression) that can interfere with daily functioning (McLaughlin et al., 2010; Slavich & Irwin, 2014). It is well known that stressor exposure can disrupt or alter physiological homeostatic systems, such as the stress-responsive hypothalamic-pituitary-adrenal (HPA) axis (Goldman-Mellor et al., 2012; Herman et al., 2016). Consequences of chronic stressor exposure include the development of anxiety and depression, and increased risk of medical conditions that can interfere with everyday functioning (Cohen et al., 2019; Schneiderman et al., 2005; Shields & Slavich, 2017; Shrira & Litwin, 2014).

HIV status is associated with functional impairment, often measured with self-report or by observations/performance-based measures (Fazeli et al., 2020; Heaton et al., 2004; Thames et al., 2010, 2013). In middle-aged people living with HIV (PLWH), level of functional impairment was associated with many physical health issues such as low muscle mass, bone density (Erlandson et al., 2013) and increased cardiometabolic risk (Erlandson et al., 2022), despite being on stable antiretroviral medication. In HIV-seropositive men who have sex with men, mental health factors such as posttraumatic stress symptoms and depression have been found to be associated with greater functional impairment (O'Cleirigh et al., 2009). Furthermore, studies have found that PLWH report more extensive trauma histories, and experience a number of adversities including financial strain, food insecurity, and stigma more so than the general population, which may explain higher reports of stress and poor clinical outcomes (e.g., cognitive and functional impairment) among this group (Thames et al., 2018; Watson et al., 2019). Recent research by López-Matos et al. (2021) examined the association between stress and level of functional impairment in sexual minority men with HIV, demonstrating a distinction between recent general stress and recent HIV-related stress and that both predicted functional impairment. This finding shows that PLWH experience unique stressors due to their HIV-status and that these stressors are associated with level of functional impairment. It is necessary to further examine the interactive effect of stress and HIV-status alongside other psychological factors that may further modify this association, as the impact of grit remains unknown.

Cognitive ability/status is another pathway that might explain vulnerability to functional impairment, particularly in the context of HIV-infection (Heaton et al., 2004). Although not a primary aim of this study, cognitive ability/status must be considered when examining functional impairment, therefore an estimate of cognitive ability was measured (i.e., premorbid IQ), and used as a covariate in primary analyses. As for acute and chronic

stressor exposure, it is challenging to accurately assess exposure to these stressors, as many inventories do so by focussing on stressors occurring over very brief periods of time (e.g., past month or year; Slavich & Shields, 2018). To address this shortcoming, Slavich developed the Stress and Adversity Inventory for Adults (STRAIN), which is designed to assess the severity, frequency, exposure timing, and duration of different types of stressors occurring over the entire life course. This inventory has been used in a variety of both non-clinical populations, such as healthy adults and adolescents (Slavich & Shields, 2018), and clinical populations, such as adolescents who have attempted suicide (Stewart et al., 2019). However, it is unclear how divergent amounts of lifetime or chronic stressors may impact PLWH and healthy controls differently. To our knowledge, the present study is the first to use the STRAIN in an HIV-seropositive cohort.

1.1 | Grit as a potential protective factor

Research of medical and psychiatric outcomes has increasingly considered the role of protective factors. Grit is one such protective factor that was first introduced by Duckworth et al. (2007) as a potential measure to explain achieving success beyond intelligence and other personality variables. Duckworth and colleagues described grit as the ability to persevere despite obstacles, maintain focus on longterm goals, and see difficult tasks through to completion. Higher levels of grit have been associated with better mental health well-being (Kannangara et al., 2018), better health management (Sharkey et al., 2017), and less suicidal ideation (Marie et al., 2019) among undergraduate students. In clinical populations, higher grit has been associated with lower reports of functional impairment and depression in veterans with a history of mental illness (Umucu et al., 2021). Among adults with substance use disorder, lower grit has been associated with more heroin use and the presence of co-occurring psychiatric disorders (e.g., depressive disorders, posttraumatic stress disorder; Griffin et al., 2016).

Grit also acts as a protective psychosocial factor among PLWH. In a sample of middle-aged adults, higher grit was associated with a reduced risk of frailty while controlling for age, HIV-status, smoking, hypertension, and hyperlipidemia (Rubtsova et al., 2018). Subsequent factor analyses indicated that the factor “Positive Resources/Outlook” (large loadings on grit, optimism, etc.) reduced the likelihood of experiencing frailty for PLWH, but not controls. A study by Moore et al. (2018) found that perseverance of effort, which is a component of grit, and ambition was found to be associated with better cognitive performance and everyday functioning among PLWH. Lastly, Rooney et al. (2019) found that grit was negatively associated with depressive symptoms and positively associated with health-related quality of life in PLWH. Specifically, it was found that PLWH who did not have depressive symptoms scored the highest on positive psychology measures (e.g., grit and resilience), whereas PLWH who did have depressive symptoms scored the lowest. Although these studies demonstrate that grit protects against many negative physical and psychological outcomes in the general population and in PLWH, whether grit moderates the association between lifetime stressor exposure and functional impairment remains unknown.

1.2 | The present study

The present study sought to expand upon prior research by examining how HIV-status and grit moderate the association between lifetime and chronic stressor exposure with level of impairment in functional outcomes. Although grit has been shown to protect against adverse outcomes, the degree to which grit protects against functional outcomes in the context of lifetime stress exposure remains unclear. Additionally, identifying modifying factors to the stress-functional outcome association is important to better understand clinical prognosis and potential intervention targets. Based on the research described above, we hypothesised that: (a) greater lifetime stressor exposure, HIV-seropositivity status, and lower grit would be independently associated with functional impairment, and (b) the association between lifetime stressor exposure and functional impairment would be moderated by HIV-status and grit. A secondary analysis examined the association of acute versus chronic stressor exposure on functional impairment, and the moderating roles of HIV status and grit in predicting functional impairment.

