

# Attention Deficit Hyperactivity Disorder in Prisoners: Increased Substance Use Disorder Severity and Psychiatric Comorbidity

María C. Vélez-Pastrana<sup>a, b</sup> Rafael A. González<sup>c, d</sup> Alexandra Ramos-Fernández<sup>a</sup>  
Rafael R. Ramírez Padilla<sup>b</sup> Frances R. Levin<sup>e</sup> Carmen Albizu García<sup>b</sup>

<sup>a</sup>PhD Program in Clinical Psychology, Universidad Carlos Albizu, San Juan, Puerto Rico; <sup>b</sup>Center for Evaluation and Sociomedical Research, Graduate School of Public Health, University of Puerto Rico, Rio Piedras, PR, USA; <sup>c</sup>National Adoption and Fostering Service & National Conduct Problems Team, Michael Rutter Centre, South London and Maudsley NHS Foundation Trust, London, UK; <sup>d</sup>Centre for Psychiatry, Division of Brain Sciences, Department of Medicine, Imperial College London, London, UK; <sup>e</sup>New York State Psychiatric Institute, Columbia University Irving Medical Center, New York, NY, USA

## Keywords

Attention deficit hyperactivity disorder · Substance use disorders · Prisoners · Comorbidity · Psychiatric disorders

## Abstract

**Objectives:** Attention deficit hyperactivity disorder (ADHD) and substance use disorders (SUD) are overrepresented among incarcerated populations. We examined whether ADHD was associated with increased severity of comorbid SUD and with increased psychiatric comorbidity among prisoners. **Methods:** Cross-sectional study of 500 randomly selected Latino male prisoners in the Puerto Rico Correctional System using validated diagnostic measures to assess *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition (DSM-5) ADHD and SUD diagnosis, antisocial personality disorder (ASP) and borderline personality disorder (BPD), major depression, and generalized anxiety disorder (GAD). We defined SUD severity by symptom count and by presence of at least 2 current SUD diagnoses (polysubstance). **Results:** Participants with ADHD had increased risk for lifetime ( $p < 0.05$ ) and current ( $p < 0.01$ ) SUDs, all comorbid psychiatric disor-

ders, and suicidality ( $p < 0.001$ ). They had more severe SUD, both in number of symptoms and number of SUD (polysubstance) diagnoses ( $p < 0.01$ ). ADHD was associated with increased psychiatric comorbidity, as participants with ADHD were more likely to have a second diagnosis, and a greater number of comorbid disorders ( $p < 0.001$ ). ASP, BPD, major depression, and GAD, but not ADHD, were significant predictors of SUD severity in adjusted models. **Conclusions:** Findings highlight the complex mental health needs of incarcerated populations, where SUD, ADHD, and other psychiatric disorders are prevalent and interrelated.

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## Introduction

Attention deficit hyperactivity disorder (ADHD) is one of the most prevalent mental health disorders in children [1, 2] and clinically significant symptoms often persist beyond childhood [3]. ADHD affects 2.8–5.3% of adults worldwide [4, 5] and conveys significant impairment [6]. It is frequently comorbid with other disorders

and thus entails substantial medical costs, particularly in adults [7]. People with ADHD are at increased risk for poorer long-term outcomes, including reduced social, academic, and occupational functioning; greater impairment; worse health outcomes; increased criminal convictions; and mortality [8–10].

Adults with ADHD tend to have additional comorbid psychiatric disorders. Prevalence of anxiety, depression, bipolar and personality disorders, schizophrenia, and substance use disorder (SUD) is 4–9 times higher in ADHD populations than in the general adult population [11]. In clinical samples, around 50% of patients with ADHD have at least one current comorbid disorder [12], while around 75% of patients in treatment for SUDs who have ADHD have at least one current comorbid disorder [13].

ADHD and SUD are frequently comorbid, with prevalence of ADHD among SUD populations ranging from 5 to 31% [14–16]. There is also an increased risk for SUD among ADHD populations [17, 18]. When ADHD and SUD are present, the risk for additional comorbidities increases [13]. ADHD is highly prevalent and persistent among people in treatment for SUD [19]. Patients with comorbid ADHD and SUD have more chronic and complex patterns of substance use than adults with SUD alone [19–21]. In patients with SUD, ADHD is associated with greater severity, independently of comorbidities, and is also associated with greater comorbidity [20]. On the other hand, when ADHD and other psychiatric comorbidities are present, there is also increased risk for SUD [18].

People in criminal justice settings and especially prisoners have higher rates of mental health morbidity; ADHD and SUD, in particular, are highly prevalent in these populations compared to the general population [22]. ADHD is overrepresented in prisoner populations, with prevalence estimates of 26%, which contrast with about 4% in the general adult populations [23, 24]. SUD also have a high prevalence among prisoner populations; about 50% of the US prisoners have SUD [25], compared to only 9% of the general population [26]. The majority of prisoners with ADHD also have at least one comorbid mental health disorder [27]. Studies of ADHD and comorbidities among prisoners report increased risk for psychiatric disorders in prisoners with ADHD [22, 24, 28, 29]. There is significant comorbidity of ADHD with SUD, mood disorders, anxiety, and personality disorders. Furthermore, prisoners with ADHD symptoms exhibit worse course indicators, such as earlier onset of criminal behavior, more offenses, and greater recidivism [30]. They also

