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The Relationship between Performance on the Shipley Institute of Living Scale (SILS) and Hepatitis C Infection among Active Injection Drug Users in Baltimore, Maryland

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Abstract

Background: Hepatitis C represents a significant public health problem, particularly among injection drug users. Other than injection drug practices, little is understood about individual level characteristics that may place some injection drug users at particularly high risk.

Objectives: The current study sought to examine two associations among active, regular heroin injection drug users. The first was to determine whether there was an association between two scales from the Shipley Institute of Living Scale (SILS: a neuropsychological measure used to estimate cognitive impairment/intellectual functioning) and self-reported preexisting conditions independent of years of drug use. The second was to examine whether performance on the scales was associated with hepatitis C infection.

Methods: Data from 260 HIV negative injection drug users from the Baltimore metropolitan region were used. Participants completed a risk behavior interview, brief neuropsychological battery, and were tested for Hepatitis C.

Results: Findings indicated that scale performances varied by self-reported learning disabilities and attention deficit disorder. Poorer performance on one scale was statistically significantly associated with greater hepatitis C prevalence on the vocabulary scale, the discrepancy scale showed a statistical trend.

Conclusions: Cognitive impairment measured among this sample of injection drug use was related to pre-existing conditions and hepatitis C independent of years of drug use. Such

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Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

impairment may exist prior to initiation of use and increase vulnerability to poor health outcomes among injection drug users.

Scientific Significance: This study highlights the need for interventions targeting a possible high risk subpopulation of injection drug users.

Keywords

ADHD; cognitive impairment; hepatitis C; heroin injection drug use; LD

INTRODUCTION

Hepatitis C infection represents a significant public health. Approximately 130 million people are infected with hepatitis C (HCV) worldwide (1) with roughly 3 million of those residing within the United States (2). Injection drug users represent a uniquely high risk population; Davis and Rodgrigue (3) report that nearly all injection drug users who share equipment are infected with HCV after 8 years. The costs related to hepatitis C are high. A study in 2005 estimated costs to be \$500 million in hospital charges in the United States alone (2).

Cognitive status as a risk factor is receiving greater attention due to its relationship with drug use (4) and drugs which are associated with the spread of infectious disease (3, 5). While there have been several studies which have indicated that drug use can result in impairments across different domains of cognitive functioning (4, 6, 7), little is known about the association of cognitive status with negative health outcomes, such as hepatitis C, among heroin users. Evidence suggests that a substantial proportion of heroin users could have learning disabilities (LD) or attention disorders such as attention deficit disorder (ADD) or attention deficit, hyperactivity disorder (ADHD) and that individuals with such disorders may have poorer health outcomes. Developmental studies suggest that adolescents who show impairments on measures of intellectual functioning and executive functioning tasks are at increased risk of developing substance use disorders (8,9). Prevalence studies have indicated high rates of LD and ADHD among substance users in treatment (10, 11). Additionally, studies have shown that cognitive impairments are associated with poorer treatment response among substance users (12, 13).

To explore the association between preexisting cognitive impairments and infectious disease among injection drug users, we utilized two scales of the Shipley Institute of Living Scale (SILS) (14). An estimated IQ based on two subscales of the SILS has been used as an estimate of premorbid functioning in drug using samples (6). However, the SILS is theoretically capable of estimating cognitive decline or impairment due to an injury by examining performance on a measure of crystallized or acquired knowledge abilities assessed in the vocabulary section relative to performance on a measure of fluid abilities assessed in the abstraction subscale. The relative stability of vocabulary measures in comparison to abstraction or executive function has been demonstrated in other studies attempting to identify measures of pre-morbid ability, e.g., (15). However, previous studies have also shown that individuals with learning disabilities and ADHD show unique discrepancies on vocabulary and performance measures (16). Based on this background, we

sought to examine two principal associations: 1) we hypothesized that variations in performance on the SILS scales would be related to self-reported developmental conditions including LD and ADHD independent of chronic drug use and 2) we hypothesized that performance the Vocabulary and Abstraction scales would be related to Hepatitis C prevalence among injection drug users independent of years of drug use.

