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The Influence of Neurocognitive Impairment, Depression, and Alcohol Use Disorders on Health-Related Quality of Life among Incarcerated, HIV-Infected, Opioid Dependent Malaysian Men: A Moderated Mediation Analysis

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Abstract

Prior research has widely recognized neurocognitive impairment (NCI), depression, and alcohol use disorders (AUDs) as important negative predictors of health-related quality of life (HRQoL) among people living with HIV (PLWH). No studies to date, however, have explored how these neuropsychological factors operate together and affect HRQoL. Incarcerated male PLWH (N=301) meeting criteria for opioid dependence were recruited from Malaysia's largest prison. Standardized scales for NCI, depression, alcohol use disorders (AUDs) and HRQoL were used to conduct a moderated mediation model to explore the extent to which depression mediated the relationship between NCI, HRQoL, and AUDs using an ordinary least squares regression-based path analytic framework. Results showed that increasing levels of NCI ($B = -.1773$, $p < 0.001$) and

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Compliance with Ethical Standards

Ethical approval

Institutional review boards at the University Malaya Medical Centre and Yale University approved the protocol for the parent study. The protocol was also reviewed and approved by the Office of Human Research Protection at the US Department of Health and Human Services (DHHS) as it involved federally-funded research with prisoners. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

depression ($B = -.6147, p < 0.001$) were negatively associated with HRQoL. The effect of NCI on HRQoL was significantly (Sobel $z = -3.5600, p < 0.001$) mediated via depression ($B = -.1230, p < 0.001$). Furthermore, the conditional indirect effect of NCI on HRQoL via depression for individuals with AUDs was significant ($B = -.9099, p = .0087$), suggesting a moderated mediation effect. The findings disentangle the complex relationship using a moderated mediation model, demonstrating that increasing levels of NCI, which can be reduced with HIV treatment, negatively influenced HRQoL via depression for individuals with AUDs. This highlights the need for future interventions to target these complex interplay between neuropsychological factors in order to improve HRQoL among PLWH, particularly incarcerated PLWH with AUDs.

Keywords

Neurocognitive impairment; HIV/AIDS; depression; alcohol use disorders; health-related quality of life; prisoners; opioid dependence

Introduction

Globally, compared to the general community, people with HIV, other infectious diseases and substance use disorders – including alcohol problems – are concentrated in criminal justice settings (CJS) [1]. The global HIV pandemic continues to be a major public health issue, with approximately 37 million people living with HIV (PLWH) worldwide [2]. With the recent advances in prophylactic and therapeutic strategies, the transformation of HIV into a chronic medical condition where PLWH can be expected to have a normal life expectancy if receiving recommended treatment [3] has resulted in their health-related quality of life (HRQoL) emerging as a key focus for researchers and healthcare providers [4]. As with any other chronic illness, PLWH face numerous personal, social, mental, and physical comorbidities that can affect their HRQoL [5, 6]. The complex interplay between HIV and these comorbidities has generated an urgency to maximize the HRQoL experienced by PLWH [7].

Malaysia, in particular, has experienced a rapid expansion of its HIV epidemic, which is mostly concentrated within people who inject drugs (PWIDs) who often interface with criminal justice systems [8]. PWIDs have the greatest burden of HIV infection, with prevalence being 19.2% [9, 10]. Incarcerated individuals, many of whom are also PWIDs [11, 12], have HIV prevalence 10–15 times greater than the general Malaysian population (4.6% vs 0.40% respectively) [13, 14]. Incarcerated PLWH, particularly PWIDs, face enormous challenges accessing evidence-based HIV prevention interventions both within the criminal justice system and in the tumultuous period after release [15–17]. Furthermore, they disproportionally experience comorbid neurocognitive impairment (NCI) [18], alcohol use disorders (AUDs) [19, 20], and depressive symptoms [11, 21, 22], which may negatively impact their HRQoL. Without adequate treatment, support and related prevention services, these individuals are at greater risk of relapsing to drug use and related risk behaviors, not being linked to HIV care, and not achieving sufficient viral suppression to improve their health and reduce HIV transmission [23, 24]. NCI among PLWH has been increasingly recognized and associated with adverse clinical consequences, including increased HIV risk-