have poorer outcomes upon release from prison [31]. Non-white people including African Americans and Hispanics/Latinos are overrepresented in prisoner populations in the USA [32–34]. It is important for research on criminal justice and prison populations across the world to pay attention to ethnic diversity issues. Ethnic minorities and foreigners are overrepresented among inmates and the number of foreign prisoners continues to rise, particularly in Western Europe [35]. Similar to the USA, in many European Union countries, people from disadvantaged backgrounds and ethnic minorities are overrepresented in criminal justice settings [36], particularly in prisons; a majority of foreign national prisoners are from a minority ethnic group [37]. For example, in the Netherlands, ethnic minority boys are greatly overrepresented in prisons and juvenile secure facilities and their sentences differ in severity from native Dutch youth [38]. Similarly, 27% of the prison population in England and Wales are from a minority ethnic group, considering British nationals (at 21% ethnic minority) and foreigners (at 62%) [37, 39]. The economic cost of ethnic minorities' overrepresentation in the England and Wales prison system is estimated to be £234m a year [40]. However, these ethnic minority populations tend to be underrepresented in research and their health and mental health needs tend to be unmet [41–43]. The role of ADHD in SUD severity and psychiatric comorbidity in minority prison populations is also understudied.

The present study examines whether ADHD is associated with increased severity of comorbid SUD and also with increased psychiatric comorbidity among Latino male prisoners. We examined associations between ADHD and comorbid disorders including SUD, antisocial personality disorder (ASP) and borderline personality disorder (BPD), major depression, and generalized anxiety disorder (GAD). Findings from our own group [22, 30] and from international collaborations [28, 44, 45] have shed light on some of the most relevant coexisting disorders with ADHD in prison and forensic contexts (i.e., anxiety and depressive disorders, personality disorders, and SUD). Therefore, comorbidities selected for our present study were based on previous literature in prison. We assessed SUD severity according to the number of symptoms (*Diagnostic and Statistical Manual of Mental Disorders*, fifth edition [DSM-5] criteria) as well as multiple (polysubstance) diagnoses and compared SUD severity in prisoners with/without ADHD, first using models not adjusted and then adjusted for comorbid psychiatric disorders.

**Table 1.** Demographic and clinical characteristics of Latino male prisoners with and without ADHD ( $N = 483$ )<sup>a</sup>

	ADHD diagnosis		Total sample, $n$ (%)
	yes, $n$ (%)	no, $n$ (%)	
Total	82 (16.98)	401 (83.02)	483 (100)
Age mean (SD)	27.85±9.04	31.23±10.21	30.66±10.09**
Education			
Less than high school	60 (73.17)	243 (60.60)	303 (62.73)*
High school or higher	22 (26.83)	158 (39.40)	180 (37.27)
Has children	43 (52.44)	240 (59.85)	283 (58.59)
Employment prior to prison	66 (80.49)	352 (87.78)	418 (86.54)
Not raised by both biological parents	64 (78.05)	276 (68.83)	340 (70.39)
ADHD positive screen	82 (100)	12 (2.99)	111 (22.20)
SUD lifetime	69 (84.15)	289 (72.02)	358 (74.12)*
SUD current	36 (43.90)	108 (26.93)	144 (29.81)**
Cigarette smoking (current)	39 (47.56)	216 (53.87)	255 (52.80)
ASP	53 (64.63)	110 (28.42)	163 (34.75)***
BPD	67 (82.72)	166 (42.24)	233 (49.16)***
Major depression	19 (24.05)	19 (4.86)	38 (8.09)***
GAD	38 (46.34)	91 (22.69)	129 (26.71)***
Suicidal thoughts (last 2 weeks)	42 (52.50)	81 (20.45)	123 (25.84)***

ADHD, attention deficit hyperactivity disorder; ASP, antisocial personality disorder; BPD, borderline personality disorder; GAD, generalized anxiety disorder. \*  $p < 0.05$ . \*\*  $p < 0.01$ . \*\*\*  $p < 0.001$ . <sup>a</sup> Total  $N = 500$ ; 17 of 111 participants who screened positive for ADHD were lost to follow-up diagnostic interview, thus  $N = 483$  for analyses involving ADHD diagnosis.