2 | METHOD

2.1 | Participants and procedures

Participants were 176 HIV-seropositive (PLWH; $n = 76$) and HIV-seronegative (HIV−; $n = 100$) adults (age range 24–85) who were part of a larger study examining lifetime stressor exposure and cognitive aging in PLWH. All procedures were approved by the University of Southern California and University of California, Los Angeles Institutional Review Boards. Participants were recruited from HIV clinics, community advertisements and social networks (e.g., friends) in the Greater Los Angeles area. Of the 176 participants, 107 identified as being African-American/Black and 69 identified as being Non-Hispanic White (see Table 1). All participants provided written, informed consent prior to completing any study-related procedures. Participants were carefully screened for any medical, neurological or psychiatric confounds and were excluded from the study if they met any of the following criteria: (1) current/past diagnosis of a psychotic spectrum disorder (e.g., schizophrenia) or mood disorder with psychotic features (assessed using a modified structured clinical interview for DSM-IV [SCID]; Spitzer et al., 1995); (2) positive urine toxicology (assessed using the Integrated E-Z Split Key; Innovacon, Inc.) or current abuse/dependence of cocaine, amphetamines, hallucinogens, methadone, methamphetamine, buprenorphine, benzodiazepines, barbiturates, phencyclidine (PCP), and/or oxycodone (assessed using the SCID); (3) history of a neurological condition/injury (i.e., head injury with a loss of consciousness or central nervous system opportunistic infection); and (4) a score of <26 on the Mini-Mental Status Exam (MMSE; Folstein et al., 1975).

2.2 | Measures

2.2.1 | HIV status—HIV status was measured by ELISA and confirmed by Western blot. For HIV-seropositive participants, nadir CD4+, highest plasma viral load, and duration of known HIV disease were collected using self-report questionnaires. In addition to self-report immunological status, blood draws were also completed as part of the larger study to assess for current plasma CD4+ and plasma viral load.

2.2.2 | Lifetime and chronic stressor exposure—Lifetime and chronic stressor exposure were assessed using the STRAIN for Adults (Slavich & Shields, 2018). The STRAIN is an online instrument that assesses the severity, frequency, exposure timing, and duration of 55 acute and chronic stressors that could have occurred over an individual's lifetime (see https://www.strainsetup.com). The STRAIN uses branching logic to ask about the specific characteristics of each stressors experienced. Individuals rate stressor severity on a 5-point Likert scale ranging from 1 (*Very slightly or not at all*) to 5 (*Extremely*). The STRAIN includes questions about stressors in 12 life domains including: housing, education, work, treatment/health, reproduction, financial, legal/crime, relationships (marital and others), death, life-threatening situations and possessions. The STRAIN has demonstrated excellent test-retest reliability as well as concurrent and discriminant validity (Slavich & Shields, 2018). The STRAIN has also shown predictive validity in relation to numerous cognitive and health outcomes in both healthy and clinical samples (Banica et al., 2020; Cazassa et al., 2020; Pegg et al., 2019; Shields et al., 2019). The present study focussed on total lifetime stressor exposure (e.g., total stressor count; M = 30.79, SD = 17.84, range: 1–97). We used the total stressor count because it encompasses both acute and chronic stressors, and provides a more holistic view of stressors experienced over the life course. For our secondary analysis, we used total count of lifetime chronic stressor exposure (M = 10.57, SD = 6.68, range: 0–32) and total count of lifetime acute stressor exposure (M = 20.22, SD = 12.13, range: 1–65).

2.2.3 | Grit—The Short Grit Scale has been used and validated in a wide range of samples (Duckworth & Quinn, 2009) including PLWH (Moore et al., 2018), and is a 12-item, positive, psychosocial questionnaire that measures an individual's perseverance and passion for longterm goals. The Grit Scale has two subscales: (1) Consistency of Interest (6-items) and, (2) Perseverance of Effort (6-items). Participants rate statements on a 5-point Likert scale ranging from 1 (*Very much like me*) to 5 (*Not like me at all*), with higher scores indicating higher self-reported grit. Average grit was used and is reported (M = 3.59, SD = 0.56, range: 1.67–5.00, α = 0.730).

2.2.4 | Functional impairment—The Barkley Functional Impairment Scale (BFIS; Barkley, 2011) is a 15-item scale used to measure impairment in 15 specified psychosocial and physical domains: home life; work; social interactions; relationships with friends; chores and household tasks; community activities; educational activities; romantic relationships; sexual activities; management of finances; driving; organising daily responsibilities; parenting; maintaining health (e.g., exercise, nutrition); and daily care (e.g., dressing, bathing). This scale has been used in a wide range of samples, including HIV-seropositive individuals (Thames et al., 2021) with high validity and test-retest reliability (Barkley, 2011). Participants rate their perceived difficulty in performing these domain-related tasks on a 10-point Likert scale that ranges from 0 (*Not at all*) to 9 (*Severe*) or 999 (*Not Applicable*). Items were averaged (i.e., Total score/Number of items answered excluding non-applicable answers) to produce a mean impairment score with higher mean scores indicative of higher functional impairment across the 15 domains (M = 1.63, SD = 1.99, range: 0–7.43, α = 0.971).

2.3 | Covariates

Demographic, psychological, and clinical variables were assessed as potential covariates by examining if they differed by HIV-status (see Table 1) and if they were correlated with functional impairment (see Table 2). The demographic characteristics assessed included items such as age, education, premorbid IQ, current socioeconomic status, gender and race/ethnicity. Current socioeconomic status (SES) was measured using the Hollingshead Four Factor Index Socioeconomic Status (Hollingshead, 1975). Clinical characteristics assessed included depressive symptoms as well as past and current substance abuse or dependence.

Premorbid Intelligence Quotient (IQ).—Considering that cognitive ability is a strong predictor of functional outcomes, we estimated premorbid IQ using The Wide Range Achievement Test 4th Edition (WRAT-4) Reading Subtest (Wilkinson & Robertson, 2006). The WRAT-4 Reading Subtest is a 70-item reading test comprising 15 letters and 55 words. Participants are instructed to read the words aloud until they meet discontinuation criteria (i.e., mispronouncing or unfamiliarity with 10 or more words in a row) or complete the list. Raw scores were entered as a covariate (M = 59.82, SD = 7.36, range: 33–70). Scores on the WRAT-4 did not differ significantly by HIV-status (see Table 1), yet were significantly correlated with functional impairment (see Table 2), and used as a covariate in subsequent analyses. The WRAT-4 Reading Subtest has been used to predict premorbid intellectual functioning among PLWH (Casaletto et al., 2014).