taking [25], difficulty in performing daily tasks [26, 27], shorter survival [28, 29], and reduced health-related HRQoL [30, 31]. Prior research has found NCI to be higher in individuals with substance use and AUDs [32, 33]. There is growing evidence that the nature of NCI (e.g., due to HIV and/or drug use) and AUDs may play a key role in increased drug- and sex-related HIV risk behaviors, two major modes of HIV transmission [25, 32, 34–37]. In addition, depression is common in PLWH, with the global prevalence ranging from 30% to 79% [11, 38–41]. In the context of Malaysian prison setting, a study by Zahari et al. (2010) found significantly high rates (44%) of lifetime psychiatric disorders, including depression, although neither NCI nor AUD profiles have been examined among HIV-infected prisoners. Thus, the cumulative impact of depressive symptoms may disrupt the daily life and self-management activities of PLWH, including for incarcerated PLWH, and thereby significantly affecting their HRQoL [42–44].

Prior research has widely recognized NCI, depression, and AUDs as important correlates of HRQoL [42–49]. Although illuminating, research to date has typically focused on the independent direct effect of these neuropsychological factors on HRQoL among PLWH. Furthermore, little is known about the extent of NCI, depression, and AUDs among incarcerated PLWH in the Malaysian or Southeast Asian context. Thus, the possible ways and the extent to which a similar outcome can occur when these factors operate together, particularly among incarcerated PLWH, remains an important unanswered question. A better understanding of how neuropsychological factors influence HRQoL is critical in developing future programs designed to improve HRQoL among this key population. In the present study, we therefore sought to test the conceptual scheme depicted in Figure 1. In examining the linkages proposed in the model, we explored whether depression mediates the influence of NCI on HRQoL as a function of the underlying AUDs among incarcerated male PLWH who were transitioning to the community. Specifically, we explored the following relationships of the extent to which: a) NCI is associated with HRQoL; b) NCI is associated with depression; c) depression is associated with HRQoL; d) depression will mediate the relationships between NCI and HRQoL; and e) AUDs moderate the mediation effect of depression on the relationships between NCI and HRQoL.

Methods

Baseline data collected from January 2010 – December 2014 for a 2×2 multi-factorial, randomized controlled trial (Project Harapan) was used to examine the relationships between NCI, depression, AUDs, and HRQoL in HIV-infected male prisoners in Malaysia. The trial was designed to evaluate and compare the relative effectiveness of a pre-release methadone maintenance program (MMP) [50, 51] and an adapted, evidence-based behavioral intervention (Holistic Health Recovery Program - Malaysia, HHRP-M) [52] in promoting post-release retention in care and reducing HIV-related risk behaviors and illicit drug use.

Institutional review boards at the University Malaya Medical Centre and Yale University approved the protocol for the parent study. The protocol was also reviewed and approved by the Office of Human Research Protection at the US Department of Health and Human

Services (DHHS) as it involved federally-funded research with prisoners. The study is registered at www.clinicaltrials.gov (NCT02396979).

Recruitment

Experienced research assistants (RAs) underwent extensive training on study methods and confidentiality procedures. Prison officers provided lists of all PLWH in the dedicated HIV unit after removing names of those who were not Malaysian or not within 90–180 days of release. These individuals were invited to attend group information sessions about the study conducted by RAs. Interested individuals added their name to a list to schedule a private meeting with the RA to learn more about the study. Meetings between RA and prisoners occurred in private spaces reserved for Project Harapan within the prison medical unit on a one-by-one basis, in the absence of prison staff, where study details were discussed. This dedicated space had a Plexiglas door separating prisoners and RAs from prison personnel to ensure privacy. Prisoners were informed that participation or continuation in the study would remain confidential and not influence their status in any way. Anyone further interested in the study were invited for further screening in a private room to determine eligibility. Prisoners who met inclusion criteria, and who were willing to participate, were invited to provide informed consent, followed by a baseline assessment.

All interviews were conducted face-to-face by trained research assistants using standardized instruments that were translated and back-translated to Bahasa Malaysia using standardized procedures [53]. No prisoners were paid during their incarceration, provided incentives or disincentives for participation and were allowed to discontinue study participation at any time.