## Materials and Methods

### Participants and Sampling

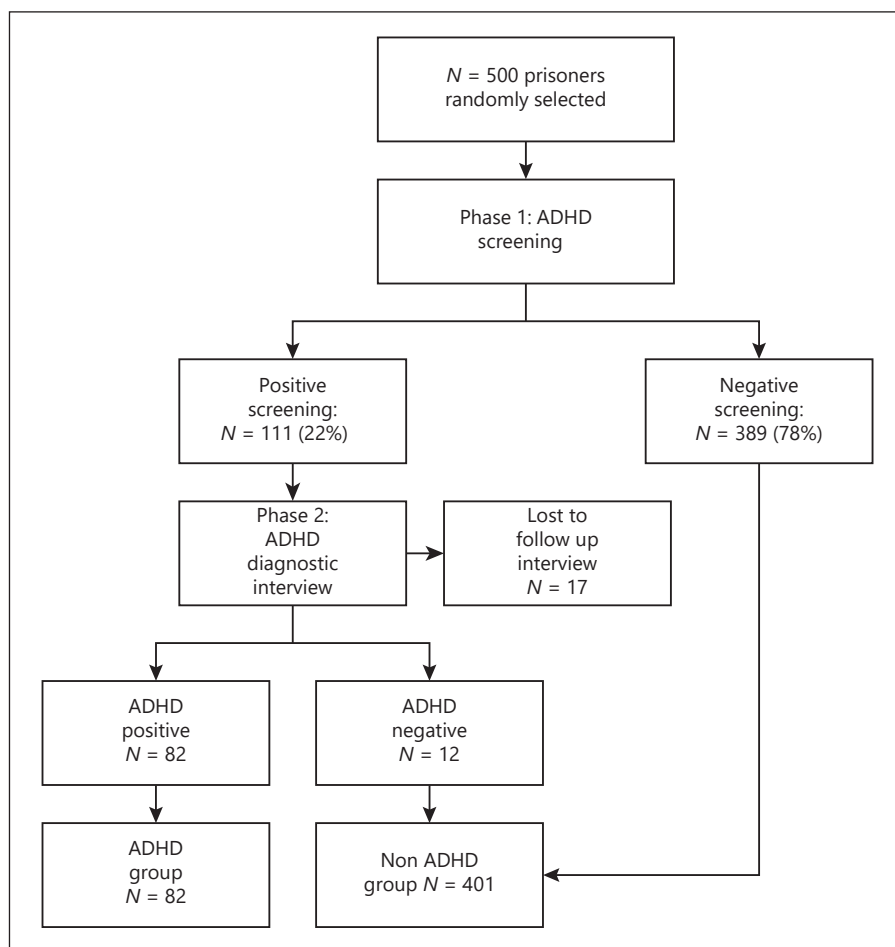
Participants were 500 randomly selected Latino male prisoners aged 18–74, who were incarcerated in the Puerto Rico Corrections Department between June 2015 and March 2016. Inclusion criteria established that all participants must be able to communicate in Spanish and absence of psychoses, mental retardation, and any other condition that may compromise the ability to understand the questionnaires and complete the interview. Participation was voluntary and confidential and no incentives were given. Sample size was estimated through power analysis. Participants were recruited from 8 out of 20 facilities, including all security levels (2 minimum, 3 medium, and 3 maximum security). The Puerto Rico Corrections Department provides data on the security level of each institution, and for most of them, information on the prevalence of testing positive for drug use within each institution. Initially, we stratified institutions using 3 categories for security level and 2 for prevalence of drug use resulting in 6 strata. We selected 1 institution from each stratum. Based on estimates from sampling frames constructed for previous studies [46], we estimated that if we selected the 6 largest institutions using this framework, our sampling frame would represent about 57% of the target population. However, due to security concerns that precluded data collection in 2 of the larger institutions originally selected, we had to select additional institutions, although maintaining the stratification by security level scheme. Random sampling was then conducted from the daily population roster of each of the selected correctional institu-

tions, using a replacement scheme; if a participant was unavailable, we called a previously determined randomly selected replacement. The sampling scheme aimed to have equal probability of selection for participants, enabling us to analyze our data using analyses appropriate for simple random samples and avoiding the effects of unequal weights on standard errors and statistical power. Refer to Table 1 for demographic characteristics. Mean age was 30.66 (10.09), 36.60% had a high school degree or higher education, and 86.54% had been employed some time prior to incarceration. The ADHD screening and diagnostic process is presented in Figure 1. The total sample included 500 participants who completed the ADHD screener in Phase 1; 111 (22.2%) screened positive for ADHD. Among those 111 who screened positive for ADHD, 17 participants were lost to the follow-up diagnostic interview of Phase 2, because they refused, were unavailable, or were transferred to another facility. The fact that the follow-up interview was conducted at a later date possibly increased the probability of losing these participants. Thus, 483 participants were available for analyses involving ADHD diagnosis. Participants with ADHD diagnosis were on average younger by approximately 3.38 years ( $p < 0.01$ ) and less likely to have completed high school (odds ratio [OR] = 0.56 [0.33, 0.96],  $p = 0.033$ ). Thus, we adjusted statistical models for age and education.

### Measures

#### Sociodemographic Characteristics

We collected data on sociodemographic characteristics via 42 questions administered by the interviewer using Computer-Assist-



**Fig. 1.** Screening and diagnostic process of participants for 500 randomly selected male Latino prisoners in the Puerto Rico Correctional System.

ed Personal Interviewing (CAPI) software. It included age, education and employment history, family composition, medical and health history, socioeconomic status, and adversity/deprivation.

#### ADHD Diagnosis

The Adult ADHD Self-Report Scale (ASRS) V1.1 was used to screen participants for ADHD. It is a 6-item version of the World Health Organization (WHO) Adult ADHD Self-Report Scale [47, 48]. The ASRS was developed in conjunction with the revision of the WHO Composite International Diagnostic Interview (CIDI) and includes 18 Likert-type items describing ADHD symptoms, following the DSM criteria. The ASRS has been translated into Spanish and other languages using the WHO back translation standard protocol and is widely used in international research. The ASRS V1.1 screener consists of 6 out of these 18 questions, selected to optimize concordance with the clinical classification. Sensitivity and specificity of the ASRS V1.1 short 6-item screener version are 87.5 and 68.6%, respectively [49]. The Diagnostic Interview for ADHD in Adults 2.0 (DIVA-2) [50] was used for ADHD diagnosis. Participants who screened positive on the ASRS V1.1 were interviewed using the DIVA-2, a structured clinical interview for adult ADHD, which assesses current and childhood (retrospective) symptoms according to the DSM criteria. The DIVA 2.0 interview has evidenced good diagnostic accuracy: 100% when com-

pared with the diagnoses obtained with the Conners Adult ADHD Diagnostic Interview for DSM-IV (CAADID) [51] and a sensitivity and specificity of 90.0 and 72.9, respectively, for diagnosing adults in clinical populations [52]. It has been used in research with clinical populations across Europe [53] and with people in forensic mental health settings, such as those involved in intimate partner violence [54].