Depressive Symptoms.—Depressive symptoms were assessed as a possible covariate due to the high rates of depression in HIV-seropositive populations as compared to HIV-seronegative populations (Rooney et al., 2019; Williamson et al., 2017). Current depressive symptoms were assessed using the Beck's Depression Inventory, 2nd Edition (BDI-II; Beck et al., 1996). The 21-item BDI-II assesses cognitive, affective, and somatic symptoms of depression (e.g., sleep disturbance) during the past 2 weeks. Participants rate symptoms within the past two weeks on a scale from 0 to 3 with higher total BDI-II scores (M = 5.74, SD = 7.47, range: 0–39, α = 0.93) indicative of more depressive symptoms. Depressive symptoms differed significantly by HIV-status (see Table 1) and was significantly correlated with functional impairment (see Table 2), therefore retained as a covariate. The BDI-II has demonstrated excellent validity and reliability and has been used to assess current depressive symptoms in non-clinical and PLWH (Berger-Greenstein et al., 2007).

Substance Use.—Substance use, which includes past and current abuse or dependence, was assessed as a potential covariate to rule out their effect on daily functioning. Substance use evaluated obtained using the modified structured clinical interview for DSM-IV (SCID; Spitzer et al., 1995) in which participants were asked to endorse use of drugs or alcohol within the last 12 months (current abuse or dependence) or prior to the last 12 months (past abuse or dependence). This SCID assessed for abuse or dependence of alcohol, marijuana, cocaine, stimulants, opiates, hallucinogens, and/or sedatives. Participants who met abuse or dependence criteria received a score of “1” whereas a score of “0” indicated the participant did not meet criteria for past or current substance abuse or dependence. Past substance abuse differed significantly by HIV status (see Table 1) and was significantly correlated with functional impairment (see Table 2), and was therefore retained as a covariate.

2.4 | Analytic plan

All statistical analyses were conducted using IBM SPSS Statistical Software (version 27). Prior to conducting any statistical analyses, normality and model assumptions were checked to identify any potential outliers. Total lifetime stressor count, grit, and level of functional impairment were treated as continuous variables, whereas HIV-status was dummy-coded as "0" HIV-seronegative and "1" HIV-seropositive. We then completed a series of preliminary analyses.

First, we assessed for HIV-status group differences in demographic, clinical and psychosocial characteristics. These were assessed using independent samples *t*-tests and chi-squared tests of independence. Second, we assessed for potential covariates of functional impairment by using independent samples *t*-tests and bivariate Pearson's correlations. Demographic, clinical and psychosocial characteristic variables (e.g., gender) that differed between the HIV-status groups were also tested as potential covariates.

Finally, a multiple regression analysis was used to determine whether HIV-status and grit score moderated the association between total lifetime stressor count and level of functional impairment. Two secondary analyses were also conducted with the same statistical model, with (1) total lifetime chronic stressor count and (2) total lifetime acute stressor count as predictors. Premorbid IQ, depressive symptoms, and past substance dependence were entered as covariates into a bootstrap moderation analysis with 5000 simulated samples (n = 176; using SPSS PROCESS v3.5 Model 3; Hayes, 2009) to examine the moderating roles of HIV-status and grit on the association between stressor exposure and functional impairment.

3 | RESULTS

3.1 | Preliminary analyses

As shown in Table 2, HIV status, total lifetime stressor count, total chronic stressor count, total acute stressor count and grit were all associated with functional impairment at the bivariate level (all ps < 0.001). We found that the HIV-status groups significantly differed in terms of total lifetime stressor count, $t(174) = 2.76$, $p = 0.006$, total acute stressor count, $t(174) = -3.32$, $p = 0.001$, functional impairment, $t(174) = 3.16$, $p = 0.002$, gender, $\chi^2(2) = 10.03$, $p = 0.007$, depressive symptoms, $t(174) = -2.51$, $p = 0.013$, past substance dependence, $\chi^2(1) = 23.44$, $p < 0.001$, and past substance abuse, $\chi^2(1) = 7.93$, $p = 0.005$; see Table 1. There were no significant HIV-status group differences with respect to total chronic stressor count, age, education (years), socioeconomic status (SES), premorbid IQ, grit, current positive toxicology screening, and current substance abuse (all ps > 0.10).

Given that past substance dependence differed between the HIV-status groups and was associated with functional impairment, $r(176) = 0.21$, $p = 0.004$, as well as total lifetime, $r(176) = 0.30$, $p < 0.001$, total chronic stressor, $r(176) = 0.22$, $p = 0.004$, and total acute stressor count, $r(176) = 0.32$, $p < 0.001$, we retained past substance dependence as a covariate. Similarly, we found statistically significant associations between depressive symptoms, $r(176) = 0.46$, $p < 0.001$, and functional impairment, as well as statistically significant associations between depressive symptoms with total lifetime, $r(176) = 0.32$, $p < 0.001$, total chronic, $r(176) = 0.29$, $p < 0.001$, and total acute stressor count, $r(176) =$

0.31, $p < 0.001$. Therefore, depressive symptoms were also included as a covariate in tests of study hypotheses (see Table 2). Although Premorbid IQ was not significantly associated with total lifetime, $r(176) = 0.12$, $p = 0.130$, or acute stressor count, $r(176) = 0.06$, $p = 0.447$, it was significantly associated with both total chronic stressor count, $r(176) = 0.20$, $p = 0.007$, and functional impairment, $r(176) = -0.20$, $p = 0.007$. Therefore, it was included as a covariate. Although past substance abuse was correlated with functional impairment, $r(176) = 0.186$, $p = 0.013$, considering that most participants who met criteria for abuse also met criteria for dependence, we retained past dependence as a covariate to minimise redundancy. Gender was not significantly associated with level of functional impairment and was not included as a covariate, $r(176) = 0.008$, $p = 0.920$.

3.2 | Test of study hypotheses

In the primary analysis, there was a significant association between HIV-seropositive status and level of functional impairment ($b = 0.62$, $p = 0.028$), and a significant association between grit and level of functional impairment ($b = -0.82$, $p = 0.005$), but no significant association between total lifetime stressor count and level of functional impairment ($b = 0.02$, $p = 0.180$). However, these main effects were qualified by a significant three-way interaction between total lifetime stressor count, HIV-seropositive status, and grit in predicting level of functional impairment, $R^2 = 0.02$, $F(1,165) = 5.06$, $b = 0.07$, $p = 0.026$, 95% CI [0.009, 0.135].