Participants

Participants were recruited from Malaysia's largest prison in Kajang prison located near Kuala Lumpur. Inclusion criteria for the study included a) age ≥ 18 years; b) HIV-infected; c) pre-incarceration criteria for opioid dependence using DSM-IV criteria; and d) Malaysian citizenship. Although both men and women were eligible for the study, only male prisoners were eventually recruited from Malaysia's largest prison, a male correctional facility located near Kuala Lumpur, because HIV-infected women in the adjacent women's facility were uncommon and did not meet eligibility criteria. The current analysis included 311 male prisoners with HIV and met criteria for opioid dependence, however, the final analytical sample included the 301 for whom complete data were available. The sample size calculation for the parent study was based on an outcome not related to the current analysis. For the current analysis, a sample size of 301 was more than sufficient to determine the present path analysis.

Setting

All prisoners in Malaysia undergo mandatory HIV testing and are then segregated into dedicated housing units. Kajang prison houses about 4,200 prisoners and is operating at 119% of its actual capacity [54]. The prison has a dedicated inpatient and outpatient medical unit. As part of the parent study, all participants underwent CD4 testing and were eligible for

antiretroviral therapy (ART) if they met national guidelines (CD4<350 lymphocytes/mL) criteria.

Measures

A number of characteristics of the participants were collected, including age, ethnicity, religion, marital status, employment and educational status, sex- and drug-related behaviors, type of criminal offense for current incarceration, visits to psychiatrist, length of current incarceration, duration since HIV diagnosis, currently taking ART, and CD4 count. All of these variables were measured as categorical variables with the exception of age, length of current incarceration, duration since HIV diagnosis, and CD4 count. In addition, we used a number of standardized scales, which were all analyzed as continuous variables with the exception of the Alcohol Use Disorders Identification Test (AUDIT), which was binary.

Neurocognitive impairment (NCI)—NCI was measured using the Brief Inventory of Neurocognitive Impairment (BINI), which is a brief, self-report measure of neuropsychological symptoms. The BINI was developed as a quick and convenient way to help elicit diagnostically relevant information about both general NCI and specific symptom subscales (e.g., attention, memory, linguistic functioning, etc.) [55]. We conducted a factor analysis to optimize the scale for use with incarcerated, HIV-infected opioid dependent men in the Malaysian context – now referred to as the Brief Inventory of Neurocognitive Impairment - Malaysia (BINI-M) [56]. The revised 54-item, 8-factor scale includes a diverse set of factors, including: Global Impairment (e.g., “My brain becomes tired easily”), Academic-related (e.g., “I have trouble writing sentences”), Language-related (e.g., “My words get mixed up”), Learning-related (e.g., “My arithmetic is poor”), Psychomotor/perception-related (e.g., “Part of my body feels numb”), Frustration tolerance-related (e.g., “I have a bad temper”), Head injury-related (e.g., “I have had epileptic seizures”), and Memory-related (e.g., “I have forgotten many things which have happened in my childhood”). The overall BINI-M score was obtained by summing responses to all items (0 – 212). Higher scores reflected greater degree of neurocognitive deficits. The scale’s reliability for the study sample was 0.96.

Depression—Patients’ depressive symptoms over the previous week were assessed using the 20-item Center for Epidemiological Studies Depression Scale (CES-D) [57]. The CES-D is a validated self-report screening measure for depressive symptoms that has demonstrated excellent reliability and validity, and has been widely used in studies of PLWH [58, 59]. Each item uses a 4-point Likert scale and the total scores range from 0 to 60, with higher scores indicating increased levels of depressive symptoms. The overall internal consistency (Cronbach’s alpha) for the entire 20-item scale was 0.74.

Alcohol use disorders (AUDs)—The World Health Organization’s (WHO) validated 10-item Alcohol Use Disorders Identification Test (AUDIT) was used to assess alcohol use disorders [60]. Participants were assessed based on their experiences in the 12 months before incarceration since access to alcohol is restricted within prison. The total sum score ranges from 0–40, with standard cut-offs associated with any AUD (score ≥ 8) [60]. The overall international consistency for the AUDIT is 0.94.