#### Substance Use Disorders

SUDs were assessed using an adaptation of the Composite International Diagnostic Interview, Substance Abuse Module (CIDI-2 SAM) [55], based on the DSM-5 criteria [56]. Substances covered in the CIDI-2 SAM include alcohol, cannabis, cocaine, heroin, opioids, amphetamines, hallucinogens, sedatives, and inhalants. The CIDI-2 SAM counts symptoms for each drug independently, and the severity of the disorder increases with the number of symptoms reported. We assessed lifetime and current (last 12 months) SUD symptoms and criteria to establish “lifetime” and “current” SUD diagnosis. We used 2 indicators for severity of SUD: number of symptoms and number of SUD diagnoses (polysubstance). Symptom counts were recoded into ordered categories corresponding to DSM-5 symptom severity categories (0–3: mild, moderate, and severe). Polysubstance was defined by presence of at least 2 current SUD diagnoses.



### Borderline Personality Disorder

The Structured Clinical Interview for DSM Disorders-II (SCID-II) [57] is a structured clinical diagnostic interview that assesses DSM-IV Axis II disorders. We administered the BPD module. We used the SCID-II available in Spanish [58].

### Generalized Anxiety and Antisocial Personality Disorder

The Mini-International Neuropsychiatry Interview (MINI) [59, 60] is a short structured diagnostic interview for the major DSM-IV and ICD-10 psychiatric disorders. The MINI modules can be administered independently. We used the 2 modules for GAD and ASP. MINI diagnoses have good or very good kappa values; it has very good operating characteristics, sensitivity mostly above 0.70, and specificity mostly above 0.85 [61].

### Depression

We used the Patient Health Questionnaire (PHQ-9) [62, 63], a 9-item self-report scale assessing major depression over the past 2 weeks. Each of the 9 DSM-IV criteria are scored from “0” (not at all) to “4” (almost every day). The PHQ-9 item on suicidal thoughts was used as indicator of suicidality and examined separately in some analyses. Sensitivity and specificity of major depression are both 88%, and alphas are 0.89 to 0.86 [62]. The PHQ-9 was selected instead of the MINI to evaluate depression because it has better documented psychometric properties for Puerto Rican adults [64].

### Procedures

The University of Puerto Rico Medical Sciences Campus Institutional Review Board (IRB Registration number: IRB00004409; OHRP Assurance number: FWA 00005561), with a prisoners' representative, approved all study procedures and a Certificate of Confidentiality (CoC) was obtained from the US National Institutes of Health to protect the sensitive data to be collected (IRB protocol number B0140114, CoC number DA-15-025). Data were gathered through face-to-face structured interviews using CAPI by trained professional interviewers and Audio Computer-Assisted Self-Interview (ACASI) to safeguard participant confidentiality and to increase disclosure of stigmatized behaviors such as drug use and criminal behavior [65, 66]. Both interview modalities were programmed with Questionnaire Development System (QDS) version 3.0. Trained interviewers were available to answer questions during the self-administered ACASI procedure. Participants who screened positive for self-reported ADHD went on to complete structured clinical interviews with the DIVA.

Data collection was divided into 2 phases and completed in a 10-month period from June 2015 to March 2016. In Phase 1, we conducted interviews using a laptop computer with the QDS, CAPI, and ACASI software described above. We used the CAPI software for collecting data on sociodemographic characteristics, ADHD, SUD, and psychiatric disorders. We used the ACASI software, which is suited for collecting sensitive data, to collect information about criminal history, prison gang membership, maltreatment history, and depression. In Phase 2, participants who had screened positive for ADHD in Phase 1 completed a full ADHD structured clinical interview administered by 2 doctoral-level graduate students of clinical psychology, trained and supervised by a licensed clinical psychologist. This ADHD screening and diagnostic process is summarized in Figure 1.

**Table 2.** Severity of comorbid SUD based on number of symptoms (DSM-5 criteria) by ADHD (unadjusted models, ordered logit,  $N = 483$ )<sup>a</sup>

	OR <sup>b</sup>	95% CI	<i>p</i> value
SUD lifetime (any substance)	2.17	1.29, 3.65	<b>0.003</b>
Alcohol	1.45	0.90, 2.33	0.129
Cannabis	2.05	1.29, 3.27	<b>0.002</b>
Cocaine	2.06	1.19, 3.57	<b>0.010</b>
Heroin	1.86	0.96, 3.58	0.064
Opioids	1.58	0.88, 2.82	0.125
Sedatives	1.66	0.97, 2.84	0.065
SUD current (any substance)	2.08	1.27, 3.43	<b>0.004</b>
Alcohol	0.67	0.25, 1.79	0.420
Cannabis	1.81	1.08, 3.03	<b>0.024</b>
Cocaine	2.93	1.28, 6.71	<b>0.011</b>
Heroin	4.32	1.79, 10.44	<b>0.001</b>
Opioids	2.38	0.95, 5.92	0.064
Sedatives	2.17	0.92, 5.12	0.077

SUD, substance use disorders; DSM-5, *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition; ADHD, attention deficit hyperactivity disorder; OR, odds ratio. <sup>a</sup> Total  $N = 500$ ; 17 of 111 participants who screened positive for ADHD were lost to follow-up diagnostic interview, thus  $N = 483$  for analyses involving ADHD diagnosis. <sup>b</sup> Baseline model adjusted for education and age.