The three-way interaction was interpreted by conducting simple two-way interactions to determine if HIV-status moderated the association between total lifetime stressor count and level of functional impairment at low, mean, and high levels of grit. These results revealed that HIV-status moderated the association between total lifetime stressor count and level of functional impairment for participants reporting low levels of grit ($b = -0.05$, $p = 0.016$). Specifically, for HIV-seronegative individuals who reported low levels of grit, greater total lifetime stressor count was related to more functional impairment ($b = 0.02$, $p = 0.048$), whereas this association was not significant for HIV-seropositive individuals reporting low levels of grit ($b = -0.03$, $p = 0.117$). Moreover, the moderating effect of HIV-status on the association between total lifetime stressor count and functional impairment was not found for HIV-seropositive or HIV-seronegative participants at either the mean ($b = -0.01$, $p = 0.434$) or high ($b = 0.03$, $p = 0.266$) levels of grit (see Figure 1).

3.3 | Secondary analysis: Chronic and acute stressor exposure

Similar to our findings on total lifetime stressor count, there was a significant a three-way interaction between total lifetime chronic stressor count, HIV-seropositive status, and grit on level of functional impairment, $R^2 = 0.02$, $F(1,165) = 4.68$, $b = 0.17$, $p = 0.032$, 95% CI [0.015, 0.334]. The three-way interaction was interpreted by conducting simple two-way interactions to determine if HIV-status moderated the association between total chronic stressor count and level of functional impairment at low, mean, and high levels of grit. The results indicated that HIV-status moderated the association between total chronic stressor count and level of functional impairment at low levels of grit ($b = -0.16$, $p = 0.005$). Specifically, for HIV-seronegative individuals who reported low levels of grit, greater total chronic stressor count was related to more functional impairment ($b = 0.08$, $p = 0.028$),

whereas this association was not found for HIV-seropositive individuals at low levels of grit ($b = -0.08$, $p = 0.069$). The moderating effect of HIV status on the association between total chronic stressor count and functional impairment was not found for HIV-seropositive or HIV-seronegative participants at either the mean ($b = -0.06$, $p = 0.101$) or high ($b = 0.03$, $p = 0.586$) levels of grit (see Figure 2).

A significant three-way interaction between total lifetime acute stressor count, HIV-seropositive status, and grit on level of functional impairment was also found, $R^2 = 0.02$, $F(1,165) = 4.47$, $b = 0.10$, $p = 0.036$, 95% CI [0.007, 0.191]. The three-way interaction was interpreted by conducting simple two-way interactions to determine if HIV-status moderates the association between total lifetime acute stressor count and level of functional impairment at low, mean, and high levels of grit. HIV status, however, did not moderate the association between total lifetime acute stressor count and functional impairment at low ($b = -0.06$, $p = 0.053$), mean ($b = -0.01$, $p = 0.871$), or high ($b = 0.05$, $p = 0.187$) levels of grit (see Figure 3). Although the three-way interaction was significant, the subsequent two-way interactions were non-significant; therefore, no additional simple slope analyses were conducted.

4 | DISCUSSION

Although the ability to maintain functional independence throughout the lifespan is known to be impaired in HIV-seropositive populations, the role that lifetime stressor exposure plays in this association remains unknown. We know of no studies that have examined how protective factors, such as psychological grit, might mitigate the negative effects of lifetime and chronic stressor exposure on functional impairment in individuals with and without HIV-infection. To address these important issues, we examined associations between HIV status, lifetime stressor exposure, and grit in predicting level of functional impairment in a well-characterised sample of HIV-seropositive and HIV-seronegative adults. As hypothesised, HIV-seropositive status and lower levels of grit were independently associated with greater functional impairment. However, lifetime stressor exposure was not independently associated with level of functional impairment. In addition, we found that HIV-status and grit significantly moderated the association between lifetime stressor exposure and level of functional impairment. For HIV-seronegative individuals, grit moderated the stressor exposure-functional impairment association as expected, insofar as there was not a significant association between stressor exposure and functional impairment for those at the mean and high levels of grit, yet there was a significant association for those reporting low levels of grit. On the other hand, grit did not moderate the stressor exposure-functional impairment association for HIV-seropositive individuals.

In secondary analysis, we examined how total lifetime chronic and acute stressor count were related to functional impairment, and whether these associations were moderated by HIV-status and/or grit. These analyses revealed that, in short, lower levels of grit and higher lifetime stressor exposure, particularly chronic stressor exposure was associated with higher functional impairment for HIV-seronegative individuals. No such association was found for the HIV-seropositive group. As for acute lifetime stressor exposure, although the three-way interaction was significant, the simple two-way interactions were not, revealing that HIV-status did not moderate the association between total lifetime acute stressor count and

level of functional impairment at any level of grit. The moderating effect of HIV-status was trending at low levels of grit (i.e., $p = 0.053$), which was in the same direction as what was found for total lifetime chronic stressor count. Therefore, this difference in results between total lifetime chronic and acute stressor counts may be an indicator that acute stressors exert less of an impact on functional impairment in the absence of chronic stressors, but additional research is needed.

Although these results are not entirely consistent with Moore et al. (2018) who found grit to be a unique predictor of better neurocognitive and everyday functioning in PLWH, the present study differed in some notable ways. Primarily, neither lifetime stressor exposure, nor acute nor chronic stressor exposure, were measured by Moore et al. (2018). Our analyses showed that lifetime, acute, and chronic stressor exposure were strongly related to functional impairment across both groups (i.e., higher count of stressor exposure was associated with higher functional impairment; see Table 2), alongside the moderating role of HIV-status and grit on the stress and functional impairment associations. These results expand upon Moore et al.'s results on the association between grit and every-day functioning in PLWH, suggesting the importance of examining grit in the context of stressor exposure's association with functional impairment, though more research is warranted.

Overall, these results showed that low levels of grit and high lifetime and chronic stressor exposure were associated with less perceived ability to perform tasks of daily living, but only for those who were HIV-seronegative. The reason for this finding may lie in the construct of grit itself. Grit was defined by Duckworth et al. (2007) as the perseverance of effort and consistency of interest in completing long term goals. Other definitions include one's ability to persevere despite obstacles, maintain focus on longterm goals, and see difficult tasks through to completion (Duckworth, et al., 2007; Duckworth & Quinn, 2009). Therefore, it is possible that individuals who have lower levels of grit and experience pervasive, chronic or lifetime stressors are less able to successfully manage, or overcome, these stressors. In other words, these individuals may be unable to persevere as well through difficult life events and, as a consequence, perceive more difficulty in daily functioning (e.g., work, household chores, social interactions, managing finances). In the case for the HIV-seronegative group, having higher levels of grit may be indirectly related to better management of stress or ability to overcome stress, stemming from experiencing adversity and life challenges. For HIV-seropositive individuals, the results suggest that grit may have a less influential impact on the association between lifetime stressor exposure and functional impairment in this group, as there was no association between lifetime or chronic stressors and functional impairment at any level of grit. Despite past literature demonstrating that HIV-seropositive individuals experience many chronic stressors unique to their HIV-seropositive status (López-Matos et al., 2021), and are at higher risk than the general population to develop functional impairment (Fazeli et al., 2020; Heaton et al., 2004; Thames et al., 2010, 2013), whether chronic stressor exposure contributes to the development of functional impairment in HIV-positive individuals remains to be determined.