Health-Related Quality of life (HRQoL)—Health-related quality of life was assessed using the RAND 36-Item Health Survey (SF-36) [61]. The SF-36 has been used in PLWH and includes 8 subscales that were assessed over the previous month, including: physical functioning, role limitations caused by physical health problems, role limitations caused by emotional problems, social functioning, emotional wellbeing, energy/fatigue, pain, and general health perceptions. Scores for individual items were recoded and mean total score was calculated to create a HRQoL index. The HRQoL index ranged from 0 to 100, with higher scores indicating higher levels of HRQoL. Cronbach's alpha value for the SF-36 survey was 0.93.

Data analysis

We tested our hypotheses using two inter-related steps. First, we examined a simple mediation model (Hypotheses a–d). Collectively, Hypotheses a, b, c, and d indicate an indirect effects model, whereby the relationship between NCI and HRQoL is transmitted via depression. This test of the mediation hypothesis was guided by the approach proposed by Baron and Kenny [62]. Second, we integrated the proposed moderator variable into the mediation model and empirically tested the overall moderated mediation model (Hypothesis e). Both the analyses included controlling for multiple covariates (age, educational status, employment status, length of current incarceration, length of HIV diagnosis, currently taking ART, and current CD4 count). Initially, “currently taking ART” and “current CD4 count” were included in the moderated mediation model because both the variables have been previously demonstrated to influence HRQoL [63–66]. They were ultimately excluded from the final model, however, because of their non-significant association with HRQoL in our sample.

We used the SPSS PROCESS macro developed by Hayes (2013) for data analyses [67]. The PROCESS macro uses an ordinary least squares (OLS) regression-based path analytic framework to test the proposed conditional direct and indirect effects. To test for significance in mediation analysis, we assumed a normal distribution and used two-tailed Sobel significance test supplemented by bootstrapping methods [68–71]. Furthermore, the conditional indirect effect was tested using Normal theory tests at different values of the moderator variable followed by the bootstrap confidence intervals and index of moderated mediation [72, 73].

Results

Tables 1 and 2 present characteristics of the participants and inter-correlations of variables of interest, respectively. The scores for NCI ranged from 0 to 136, with a mean score of 33.45 (± 26.05). In addition, the mean total score was 14.9 (± 6.0) for depression and 77.7 (± 14.9) for HRQoL. Overall, 16.6% met criteria for having any AUD (score ≥ 8) [60]. NCI was significantly and positively correlated with depression ($r = 0.370$, $p < 0.001$) and AUDs ($r = 0.117$, $p = 0.042$), but was negatively correlated with HRQoL ($r = -0.302$, $p < 0.001$). Depression was negatively correlated with HRQoL ($r = -0.362$, $p < 0.001$).

Tests of mediation

Table 3 presents the results of the OLS regression analyses for simple mediation. As hypothesized, NCI was positively associated with depression ($B = .0883, p < 0.001$) and negatively associated with HRQoL ($B = -.1773, p < 0.001$). Similarly, depression was negatively associated with HRQoL ($B = -.6147, p < 0.001$). And finally, an inverse relationship was found between NCI and HRQoL, controlling for depression ($B = -.1230, p < 0.001$). This supports our fourth hypothesis of an indirect effect (i.e., partial mediation) of NCI on HRQoL via depression ($Effect = -.0543$) (see Figure 2). The formal two-tailed significance test demonstrated that the indirect effect was significant (Sobel $z = -3.5600, p < 0.004$). Bootstrap results confirmed the Sobel test (Table 3), with a bootstrapped 95% confidence interval around the indirect effect not containing zero ($-.0948, -.0234$).

Tests of moderated mediation

Table 4 presents the results for the conditional indirect effect (i.e., moderated mediation model). With regard to the fourth hypothesis, we predicted that the inverse relationship between NCI and HRQoL via depression would be higher for individuals with AUDs than for their counterparts without AUDs. The results indicated that the interaction effect between depression and AUDs on HRQoL was significant ($B = -.9099, p = .0087$). In addition, we examined the conditional indirect effect of NCI on HRQoL (through depression) for individuals with and without AUDs. Normal-theory tests indicated the conditional indirect effect (based on moderator: with and without AUDs) were negative and significant. Bootstrap confidence intervals and index of moderated mediation corroborated these results (Table 4). Thus, our fifth hypothesis was supported, such that the higher degree of indirect and negative effect of NCI on HRQoL through depression was observed among individuals with AUDs, whereas this effect was lower (but significant) for those without AUDs (Figure 3).