### Data Analysis

We report absolute ( $n$ ) and relative frequencies (%) to describe all categorical variables and means and standard deviations for continuous variables. To explore the association between categorical variables, we used  $\chi^2$ /Wald distribution tests and logistic regression. We tested unadjusted univariate logistic regression models and calculated their respective ORs. We examined binary logistic regression models using ADHD in association with binary outcomes and adjusting for the effects of age and education, which were significantly associated with ADHD as baseline models. We adjusted for all the other comorbidities in the adjusted models. We used ordered logistic regression models to examine association with DSM-5 SUD severity outcomes. Finally, we tabulated the number of comorbid disorders (0–5) and used ordered logistic regression models to examine their association with ADHD, adjusting for education and age. Statistical analyses were conducted using Stata 15.

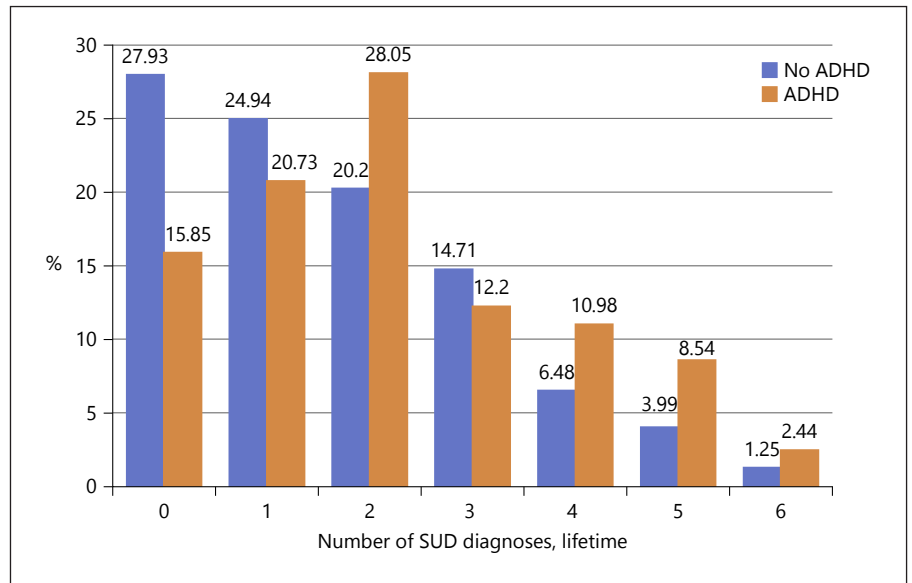
### Results

We found that 17% ( $n = 82$ ) of participants met the DSM-5 diagnostic criteria for adult ADHD (Table 1). In terms of SUD, 74% ( $n = 358$ ) of all participants met the DSM-5 diagnostic criteria for lifetime SUD, while 30% ( $n = 144$ ) met the criteria for current SUD. Having ADHD significantly increased the odds of having a lifetime

**Table 3.** Severity of SUD based on number of symptoms (DSM-5 criteria) by ADHD in models adjusted for comorbid psychiatric disorders (ordered logit,  $N = 500$ )<sup>a</sup>

Comorbid disorder	Lifetime SUD severity (DSM-5)		Current SUD severity (DSM-5)	
	adjusted OR <sup>b</sup> [95% CI]	<i>p</i> value	adjusted OR [95% CI]	<i>p</i> value
ADHD	1.06 [0.59, 1.90]	0.838	1.12 [0.64, 1.98]	0.691
ASP	2.29 [1.44, 3.65]	<b>0.001</b>	1.80 [1.14, 2.84]	<b>0.012</b>
BPD	2.55 [1.55, 4.18]	<b>&lt;0.001</b>	1.99 [1.22, 3.26]	<b>0.006</b>
Major depression	1.51 [0.67, 3.39]	0.322	2.75 [1.24, 6.08]	<b>0.013</b>
GAD	1.97 [1.14, 3.40]	<b>0.016</b>	1.01 [0.59, 1.71]	0.982

SUD, substance use disorders; DSM-5, *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition; ADHD, attention deficit hyperactivity disorder; OR, odds ratio; ASP, antisocial personality disorder; BPD, borderline personality disorder; GAD, generalized anxiety disorder. <sup>a</sup> Numbers may vary due to missingness. <sup>b</sup> ORs for each comorbid disorder are adjusted for all the others (ADHD, depression, generalized anxiety, BPD, and ASP), as well as education and age.



**Fig. 2.** Number of lifetime SUD diagnoses by ADHD ( $N = 483$ ). SUD, substance use disorder; ADHD, attention deficit hyperactivity disorder.

(AOR = 1.89 [1.00, 3.58],  $p = 0.05$ ) and current (AOR = 1.88 [1.14, 3.11],  $p = 0.013$ ) DSM-5 diagnosis of SUD, after adjusting for age and education.