METHOD

Participants

This study utilized baseline data from the NEURO-HIV Epidemiologic Study, a longitudinal epidemiological investigation funded by the National Institute on Drug Abuse (NIDA). The study was designed to evaluate neuropsychological and social-behavioral risk factors of contracting HIV, hepatitis A, hepatitis B, and hepatitis C among injection and non-injection drug users. Participants were recruited using a variety of community-based outreach strategies and received a monetary incentive (\$45) for participation. The project was approved and monitored by the Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health. More detailed descriptions of the dataset and methods are available other publications, see e.g., (17).

The present study sample ($N = 260$) was comprised of individuals who reported regular injection use of either heroin alone or speedball (i.e., cocaine and heroin together). Regular use was defined as daily or nearly daily use for three months or more. Participants who were HIV positive were excluded due to the potential confounding effects of cognitive impairment on the association with HCV and cognitive decline. In addition, to reduce the influence of acute affects on performance, only participants who reported use of either drug within the past week were included. The demographic characteristics of the sample are presented in Table 1.

Measures

HIV Risk behavior assessment.—This self-report interview obtained detailed demographic, educational, and drug use information on each participant. The measure of self-reported history of a developmental disorder was a single item where participants were asked in two consecutive questions if they had ever been told that they had a learning disability or ADHD. Based on responses to these items, three mutually exclusive categories including no LD/ADHD reported, ADHD/no LD, LD with or without ADHD were created.

Demographic information was also based on participant self-report. Participants answered items measuring their education attainment, age, gender, and ethnicity. Education was dichotomized into less than a high school education vs. high school diploma, GED, or some college. Ethnicity was categorized as non-white vs. white. Each participant was asked detailed questions about their drug use history. The current study used time from first reported injection drug use to current age as the measure of years of injection drug use.

Laboratory data.—Participants provided blood samples as part of their assessments. Each participant was tested for the presence of HIV, hepatitis A, B, and C at baseline and follow-up. Only results from the hepatitis C tests were used. In some instances, phlebotomists were

unable to draw sufficient blood for sampling. If this occurred, participants were asked to return at a later date or no sample was taken. Only samples taken within thirty days were considered observed, while other results were considered missing. Because these missing data were likely associated with observed variables, such as length of drug use, the data were considered missing at random and multiple imputation (18) using the Stata ICE (19, 20) program was used.

SILS (14) is comprised of two components, i.e., Vocabulary and Abstraction. The first section is a vocabulary test with a list of forty target words. For each target word participants chose its synonym from among a choice of four candidate words. The Vocabulary score is computed by summing the number of correct items (1 for a correct item, .25 for a missing item, 0 for an incorrect item). For the second component of the *SILS*, that is, the Abstraction section, participants completed twenty word problems. The Abstraction score is a sum of the total of correct attained multiplied by two. The *SILS* is appealing as an estimate of intellectual functioning due to its brevity, ease of administration, and association with more comprehensive IQ measures (14, 21).

Since the Vocabulary and Abstraction subscores were highly correlated ($r = .54, p < .001$), we calculated a discrepancy score by subtracting the vocabulary score from the abstraction score. This approach allowed us to use the *SILS* as an identification of cognitive impairment relative to pre-morbid abilities, while avoiding problems due to multi-collinearity in the regression analyses. We assessed the correlation between the discrepancy and vocabulary scales to be $r = -.12, (p < .001)$, much less than the association between the unadjusted scaled scores for the vocabulary and abstraction scales.

To address the concern of demographic variables explaining variations in performance, we calculated age, gender, education, and ethnicity corrections on the Vocabulary and the Discrepancy scales using expected values from linear regression analysis. Values were set to z-scores, with a mean of 0 and a standard deviation of 1 within the sample. Previous studies have used age-adjusted standard scores of the combined score of *SILS* as an estimate of pre-morbid IQ in drug using samples (6). In this sample, higher scores are indicative of better performance.