Discussion

This study is the first to examine the influence of NCI, depression, and AUDs on HRQoL within the context of incarcerated male PLWH in Malaysia. Findings here from an integrated conceptual model suggest that the relationships between neuropsychological factors and HRQoL are more complex than prior research has indicated [47, 74–78]. Initially, we examined whether depressive symptoms would operate as a mediating mechanism between NCI and HRQoL. We then determined whether AUDs amplify or attenuate the indirect relationship between NCI and HRQoL via depression. Study results supported the hypothesized moderated mediation model, demonstrating that the magnitude of the indirect effect was contingent upon an individual's pre-incarceration alcohol use. This finding establishes the presence of a heretofore unexplored condition (i.e., alcohol use) influencing the impact of NCI and depression on HRQoL among incarcerated PLWH.

We believe our results contribute to the literature by first corroborating and then extending prior findings. Our results emphasized the impact of both NCI and depression on HRQoL, as both showed main effects on HRQoL. Consistent with prior findings, our study showed a strong association between the presence and severity of NCI and reduced HRQoL [74–76].

Furthermore, a greater degree of NCI was associated with depressive symptoms [79] and depression was linked with decreased HRQoL [47, 77]. These findings are important because incarcerated PLWH, nearly all of whom had injected opioids, have a greater likelihood of being cognitively impaired and exhibiting depressive symptoms due to disease process, lifestyles, and chronic substance use behaviors [11, 22, 80]. As a result, there is a greater likelihood of a deteriorating HRQoL through the complex interaction of HIV infection, substance use disorders and depression.

Furthermore, the present study is the first to broaden the focus of how NCI influences HRQoL, taking into consideration depression among incarcerated PLWH. The results suggested that the association between NCI and HRQoL was partially mediated by depression. That is, a higher degree of neurocognitive deficit was associated with worse depressive symptoms. Worse depressive symptoms, in turn, predicted lower HRQoL in our sample. This indirect effect represents a facilitating mechanism. In effect, people with a higher degree of NCI are more likely to exhibit depressive symptoms and, thus, are more likely to have a reduced HRQoL. Alternatively, it may be that NCI and depression are so intertwined in the problems of patients with opioid dependence and HIV infection that the cumulative impact of these two factors may disrupt the daily life and self-management activities of incarcerated PLWH, and significantly impact their HRQoL. These findings may, in part, explain the profoundly negative impact on retention in HIV care, antiretroviral medication adherence and viral suppression post-release [81–84], unless cognitive remediation factors or healthcare engagement strategies are provided.

Our findings also contribute to research on AUDs and how it may interact with NCI and depression to impact HRQoL in this high-risk population. As an extension of prior literature, we found a moderating effect of AUDs on the relationship between NCI and HRQoL via depression. That is, the presence of depressive symptoms reinforces the negative influence of NCI on HRQoL, and particularly so among PLWH with AUDs compared to their counterparts without AUDs. By incorporating moderated mediation, we assert that the indirect effect described above works differently in subgroups of individuals. Specifically, PLWH with AUDs are likely to experience an increased negative contribution of NCI and depression on HRQoL. These findings highlight the importance of precisely targeting NCI, depression, and AUDs, while developing interventions to improve HRQoL for incarcerated PLWH, especially as nearly all will transition to the community.

Implications and future studies

Our data suggest that cognitive impairment, depression, and AUDs may be important barriers to optimal HRQoL for incarcerated, opioid-dependent individuals living with HIV. Improving HRQoL may depend on first determining whether cognitive functioning is impaired and then making appropriate accommodations. As such, a systematic assessment of cognitive functioning should be used in routine clinical assessment and interventions should be tailored to address and take into account the possible effect of NCI among this high-risk population. Ignoring NCI will likely result in poor treatment engagement post-release. Also, the findings help clarify the role of depressive symptoms and AUDs on HRQoL among

incarcerated PLWH. Hence, more effective ways of assessing and treating depressive symptoms and AUDs are needed to improve HRQoL in this populations.