The results of this study are also related to previous research on Black women living with HIV (WLWH), where experiencing recent stress and lifetime traumatic events has many negative outcomes, such as missing HIV care appointments (Chapman Lambert, Wright, et

al., 2022). Positive factors (i.e., social support and resilience) have been found to mediate the association between different dimensions of stigma (e.g., enacted stigma in the community) and patient activation (the patient's overall ability to manage a chronic condition) in Black WLWH, where these positive factors appear to buffer against the negative effects of stigma (Chapman Lambert, Fazeli, et al., 2022). Given that HIV-seropositive individuals experience stressors unique to their HIV-status (Chapman Lambert, Wright, et al., 2022; López-Matos et al., 2021), the difference in the stressor exposure and functional impairment association at low levels of grit between HIV status groups in our study may be related to the stigma the HIV-seropositive group experiences. Although lifetime and chronic stressor exposure did not predict functional impairment in the HIV-seropositive group at any level of grit, it may be that the development of functional impairment is tied specifically to stressors related to stigma, which future studies should examine. It is also possible that other psychosocial factors or variables (e.g., coping, optimism, social support) influence the stress-functional impairment association for this population. Further research is thus warranted to examine the role of other positive psychosocial characteristics in relation to stress-induced functional impairment.

4.1 | Limitations and strengths

These results are subject to some limitations. First, women were underrepresented in both HIV-status groups (76.3% of participants were male in the HIV-seropositive group and 56.77% were male in the HIV-seronegative group), potentially limiting the generalisability of these findings. Second, the instruments used included self-reported measures of stressor exposure, grit, and functional impairment. Although the STRAIN has been shown to be insensitive to self-reporting biases (Slavich & Shields, 2018), these instructions are all retrospective and can be subject to unmeasured memory or other biases. Third, this study was cross-sectional, and directionality and causality of effects cannot be determined. Fourth, cognitive functioning was not comprehensively measured, which may be a pathway through which lifetime stressor exposure impacts functional impairment. Although not a comprehensive measure of cognitive functioning, premorbid IQ was controlled for as an estimate of cognitive functioning. Finally, this study did not examine biological mechanisms such as inflammation that could have explained the link between stressor exposure and functional impairment (Furman et al., 2019).

Despite these limitations, this study has several strengths. First, this study had a relatively large sample size for its unique clinical sample (n = 176). Second, the present investigation is the first to examine if grit mitigates the negative effects of lifetime stressor exposure on functional impairment in HIV-seropositive and HIV-seronegative adults. Additionally, the stressor measure (i.e., STRAIN) is unique in that it focuses on cumulative lifetime as well as chronic and acute stressor exposure, whereas most stress measures only assess current or recent stress levels (Monroe & Slavich, 2020; Slavich, 2019). This study was also the first to utilise the STRAIN measure in an HIV-seropositive sample. Finally, although this study was racial and ethnically representative (57.9% African American/ Black in the HIV-seropositive group and 63.0% African American/ Black in the HIV-seronegative group), there may be unique racial/ ethnic differences that emerge when examining associations

between lifetime stressor exposure, grit, and functional impairment across these groups, which was not examined here.

4.2 | Implications

Considering that not all individuals exposed to major lifetime stressors will develop functional impairment, it is important to determine which psychosocial factors place individuals at risk or protect against poor functional outcomes. Prior research in PLWH has demonstrated various biological and clinical variables that contribute to functional impairment including neurocognitive status and ability and depressed mood (Fazeli et al., 2020; Heaton et al., 2004; Sadek et al., 2007), which were controlled for in the present investigation. More recent studies highlight the role of psychosocial factors such as trauma, economic hardship and stress that contribute to the development of functional impairment in PLWH (Watson et al., 2019). The present study's results have implications for considering the moderating role of grit in the lifetime stressor exposure-functional impairment association in HIV-seronegative, but not HIV-seropositive individuals. Interventions designed to reduce the adverse effects of stressor exposure, in addition to commonly prescribed medical interventions (e.g., mindfulness, cognitive behavioural therapy, antidepressants), may help to protect against the development of functional impairment and be able to live longer, healthier lives.

Although the present study has broad implications for understanding the association between lifetime stressor exposure and functional impairment, there is still much that remains unknown. First, future studies should examine the ability for grit to predict positive outcomes long-term, especially in clinical samples. For example, a longitudinal study could examine grit levels in PLWH and its ability to predict the development of functional impairment later in life. Rhodes et al. (2016) conducted a similar study finding that adolescent grit scores predicted better cognitive ability in older adults. Given that HIV-seropositive individuals experience many stressors specific to their HIV-status (e.g., stigma; Chapman Lambert, Wright, et al., 2022; López-Matos et al., 2021), future studies should examine the impact of these HIV-related stressors in relation to grit and functional impairment.

In addition, given the abovementioned limitations related to recall bias, future studies should examine the moderating effect of grit on stress-related biomarkers (e.g., anti-inflammatory cytokines, antibodies, immune cell counts; Shields et al., 2020) in PLWH. It is also necessary to further isolate stressors unique to being HIV-seropositive and how these stressors may or may not be associated with functional impairment. Finally, future studies should identify the neural correlates of grit and how this is implicated in the association between stressor exposure and functional impairment. Recent studies have found that grit is related to both increased spontaneous activity (Wang et al., 2017) and regional gray matter (Wang et al., 2018) in the dorsomedial prefrontal cortex. However, future studies need to further localise the neural basis of grit and examine its role in predicting functional impairment.