Statistical analysis.—Two linear regressions were conducted with the standardized z-scores from the vocabulary and discrepancy scales regressed on self-reported LD with or without LD, ADHD without LD, years of injection drug use, and other potential confounders. In addition, a multiple logistic regression analysis with Hepatitis C as the outcome regressed on the two subscales of the *SILS* adjusted for age, gender, education, and ethnicity. To account for missing data in this model, estimates were combined across 5 multiply imputed datasets using Rubin's rules (22).

RESULTS

Table 2 presents results from the multiple linear regression analyses. Findings indicate that participants who reported being diagnosed with a LD performed significantly worse on the vocabulary section of the *SILS* than those with no diagnosis ($\beta = -.92, t = 4.82, p < .001$).

On the discrepancy score, individuals who reported a diagnosis of ADHD, but not LD, performed worse than those without either diagnosis ($\beta = -.63$, $t = 3.06$, $p = .002$). There was also a trend toward a lower performance on the discrepancy score among individuals who reported being diagnosed with a LD with or without ADHD ($\beta = -.36$, $t = 1.82$, $p = .069$). Neither of the SILS scales was significantly associated with any of the drug use or demographic characteristics. Figure 1 displays the means and confidence intervals of the two SILS scales for each group of respondents defined by diagnostic category (i.e., LD, no LD, ADHD, no ADHD) and length of injection drug use (i.e., less than 4 years vs. 4 or more years).

The second step of the analysis focused on testing the associations between performance on the two SILS scales and hepatitis C infection among injection drug users, while adjusting for relevant covariates. Table 3 presents the results from the final model using Rubin's rules (22) for combining estimates. After adjusting for years of injection and demographic variables, the Vocabulary z-score (AOR = .70, 95% CI: .50–.97) was statistically significantly associated with HCV with better scores indicating a lower odds of infection with HCV. There was a statistical trend in the same direction in the association between the Discrepancy z-score and HCV (AOR = .71, 95% CI: .49–1.04), but this result did not reach statistical significance ($p = .07$). We found significant associations between HCV infection and demographic characteristics, such that each additional year of injection drug use was associated with a 12% increase in the odds of HCV (AOR = 1.12, 95% CI: 1.04–1.21) and that respondents with less than twelve years of education had more than twice the odds of being infected with HCV (AOR = 2.24, 95% CI: 1.19–4.25) than those with a high school education or more.

DISCUSSION

Overall, our findings indicate associations between performance on SILS scales and developmental conditions, independent of years of injection heroin use, which showed no statistically significant association with either scale. Specifically, we found that respondents with self-reported LD, regardless of ADHD diagnosis, performed significantly worse on the vocabulary measure. Respondents with ADHD who did not have LD performed significantly worse on discrepancy scores independent of years of drug use. The first result with the vocabulary measure is expected given that it was designed to be more resistant to decline and associated with a pre-existing condition. The finding with regard to the discrepancy score is interesting as this scale is theoretically intended to estimate cognitive decline due to brain injury. Based on this principal, the discrepancy scale would be associated with years of regular drug use independent of preexisting conditions. This finding suggests that the discrepancy scale may reflect literature on ADHD indicating that the disorder is the result of executive dysfunction with intact intellectual functioning (23) rather than identify cognitive decline related to use of heroin and/or cocaine. These findings also suggest that the SILS may not only aid in the identification of cognitive impairment but it may be useful in discriminating among developmental conditions and subsequent risks. However, these result needs to be explored further using more clinically valid measures of developmental disorders. This study also suggests that poor performance on cognitive measures is associated with the prevalence of disease among injection drug users, particularly a measure

of premorbid cognitive abilities. This finding may indicate that a subpopulation of substance users is more vulnerable to negative health outcomes.