The validity of the moderated mediation model highlights the importance of accounting for the participants' NCI status, depressive symptoms, and AUDs, when developing interventions for incarcerated, drug dependent PLWH. Additionally, the findings provide an important opportunity for intervening in this high-risk population group, such as incarcerated PLWH, to establish effective interventions for those transitioning back to the community. As such, prison diversion programs could play an effective role for those who enter the criminal justice system with NCI, depression and AUDs. This also argues for routine effective screening and treatment for mental illness and AUDs. Alternatively, evidence-based intervention should be implemented within these programs or offered as an alternative to incarceration.

Additionally, the present analyses suggest some interesting directions for future research. For example, we did not assess perceived or available social support, which may buffer the adverse impact of NCI, depression, and AUDs on HRQoL. Future research that expands the proposed model to include such variables would make for an interesting contribution. Furthermore, future studies need to investigate the HRQoL among this high-risk population as they transition through prison and back to the community. Adding to that, future studies should test this moderated mediation model among different study samples to confirm its generalizability.

Limitations

The findings from this study must be considered in light of a few inherent limitations. First, we used self-report assessments, which may have reduced the ability to accurately detect some variables due to participants' reluctance to self-report sensitive or socially undesirable behaviors. In addition, the data may have been subject to potential biases associated with the desire to misrepresent levels of awareness about particular items in the questionnaire. This may have been diminished, however, by the use of ACASI, which provided participants with a high level of privacy. Second, the cross-sectional and observational nature of data precluded our ability to infer cause-and-effect relations. Third, the BINII-M, although a very user-friendly and convenient screening instrument for difficult-to-reach populations, is not designed to provide a comprehensive assessment of NCI, and does not measure all possible cognitive domains. It does include, however, a diverse set of factors with excellent overall reliability. Finally, the results in this study are specific to incarcerated, male PLWH with opioid use disorders in Malaysia, and may not be generalizable to other risk populations. Therefore, further research may be required before the findings can be generalized to other locations or populations. Despite these limitations, our findings have several clinical and research implications and add to our understanding of the processes by which neuropsychological variables impact on different dimensions of HRQoL.

Conclusions

The findings from this study contribute to a burgeoning literature on NCI, depression, and AUDs as the key factors associated with HRQoL among PLWH [47, 74–79]. Furthermore,

the results provide preliminary evidence of interactions between depression and AUDs, such that NCI has an increased negative effect on HRQoL via depression for individuals with AUDs. The results of our study, therefore, make an important contribution to our understanding of the applicability of moderated mediation model for improving HRQoL among PLWH with a history of incarceration and opioid dependence. Given the context of greater likelihood of cognitive deficits and depressive symptoms, and high prevalence of AUDs among this high-risk population [22, 80], future interventions seeking to improve their HRQoL should include accommodating their NCI and depressive symptoms and screening and treating AUDs as primary goals.

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Figure 1.
The proposed conceptual scheme for moderated mediation model in the study

Figure 2.

Depression as a mediator between neurocognitive impairment and health-related quality of life

Note:

Controlling for age, educational status, employment status, length of current incarceration, length of HIV diagnosis, currently taking ART, and current CD4 count

Figure 3.

Moderating effect of alcohol use disorders on the mediation effect of depression on the relationship between neurocognitive impairment and health-related quality of life

Note:

Controlling for age, educational status, employment status, length of current incarceration, length of HIV diagnosis, currently taking ART, and current CD4 count

Table 1Characteristics of the participants ($N = 301$)

Variable	Frequency	%
Age		
Mean ($\pm$ SD)	38.9 (6.8)	
Range	21–58	
Ethnicity		
Malay	216	71.8
Chinese	28	9.3
Indian	50	16.6
Other	7	2.3
Muslim		
Yes	228	75.7
No	73	24.3
Marital status		
Single	192	63.8
Married	34	11.3
Widow	58	19.3
Divorced	17	5.6
Employed full-time before incarceration		
No	111	36.9
Yes	190	63.1
Highest level of education		
Primary or below	58	19.4
Incomplete secondary	197	65.9
Secondary or higher	46	14.7
Unprotected sexual contact prior to incarceration		
No	44	14.6
Yes	257	85.4
Drug injection before incarceration		
No	17	5.6
Yes	284	94.4
Type of offense(s) for current incarceration		
Homicide	1	0.3
Violent-related crime	23	7.7
Property-related crime	50	16.7
Substance-related offence	204	68.2
Sexual-related crime	1	0.3
Others	18	6.0
Ever visited psychiatrist prior to incarceration		
No	283	94.0
Yes	18	6.0