#### ADHD Is Associated with Increased SUD Severity DSM-5 SUD Severity (Number of Symptoms)

Table 2 shows severity of lifetime and current SUD for any substance and for each specific substance, comparing participants with and without ADHD, in terms of symptom count. Participants with ADHD had more severe lifetime and current SUD (OR = 2.17 [1.29, 3.65],  $p = 0.003$ ; OR = 2.08 [1.27, 3.43],  $p = 0.004$ , respectively). Examining

the number of symptoms by substance, participants with ADHD had significantly more severe lifetime cannabis and cocaine use disorders (OR = 2.05 [1.29, 3.27],  $p = 0.002$ ; OR = 2.06 [1.19, 3.27],  $p = 0.01$ ) and more severe current cannabis, cocaine, and heroin use disorders (see Table 2). In models adjusted for comorbid psychiatric disorders (presented in Table 3), ADHD was not significantly associated with increased number of symptoms in either current or lifetime SUD. However, ASP, BPD, and GAD were significantly associated with more lifetime SUD symptoms, and ASP, BPD, and major depression were associated with more current SUD symptoms.

**Table 4.** Severity of SUD based on polysubstance use by ADHD and comorbid psychiatric disorders ( $N = 500$ )<sup>a</sup>

Comorbid disorder	Lifetime polysubstance (2 or more SUD diagnoses)		Total sample, $N$ (%) <sup>a</sup>	Unadjusted OR <sup>b</sup> [95% CI]	Adjusted OR <sup>c</sup> [95% CI]
	yes, $n$ (%)	no, $n$ (%)			
Total	253 (50.60)	247 (49.40)	500 (100)		
ADHD	52 (21.58)	30 (12.40)	82 (16.98)	1.83 [1.11, 3.00]*	0.83 [0.47, 1.49]
ASP	117 (46.43)	56 (23.93)	173 (35.60)	2.68 [1.84, 3.98]***	1.97 [1.26, 3.09]**
BPD	162 (65.32)	84 (34.57)	246 (50.10)	3.56 [2.44, 5.19]***	2.72 [1.72, 4.33]***
Major depression	33 (13.36)	11 (4.58)	44 (9.03)	3.17 [1.56, 6.45]***	1.26 [0.54, 2.94]
GAD	95 (37.55)	43 (17.41)	138 (27.60)	2.80 [1.84, 4.25]***	1.41 [0.83, 2.39]

Comorbid disorder	Current polysubstance (2 or more SUD diagnoses)		Total sample, $N$ (%) <sup>a</sup>	Unadjusted OR <sup>b</sup> [95% CI]	Adjusted OR <sup>c</sup> [95% CI]
	yes, $n$ (%)	no, $n$ (%)			
Total	71 (40.20)	429 (85.80)	500 (100)		
ADHD	17 (25.76)	65 (15.59)	82 (16.98)	1.78 [0.95, 3.31]	0.86 [0.42, 1.77]
ASP	39 (59.43)	134 (32.29)	173 (35.60)	2.43 [1.44, 4.09]***	2.09 [1.15, 3.77]*
BPD	51 (72.86)	195 (46.32)	246 (50.10)	2.93 [1.67, 5.16]***	2.13 [1.08, 4.19]*
Major depression	15 (21.74)	29 (6.94)	44 (9.03)	3.79 [1.89, 7.60]***	3.09 [1.30, 7.34]*
GAD	27 (38.03)	111 (25.87)	138 (27.60)	1.73 [1.02, 2.94]*	0.78 [0.39, 1.56]

SUD, substance use disorders; ADHD, attention deficit hyperactivity disorder; ASP, antisocial personality disorder; BPD, borderline personality disorder; GAD, generalized anxiety disorder. \*  $p \leq 0.05$ . \*\*  $p \leq 0.01$ . \*\*\*  $p \leq 0.001$ . <sup>a</sup> Numbers may vary due to missingness. <sup>b</sup> In baseline (“unadjusted”) model, ORs are adjusted for education and age. <sup>c</sup> ORs for each comorbid disorder are adjusted for all the others (ADHD, depression, generalized anxiety, BPD, and ASP), as well as education and age.