5 | CONCLUSION

In conclusion, these findings demonstrate complex associations between lifetime stressor exposure, grit, and functional impairment in individuals with and without HIV-infection. The findings of the present study are novel, demonstrating that lifetime stressor exposure in combination with low grit negatively affect a person's ability to perform everyday tasks; therefore, future studies are that are targeted at improving stress management and building grit are warranted. Specifically, interventions aimed at reducing stress should include consideration of stressors experienced over the course of one's lifetime alongside chronic stressors, as well as any unresolved issues of trauma. Although educational interventions exist for promoting constructs of grit in student populations for increasing academic performance (Sisk et al., 2018; Yeager et al., 2016), there are currently no standardized interventions for promoting grit in clinical populations.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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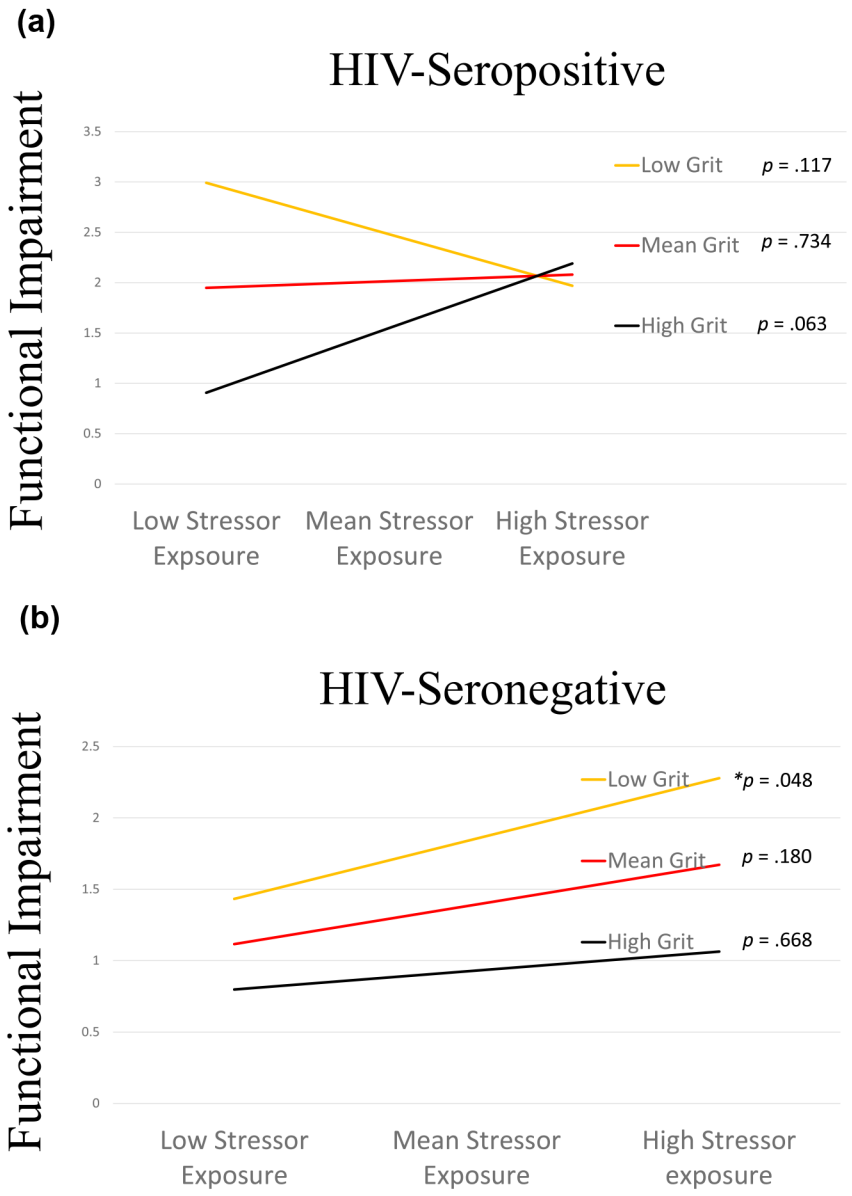

FIGURE 1.

Grit as a moderator in the association between lifetime stressor exposure and functional impairment for (a) HIV-seropositive and (b) HIV-seronegative participants.