Variable	Frequency	%
Months completed for current incarceration		
Mean ($\pm$ SD)	34.0 (49.4)	
Range	4–290	
Time since HIV diagnosis (years)		
Mean ($\pm$ SD)	8.3 (5.3)	
Range	0.02–24	
Currently on ART		
No	264	87.7
Yes	37	12.3
CD4 count		
Mean ($\pm$ SD)	445.04 (286.54)	
Range	8–1752	
Alcohol Use Disorders (AUDs)		
No (7)	251	83.4
Yes (8) ^f	50	16.6

SD: standard deviation; ART: antiretroviral therapy

Table 2

Summary statistics and inter-correlations of variables of interest among the participants

	Mean	SD	NCI	Depression	AUDs	HRQoL
NCI	33.45	26.05	1			
Depression	14.90	6.00	.370**	1		
AUDs	3.20	6.29	.117**	.049**	1	
HRQoL	77.70	14.90	-.302**	-.362**	-.086	1

SD: standard deviation; NCI: neurocognitive impairment; AUDs: alcohol use disorders; HRQoL: health-related quality of life

* $p < 0.05$

** $p < 0.001$

Table 3

Regression results for simple mediation

Variable ^d	Coeff.	SE	t	p
HRQoL regressed on NCI	-.1773	.0318	-5.5766	<0.001
Depression regressed on NCI	.0883	.0128	6.9154	<0.001
HRQoL regressed on depression	-.6147	.1465	-4.1957	<0.001
HRQoL regression on NCI controlling for depression	-.1230	.0335	-3.6750	<0.001
Indirect Effect of NCI on HRQoL				
Depression	Effect	Boot SE	BootLLCI	BootULCI
	-0.0543	0.0175	-0.0948	-0.0234
Tests for Indirect Effect				
Sobel test	Effect	SE	z	p
	-0.0543	0.0153	-3.5600	0.0004

HRQoL: health-related quality of life; NCI: neurocognitive impairment; SE: standard error

Note:

^aControlling for age, educational status, employment status, length of current incarceration, length of HIV diagnosis, currently taking ART, and current CD4 count

Table 4

Regression results for the conditional indirect effect (moderated mediation model)

Explanatory Variable	Consequent							
	M (Depression)			Y (HRQoL ^e)				
	Coeff.	SE	p	Coeff.	SE	p		
NCI ^b	a	.0883	.0128	<0.001	c'	-.1206	.0332	<0.001
Depression	-	-	-	-	b ₁	-.4565	.1566	0.0038
AUD _{s,c,d}	-	-	-	-	b ₂	11.6942	5.7081	0.0415
Depression x AUD _s	-	-	-	-	b ₃	-.9099	.3444	0.0087
Constant	i ₁	17.3558	2.3307	<0.001	i ₂	94.6678	5.6492	0.0000
<div>$R^2 = 18.95\%$ $F(8,272) = 7.9515, p < 0.001$ $R^2 = 23.79\%$ $F(11,269) = 7.6355, p < 0.001$</div>								
Conditional indirect effect of NCI on HRQoL at values of the moderator (No/Yes)								
Mediator	Moderator	Coeff.	Boot SE	Boot LCI	Boot ULCI			
Depression	No	-.0403	.0177	-.0799	-.0095			
Depression	Yes	-.1207	.0341	-.1892	-.0607			
Index of moderated mediation								
Mediator	Index	SE (Boot)	Boot LCI	Boot ULCI				
Depression	-.0804	.0342	-.1531	-.0250				

^aControlling for age, educational status, employment status, length of current incarceration, length of HIV diagnosis, currently taking ART, and current CD4 count^bNeurocognitive impairment^cAlcohol use disorders^dDichotomous: 0 = No, 1 = Yes (Reference group: No)^eHealth-related quality of life