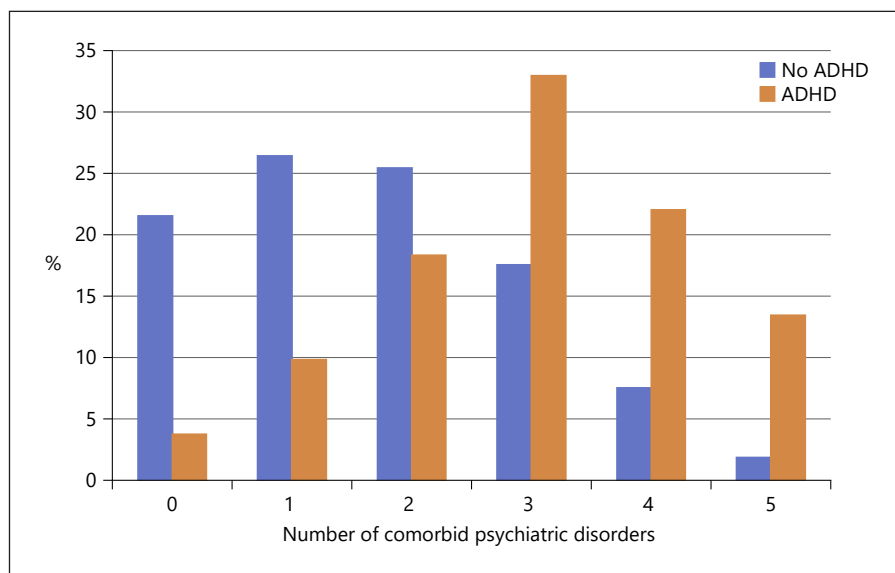
### Polysubstance Diagnoses

Figure 2 shows the number of SUD diagnoses by ADHD. Participants with ADHD had significantly more SUD diagnoses than those without ADHD ( $p < 0.001$ ). Table 4 presents SUD severity in terms of polysubstance use (coded as binary variable meaning having 2 or more SUD diagnoses) by ADHD in unadjusted models and models adjusted by other comorbid psychiatric disorders. For lifetime polysubstance diagnoses, ADHD, ASP, BPD, major depression, and GAD significantly increased odds for polysubstance use in models adjusted only for education and age. In models adjusted for all other comorbid disorders, only ASP and BPD significantly increased odds for lifetime polysubstance. Participants with these 2 personality disorders had an approximately 2-fold increase in odds for lifetime polysubstance diagnoses. ASP, BPD, and major depression, but not ADHD, were associated with increased odds for current polysubstance diagnoses in both adjusted and unadjusted models. GAD significantly increased odds for current polysubstance only in unadjusted models but was not significant in models adjusting for other comorbidities.

### ADHD Is Associated with Increased Psychiatric Comorbidity

Comorbidity of ADHD with SUD and other psychiatric disorders including ASP, BPD, major depression, GAD, and suicidality is presented in Table 1. Participants with ADHD were more likely to have an additional comorbid disorder. They had significantly increased odds for SUD, ASP, BPD, major depression, and GAD, with ORs ranging from 6.59 [3.19, 13.61] (depression) to 2.90 [1.75, 4.81] (generalized anxiety). Participants with ADHD had a 2- to 3-fold increase in odds for ASP, BPD, major depression, and suicidality, even after adjusting for all comorbid disorders (see online suppl. Table 1; for all online suppl. material, see [www.karger.com/doi/10.1159/000508829](http://www.karger.com/doi/10.1159/000508829)). OR ranged from 3.53 [1.75, 7.12] ( $p < 0.001$ ) for BPD to 2.91 [1.66, 5.08] ( $p < 0.001$ ) for ASP.

Participants with ADHD were also more likely to have a greater number of comorbid psychiatric disorders compared to those without ADHD (OR 5.48 [3.48, 8.63],  $\chi(3) = 69.28$   $p < 0.001$ ). Figure 3 displays the number of comorbid psychiatric disorders, including SUD, major depression, ASP, BPD, and GAD, comparing participants



**Fig. 3.** Number of comorbid psychiatric disorders by ADHD (N = 483). ADHD, attention deficit hyperactivity disorder.

with versus without ADHD diagnosis. As Figure 3 shows, the gap between ADHD/non-ADHD participants widens as the number of comorbid disorders increases.

## Discussion

ADHD is associated with greater risk for SUD diagnosis among prisoners. Participants with ADHD had a 2-fold increase in odds for lifetime and current SUD diagnosis. There seems to be a consistency in these findings – a meta-analytic study of ADHD and comorbidities in prisoners reports OR of 2.48 [28]. Similarly, the study of Hamzeloo et al. [24] on Iranian male prisoners reports 85% of those with ADHD also have lifetime SUD, which is similar to 84.2% in our study.

Beyond increasing the risk for presence of SUD, ADHD is associated with greater severity of SUD in prisoners, both in terms of symptom count and number of SUD (polysubstance) diagnoses. Participants with ADHD had greater severity in both lifetime and current SUD, indicated by more symptoms, as well as by polysubstance diagnoses. Recently, studies of male prisoners have reported that those with ADHD have greater severity of SUD [31, 67]. Similarly, studies of community adults in treatment for opioid or cocaine dependence had concluded that ADHD is associated with greater substance dependence and psychiatric comorbidity and greater severity of addiction [15, 68].

Participants with ADHD had significantly higher odds for all comorbid psychiatric disorders studied, including

major depression, GAD, BPD, and ASP. They also had greater odds for suicidality and a greater number of comorbid disorders. These comorbid disorders may have a potential role in the association between ADHD and SUD severity, as in models adjusting for these comorbidities ADHD no longer predicted SUD severity, but ASP, BPD, major depression, and GAD did. ADHD, BPD, ASP, and also SUD share features related to executive function deficits, including impulsivity, reward sensitivity, and novelty seeking. This shared underlying psychopathology may help explain the relationship between ADHD and SUD. For instance, impulse control deficits play an important role in addiction [69] and also characterize ADHD, BPD, and ASP [70, 71], which often co-occur with SUD [13]. More recently, a network analysis approach hypothesizes that comorbid disorders may co-occur due to mutual interactions among symptoms [72, 73]. Previous studies of comorbidities among prisoners with ADHD have shown relevant results, for instance, the 2015 meta-analysis examining ADHD and comorbid psychiatric disorders among incarcerated populations [28] reported increased risk (OR) among prisoners with ADHD for all comorbidities studied. These included conduct disorder, SUD, mood, anxiety, and personality disorders. More recent studies are consistent, showing SUD, mood, anxiety, BPD, ASP [24, 29, 74], and increased suicidality [15] to be significantly associated with ADHD in various prison populations. For instance, although the estimated prevalence of major depression in male prisoners is 10% [75], similar to the 8% reported in the present



study, we found a higher prevalence of depression of 24% among those with ADHD. We focused on potential associations between ADHD, SUD, anxiety, mood disorders, and personality disorders based on previous prison research [22, 28, 30, 44]. Recent data on PTSD show that PTSD is also overrepresented among prison inmates [76], that it is associated with ADHD among incarcerated adults [77] and that there is a prospective link between these disorders in the population [78].

