

RESEARCH ARTICLE

Association between substance use disorders and self- and other-directed aggression: An integrated model approach

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Abstract

Our study's objective is to determine whether substance use disorders' association with aggression differs according to the type of substance and/or the form of aggression, within the same population. We used data from the National Survey on Drug Use and Health across 2008–2014, with a pooled sample of 270,227 adult respondents. We used regression models to estimate the odds ratios for those having alcohol and/or drug use disorder(s) perpetrating (a) each form of aggression compared with no aggression and (b) other-directed compared with self-directed aggression. Alcohol use disorder alone and drug use disorder(s) alone were both associated with significantly increased odds of committing self-directed, other-directed, and combined aggression. Individuals with drug use disorder(s) alone were more likely to commit other-directed than self-directed aggression (adjusted odds ratio = 1.46, 95% CI = 1.04–2.05). Individuals with alcohol use disorder alone were not likely to commit one over the other (adjusted odds ratio = 1.20, 95% CI = 0.90–1.61). In conclusion, the integrated model of aggression based on the stress–diathesis model is a relevant framework to study risk factors for aggression. Further research is needed to identify longitudinal predictors of directionality of aggression.

KEYWORDS

aggression, epidemiology, substance use disorders, suicide

1 | INTRODUCTION

Extensive epidemiological, clinical, and neurobiological research has shown that self-directed and other-directed aggression (SDA and ODA) share similarities in diathesis and stressors (Lubell & Vetter, 2006; Turecki & Brent, 2016). A recent systematic review into the co-occurrence of both forms of aggression found that, regardless of the methodology used, they are positively associated, and that displaying one behavior increases the risk of displaying the other, with a co-occurrence prevalence higher than 20% in most studies (O'Donnell, House, & Waterman, 2015). Yet, several questions remain unanswered, probably due to a lack of a uniform evidence-based conceptual approach to

aggression (Ferguson & Dyck, 2012; Lubell & Vetter, 2006; O'Donnell et al., 2015; Prabha Unnithan, Huff-Corzine, Corzine, & Whitt, 1994). Although multiple risk and protective factors have been identified, current models of suicide and interpersonal aggression have failed to reliably and accurately predict occurrence of events (Quinlivan et al., 2016; Whittington et al., 2013). Given the burden of violence, it is crucial to further explore the pathophysiology of aggressive behavior to identify predictive factors and design avenues for treatment. An integrated model approach to aggression can help bridge that gap (Hillbrand, 2001; Lubell & Vetter, 2006; O'Donnell et al., 2015; Prabha Unnithan et al., 1994).

However, few conceptualizations (Lubell & Vetter, 2006; Plutchik, van Praag, & Conte, 1989; Prabha Unnithan et al., 1994) have adopted

such a model. Prabha Unnithan's team argued for an integrated explanatory model of violence, studying suicide and homicide as "two sides of one coin" rather than two separate independent entities (Prabha Unnithan et al., 1994). Their sociological model identified two sets of causal factors for violence within a population: "forces of production," responsible for the production of total lethal violence, and "forces of direction," responsible for the direction of violence, that is, for choosing between suicide and homicide (Prabha Unnithan et al., 1994).

Using individual-level data from psychiatric patients, Plutchik's team designed the "Two-Stage Model of Countervailing Forces," based on the premise that "any [violent] event is a vectorial resultant of the interaction of opposing forces" over two stages (Plutchik et al., 1989). They argued that aggressive impulses are a common denominator between self-directed and interpersonal aggression, and that they are generated by "triggers." At the first stage, these impulses are subjected to "amplifiers" and "attenuators," and the probability of it turning to aggressive behavior depends on the "vectorial resultant of the presence of these opposing or countervailing forces." At the second stage, the "goal" of the aggressive behavior is selected, depending on another set of forces (Plutchik et al., 1989).

The aforementioned research postulates a stress–diathesis model to explain the production and direction of aggression. Some researchers have argued for conceptualizing SDA and ODA as two phenomena sharing a common diathesis, such as impulsivity (Lubell & Vetter, 2006; O'Donnell et al., 2015). Substance (alcohol and illicit drugs) use has been identified as an independent environmental risk factor for perpetration of both SDA and ODA through different mechanisms (Krug et al., 2002); in a stress–diathesis model, substance use would be a stressor. Recent evidence points to shared causal and predisposing processes to impulsivity, substance use, suicidal behavior, and interpersonal aggression: impulsivity, through impairing decision-making capacity, appears to be a mediating factor between substance use and SDA and ODA (Fineberg et al., 2014; Turecki, 2005).

Our study explores the association between substance use disorders and self-directed and other-directed physical aggression using an integrated model based on a stress–diathesis model. Our framework adopts a unified strategy for outcome assessment within the same population, relying on self-reported intentionality to engage in physically aggressive behavior toward self (i.e., attempted suicide) and toward others (i.e., assault). We hypothesized that drug use disorder(s), unlike alcohol use disorder, will act as a "force of direction" by significantly increasing the odds of assault compared with suicide attempts. The integrated model of aggression can shed some light on identifying determinants of directionality of aggressive behavior and thus help develop targeted prevention strategies.