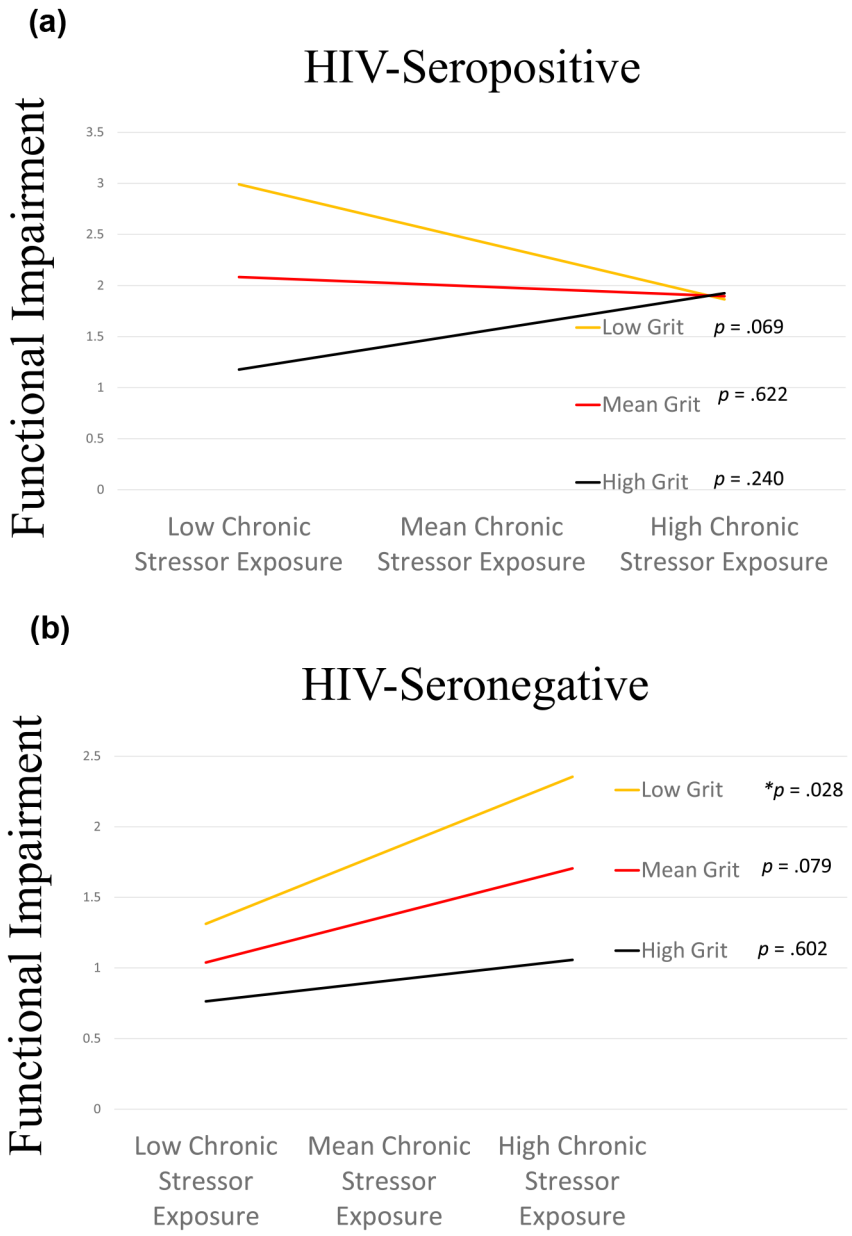

FIGURE 2.

Grit as a moderator in the association between chronic stressor exposure and functional impairment for (a) HIV-seropositive and (b) HIV-seronegative participants.

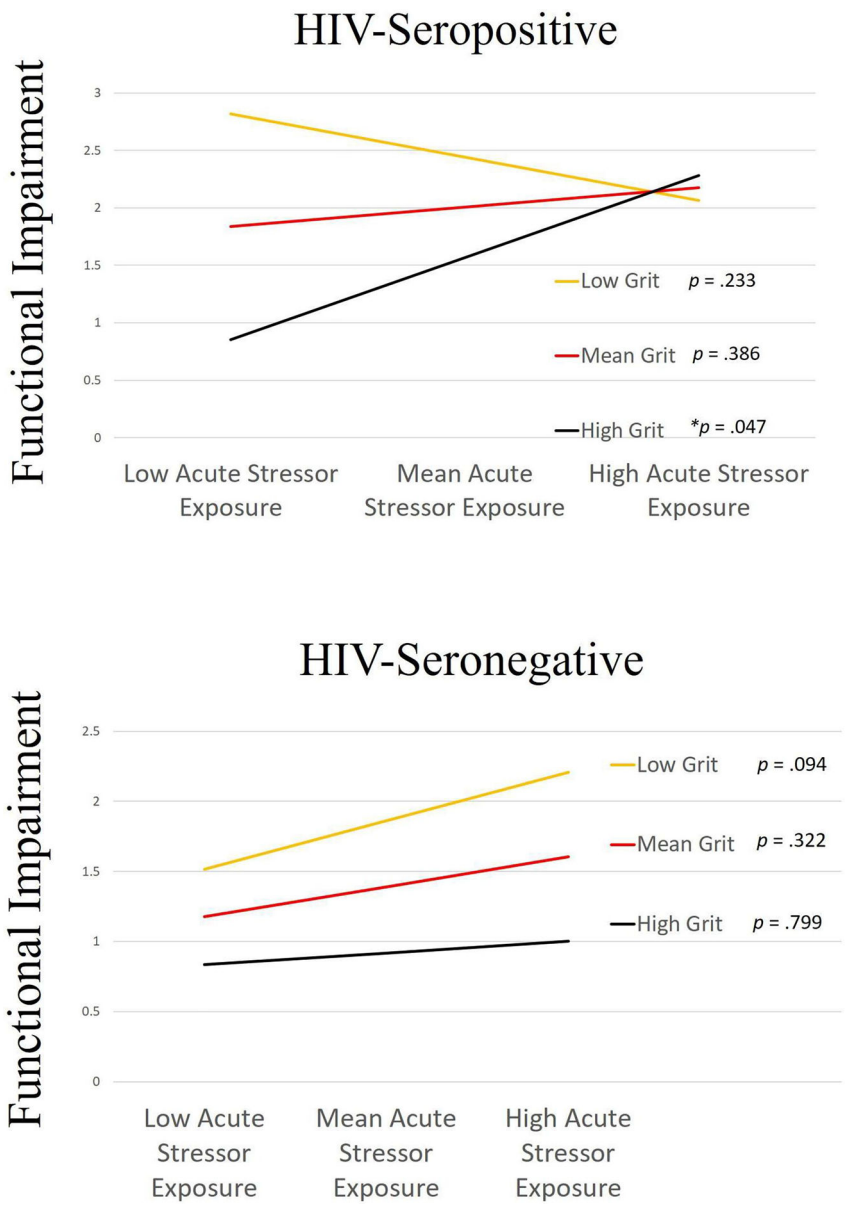

FIGURE 3.

Grit as a Moderator in the Association Between Acute Stressor Exposure and Functional Impairment for (a) HIV-seropositive and (b) HIV-seronegative Participants. Although the three-way interaction between total lifetime acute stressor exposure, HIV-seropositive status, and grit on level of functional impairment was significant ($p = 0.036$), the simple two-way interactions were not significant at low ($p = 0.053$), mean ($p = 0.871$), or high ($p = 0.187$) levels of grit.

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TABLE 1

Participant demographic characteristics based on HIV status.

	HIV+ (*n* = 76)	**HIV− (*n* = 100)**	***p*–value**
Demographic information			
Age [M_{years} (*SD*)]	57.96 (7.52)	56.77 (10.01)	$p = 0.387$
Education [M_{years} (*SD*)]	13.80 (2.26)	14.15 (2.35)	$p = 0.325$
Current SES hollingshead [*M* (*SD*)]	43.80 (11.35)	41.09 (12.41)	$p = 0.138$
Gender (%)			
❑ Male	76.3%	62.0%	χ^2 (2) = 10.03, $p = 0.007$
❑ Female	19.7%	38.0%	
❑ Transgender (male-to-female)	3.9%	--	--
Race/Ethnicity (%)			
❑ Non-hispanic African American/Black	57.9%	63.0%	χ^2 (1) = 0.472, $p = 0.492$
❑ Non-hispanic white	42.1%	37.0%	--
Premorbid IQ (WRAT-4 total reading subtest [*M* (*SD*)])	59.32 (7.31)	60.21 (7.41)	$p = 0.426$
HIV+ characteristics			
Duration of HIV disease [M_{years} (*SD*)]	21.02 (9.51)	--	--
Nadir plasma CD4+ [M_{cells/mm^3} (*SD*)]	274.03 (241.32)	--	--
Highest ever plasma viral load [$M_{copies/mL}$ (*SD*)]	303,466.09 (647,164.61)	--	--
Current plasma CD4+ [M_{cells/mm^3} (SD)]	671.76 (312.07)	--	--
Viral load detectable (%)	36.1%	--	--
Clinical characteristics			
Depressive symptoms (BDI-II total [*M* (*SD*)])	7.38 (8.28)	4.49 (6.55)	$p = 0.013$
Positive urine toxicology (%)	39.2%	27.4%	χ^2 (1) = 2.65 $p = 0.104$
Substance use (%)			
❑ Past dependence	51.3%	17.0%	χ^2 (1) = 23.44, $p < 0.001$
❑ Past abuse	48.7.0%	28.0%	χ^2 (1) = 7.93, $p = 0.005$
❑ Current abuse	9.2%	9.0%	χ^2 (2) = 1.33, $p = 0.515$
Psychosocial characteristics			
Grit [*M* (*SD*)]			
❑ Average score	3.58 (0.50)	3.59 (0.61)	$p = 0.994$