The present study expands the existing body of literature on ADHD and SUD while also shedding light on ethnic minority prisoners. These populations tend to be overrepresented in prisons across the world [35, 37, 38] while also being sub-represented in research. Preliminary data from our research group [46] from a sample of 1,179 sentenced inmates (81.3% male) representative of the prison population of Puerto Rico were analyzed in terms of the ADHD-SUD relationship and other variables [22]. Thirty-two percent of inmates presented a childhood history of ADHD symptoms, and childhood ADHD was associated with a host of adverse adult outcomes related to SUD, criminality, and health risk behaviors. Inmates with childhood ADHD symptomatology had increased probability of adverse health outcomes, additional psychiatric comorbidity and SUD, and earlier onset of criminality and greater recidivism. However, these preliminary studies focused on childhood symptoms of ADHD and lacked current diagnosis by clinical interview, as well as lacking data on personality disorders such as ASP, important in the ADHD-SUD association. The present study addressed those limitations. Using diagnosis by clinical interview, in the current study, 17% of the Latino male participants assessed presented ADHD diagnosis. This is comparable to the prevalence of ADHD among prisoners reported by previous studies in other countries with ethnically different prisoner populations [23, 24, 29]. In their meta-analysis of 42 studies reporting prevalence of ADHD in prison populations, Young et al. [23] reported a prevalence of ADHD of 20.5% when diagnosis by interview is used. More recently, Hamzeloo et al. [24] reported a prevalence of 16.2% among Iranian male prisoners, while Moore et al. [29] reported a prevalence of 17% among Australian male and female prisoners. Thus, there seems to be a consistency in studies across ethnically and culturally diverse prison populations, when ADHD is established by clinical interview. Regarding SUD, prevalence of SUD was 74% (lifetime) and prevalence of current SUD was 30%. A recent systematic review by Fazel et al. [79] reported that 10–61% of male prisoners had drug abuse or dependence.

### *Limitations*

The present study has advantages and limitations. The principal strengths are the relatively large sample size, and the fact that we study an underrepresented and underserved minority within the US context that nonetheless tends to be overrepresented among criminal justice populations. Other strengths include the fact that participants were randomly selected, diagnostic instruments with sound psychometric properties were used, careful measures were taken to enhance validity of the reporting of sensitive information, and data were rigorously monitored for quality control. The study has some limitations. The sample included only male prisoners in the Puerto Rico correctional system and therefore is representative of this subset of Latino prison inmates. Although they tended to be consistent with studies from different ethnic and cultural settings, findings may not generalize to other prison populations, particularly female prisoners. Because we used face-to-face interviews and self-reported data of sensitive information by prison inmates, who are a vulnerable population, the accuracy of responses is always an issue. However, we took care and implemented measures to protect voluntariness and safeguard privacy and thus maximize validity and accuracy of information collected. For example, we did not collect identifying information, the IRB waived the requirement of signatures on consent forms to protect participants' identities, and we used a self-administered computer interface rather than interviewer's questions for the most sensitive information, as well as securing a CoC to protect the data.

### **Conclusions**

Prisoners with ADHD have more severe SUDs and are at greater risk for all comorbid psychiatric disorders and suicidality; they also have more comorbid disorders, which may have an explanatory role in the ADHD-SUD severity association. It is possible that the shared underlying psychopathology among ADHD, BPD, and ASP (including impulsivity, reward sensitivity, and novelty seeking) has an important explanatory role in the observed relationship between ADHD and SUD. For example, the role of impulse control deficits across these disorders has been highlighted. Results underscore the complexity of ADHD, SUD, and comorbidities, particularly in prisoner populations, where ADHD, SUD, and other psychiatric disorders are prevalent and interrelated. ADHD complicates and exacerbates the mental health needs of prisoners and thus requires treatment approaches that respond

to this complexity. As ADHD is prevalent among criminal justice and SUD populations, screening for ADHD in criminal justice and prison settings should be routine, and there is evidence suggesting that treating ADHD may reduce criminality and recidivism [80]. Attending to the complex mental health needs of incarcerated populations and providing responsive and appropriate care within the prison setting could reduce recidivism and improve outcomes of the rehabilitation process.

## Statement of Ethics

Written informed consent was obtained from participants, and the study protocol was approved by the University of Puerto Rico Medical Sciences Campus Institutional Review Board (IRB Registration number: IRB00004409; OHRP Assurance number: FWA 00005561) with a prisoners' representative. A Certificate of Confidentiality (CoC) was obtained from the US National Institutes of Health (NIH) to protect the sensitive data to be collected (IRB protocol number B0140114, CoC number DA-15-025).

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## Author Contributions

All the authors who contributed to the writing of this manuscript concurred with its submission and have approved the final manuscript. M.C.V.-P. – study design, data collection, data management, analysis plan, statistical analyses, drafted introduction/method/results/discussion, and edited the manuscript. R.A.G. – study design, data collection, data management, analysis plan, and statistical analyses. A.R.-F. – drafted introduction and updated manuscript. R.R.R.P. – commented on drafts of application and manuscript. F.R.L. – commented on drafts of application and manuscript. C.A.G. – commented on drafts of application and manuscript.

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