This study does have notable limitations. Foremost, these analyses utilized cross-sectional data, which limits causal inference. Researchers have noted that hepatitis C is associated with cognitive decline (24), which suggests that the theoretical causal direction proposed in this study may be reversed. In addition, only hepatitis C status was assessed in the current study, not severity of illness. Therefore, the extent to which the observed associations reflect impairment due to hepatitis C infection and the treatment of the disease rather than due to preexisting conditions cannot be determined. However, the association between hepatitis C infection and the theoretically more resistant vocabulary scale would suggest that hepatitis C is appropriately considered as an outcome and a result of cognitive impairment prior to infection. In addition, the study design did not allow for a detailed assessment for psychiatric conditions which are potential confounders of the associations of interest. Therefore, we are unable to determine the extent to which poorer performance on the cognitive measures is associated with mood disorders associated with drug use, hepatitis C infection and treatment, developmental disorders, or a combination of these factors. While this is a notable limitation, the observed findings do suggest that cognitive impairment, regardless of etiology, is associated with hepatitis C infection. This finding hopefully will initiate further inquiry into the causes of the observed impairment which may eventually improve interventions that target injection drug users.

Another limitation is that the SILS test has received notable criticisms, see discussions in Lezak (21). There may be concern over the potential cultural and socioeconomic biases inherent in SILS. While the SILS does provide age adjusted standardized scores for both the Abstraction and Vocabulary sections (14), it does not provide scores adjusted for ethnicity, gender, or education; all of which may result in a performance that does not accurately assess a person's ability. Such variables lead to concern about potential confounders in examining associations and may increase the likelihood of inaccurate estimates of cognitive disorders by demographic groups. This study is novel in that we minimized the influence of such factors by using age, gender, ethnicity, and education adjusted standardized scores. While this method does not fully remove potential biases in the assessment of intellectual function, the current study brings attention to a population of substance users who may be more vulnerable to infectious diseases. Future studies could examine whether this susceptibility is the result of treatment failure, social networks or norms, or other mechanisms. In addition, future studies should examine adaptations to treatment and harm reduction programs that address the special needs of individuals with cognitive impairment.

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Figure 1.
Mean standardized scores of SILS measures across self-reported diagnoses and years of injection drug use.

TABLE 1.

Demographic characteristics of sample.

Variable	N (%)
Learning disability	
No	230 (88.5%)
Yes	30 (11.5%)
ADHD	
No	231 (88.0%)
Yes	29 (11.1%)
Education	
Less than 12 years	164 (63.1%)
12 years or more	96 (36.9%)
Gender	
Male	175 (67.3%)
Female	85 (32.7%)
Ethnicity	
White	184 (70.8%)
Other ethnicity	76 (29.2%)
Hepatitis C	
Negative	63 (24.2%)
Positive	170 (65.4%)
Missing	27 (10.4%)
	Mean (SD)
Years injection	8.67 (7.07)
Age	30.89 (7.06)
Shipley vocabulary raw	23.81 (5.76)
Shipley abstraction raw	20.92 (9.00)
Shipley vocabulary <i>t</i> -score	39.75 (10.33)
Shipley abstraction <i>t</i> -score	47.64 (8.96)
Shipley discrepancy	2.83 (7.64)

Table 2.

Linear regression analyses of z-scores from SILS scales on developmental disorders, drug use, and demographic variables.

Variable	Vocabulary β (se)	Discrepancy β (se)
ADHD without LD	.084(.199)	-.597(.195) **
LD with or without ADHD	-.914(.190) ***	-.338(.186)
Years of injection drug use	.008(.011)	<.001(.011)
Education (less than 12 vs. 12 or more)	.064(.128)	-.024(.125)
Age	.019(.011)	-.057(.012)
Gender (female vs. male)	-.008(.129)	-.034(.134)
Ethnicity (non-white vs. white)	.138(.145)	-.038(.151)
Regular cocaine use	-.397(.213)	.317(.221)

 $p > .001$

**
 $p < .01$.

TABLE 3.

Estimates from multiple logistic regression analysis combined across multiply imputed datasets of hepatitis C infection on covariates.

Variable	AOR	95% CL
SILS vocabulary	.70 *	.50–.97
SILS discrepancy	.71 †	.49–1.04
Years of injection drug use	1.12 **	1.04–1.21
Education (less than 12 vs. 12 or more)	2.24 *	1.19–4.25
Age	1.02	.97–1.07
Gender (female vs. male)	.82	.42–1.59
Ethnicity (non-white vs. white)	1.59	.72–3.48
Regular cocaine use	1.27	.47–3.40

† $p < .10$

* $p < .05$

** $p < .01$.