	HIV+ (*n* = 76)	HIV− (*n* = 100)	*p*–value
STRAIN [*M* (*SD*)]			
❑ total lifetime stressor count	35.08 (19.18)	27.53 (16.09)	$p = 0.003$
❑ total lifetime chronic stressor count	11.47 (7.18)	9.88 (6.21)	$p = 0.117$
❑ total lifetime acute stressor count	23.60 (12.95)	17.65 (10.85)	$p = 0.001$
Daily functioning			
Level of functional impairment (BFIS mean impairment [*M* (*SD*)])	2.18 (2.15)	1.22 (1.76)	$p = 0.002$

Abbreviations: BD, Beck's Depression Inventory; BFIS, The Barkley Functional Impairment Scale; CD4+, cluster of differentiation 4; HIV, human immunodeficiency virus; IQ, intelligence quotient; SES, socioeconomic status; STRAIN, Stress and Adversity Inventory for Adults; WRAT-4, Wide Range Achievement Test, 4th Edition.

TABLE 2

Correlation matrix of primary variables of interest ($n = 176$).

	HIV status (0 = HIV+/ 1 = HIV−)	Total lifetime stressor count	Total lifetime acute stressor count	Total lifetime chronic stressor count	Average grit	BFIS mean impairment (functional impairment)	BDI total score	WRAT total score (premorbid IQ)	Past substance dependence
HIV status (0 = HIV+/1 = HIV−)	---	$r = 0.21$, $p = 0.005$*	$r = 0.244$, $p = 0.001$	$r = 0.12$, $p = 0.117$	$r = -0.001$, $p = 0.994$	$r = 0.24$, $p = 0.001$*	$r = 0.19$, $p = 0.011$*	$r = -0.06$, $p = 0.426$	$r = 0.37$, $p < 0.001$*
Total lifetime stressor count	$r = 0.21$, $p = 0.117$	---	$r = 0.972$, $p < 0.001$*	$r = 0.91$, $p < 0.001$*	$r = -0.13$, $p = 0.083$	$r = 0.25$, $p = 0.001$*	$r = 0.32$, $p < 0.001$*	$r = 0.12$, $p = 0.130$	$r = 0.30$, $p < 0.001$*
Total lifetime acute stressor count	$r = 0.244$, $p = 0.001$	$r = 0.972$, $p < 0.001$*	---	$r = 0.780$, $p < 0.001$*	$r = -0.135$, $p = 0.074$	$r = 0.262$, $p < 0.001$*	$r = 0.312$, $p < 0.001$*	$r = 0.058$, $p = 0.447$	$r = 0.315$, $p < 0.001$*
Total lifetime chronic stressor count	$r = 0.12$, $p = 0.117$	$r = 0.91$, $p < 0.001$*	$r = 0.780$, $p < 0.001$*	---	$r = -0.11$, $p = 0.165$	$r = 0.18$, $p = 0.017$*	$r = 0.29$, $p < 0.001$*	$r = 0.20$, $p = 0.007$*	$r = 0.22$ $p = 0.004$*
Average grit	$r = -0.001$, $p = 0.994$	$r = -0.13$, $p = 0.083$	$r = -0.135$, $p = 0.074$	$r = -0.11$, $p = 0.165$	—	$r = -0.37$, $p < 0.001$	$r = -0.35$, $p < 0.001$*	$r = 0.11$, $p = 0.137$	$r = -0.13$, $p = 0.095$
BFIS mean impairment (functional impairment)	$r = 0.24$ $p = 0.001$*	$r = 0.25$, $p = 0.001$*	$r = 0.262$, $p < 0.001$*	$r = 0.18$, $p = 0.017$*	$r = -0.37$, $p < 0.001$*	—	$r = 0.46$, $p < 0.001$*	$r = -0.20$, $p = 0.007$*	$r = 0.21$, $p = 0.004$*
BDI total score	$r = 0.19$, $p = 0.011$*	$r = 0.32$, $p < 0.001$*	$r = 0.312$, $p < 0.001$*	$r = 0.29$, $p < 0.001$*	$r = -0.35$, $p < 0.001$*	$r = 0.46$, $p < 0.001$*	—	$r = -0.07$, $p = 0.358$	$r = 0.20$, $p = 0.008$*
WRAT total score (premorbid IQ)	$r = -0.06$, $p = 0.426$	$r = 0.12$, $p = 0.130$	$r = 0.058$, $p = 0.447$	$r = 0.20$, $p = 0.007$*	$r = 0.11$, $p = 0.137$	$r = -0.20$, $p = 0.007$*	$r = -0.07$, $p = 0.358$	—	$r = -0.09$, $p = 0.244$
Past substance dependence	$r = 0.37$, $p < 0.001$*	$r = 0.30$, $p < 0.001$*	$r = 0.315$, $p < 0.001$*	$r = 0.22$, $p = 0.004$*	$r = -0.13$, $p = 0.095$	$r = 0.21$, $p = 0.004$*	$r = 0.20$, $p = 0.008$*	$r = -0.09$, $p = 0.244$	—

Abbreviations: BDI, Beck's Depression Inventory; BFIS, The Barkley Functional Impairment Scale; HIV, human immunodeficiency virus; IQ, intelligence quotient; WRAT-4, Wide Range Achievement Test 4th Edition.