2 | MATERIALS AND METHODS

2.1 | Data source

We retrieved the publicly available data of the National Survey on Drug Use and Health (NSDUH) from the Inter-university Consortium

for Political and Social Research (ICPSR) (Inter-university Consortium for Political and Social Research, 2017). The NSDUH is "an annual nationwide survey involving interviews with ~70,000 randomly selected individuals aged 12 years and older" (National Survey on Drug Use and Health, 2017). The NSDUH survey uses a multistage area probability sampling technique in each of the 50 states and the District of Columbia, to select a nationally representative sample of the noninstitutionalized, household-based civilian population aged 12 years and older (Inter-university Consortium for Political and Social Research, 2017). All variables that could potentially be used as identifiers were either encrypted, substituted, or removed. Details about the methodology of each survey are available in the yearly methodology reports (Substance Abuse and Mental Health Services Administration, 2018).

For the purposes of our study, we pooled data from consecutive cross-sectional NSDUH surveys from 2008 through 2014 (United States Department of Health and Human Services. Substance Abuse and Mental Health Services Administration. Center for Behavioral Health Statistics and Quality, 2015a, 2015b, 2015c, 2015d, 2016; United States Department of Health and Human Services. Substance Abuse and Mental Health Services Administration. Office of Applied Studies, 2015a, 2015b). Public-use files include 391,753 records out of 477,896 respondents from 2008 to 2014. We analyzed the data of the 270,227 adult respondents (aged 18 years or older) from 2008 to 2014. Institutional Review Board approval was not required, as data were de-identified and made publically available.

2.2 | Measures

2.2.1 | Dependent variable

We constructed a composite categorical variable measuring aggression (A) based on answers to two questions: "During the past 12 months, did you try to kill yourself?" and "During the past 12 months, how many times have you attacked someone with the intent to seriously hurt them?."

Its categories as self-reported within the past 12 months are as follows:

- Nonaggressive (NA): No aggression reported.
- SDA: At least one suicide attempt reported and no physical assault reported.
- ODA: At least one physical assault reported and no suicide attempt reported.
- Combined aggression (CA): At least one suicide attempt and one physical assault reported.

2.2.2 | Independent variable

We constructed the independent variable (U) to measure substance use disorders. NSDUH used the DSM-IV criteria for the diagnoses of past-year substance abuse and dependence. Substances assessed in the NSDUH are as follows: tobacco, alcohol, cannabis,

cocaine, crack, stimulants, hallucinogens, inhalants, heroin, prescription pain relievers, tranquilizers, and sedatives (Center for Behavioral Health Statistics and Quality, 2016). We excluded tobacco from our independent variable, because it was not measured in the NSDUH according to DSM criteria.

Changes implemented in DSM-5 have led to a re-evaluation of the NSDUH diagnostic algorithms' validity (Center for Behavioral Health Statistics and Quality, 2016). To better align NSDUH's algorithms with DSM-5 criteria for substance use disorders, and based on SAMHSA's suggestions and previous studies using the same data (Harford, Chen, & Grant, 2016), the past 12 months diagnostic criteria for substance use disorders were assessed by combining DSM-IV substance abuse and dependence criteria, and dropping the legal criterion. A diagnosis of substance use disorder was deemed positive if, for any one substance, two or more of the criteria are fulfilled. Hence, the categories of the independent variable (U), as self-reported within the last 12 months are as follows:

- No substance use disorder (NSUD) reported.
- Alcohol use disorder alone (AUDa) reported.
- Drug use disorder(s) alone (DUDa) reported: any positive substance use disorder, except for alcohol.
- Alcohol and drug use disorders (ADUD) reported.

2.2.3 | Control variables

We controlled for age (three categories: 18–25, 26–49, 50 years or older), sex, race/ethnicity, marital status, household type, education level, past-year employment, personal income level, area of residence, religiosity, past-year tobacco use, past-year psychiatric disorder (excluding substance use disorders), past-year mental health treatment, past-year substance use treatment, juvenile substance use, and survey year. We tried to be exhaustive in selecting variables that have been reported in the literature to be associated with aggression. Please refer to Supporting Information Material 1 for more information regarding our measures design.

2.3 | Analysis plan

We conducted the analyses using the Complex Samples module in the Statistical Package for Social Sciences version 21. This module allowed us to account for the complex survey design by using the sample design variables Analysis Stratum (VESTR: variance estimation [pseudo] stratum) and Analysis Replicate (VEREP: variance estimation [pseudo] replicate within stratum). As we pooled data from 2008 through 2014, we adjusted sample weights by computing a variable (We) according to the following formula, as recommended (United States Department of Health and Human Services. Substance Abuse and Mental Health Services Administration. Center for Behavioral Health Statistics and Quality, 2015a, 2015b, 2015c, 2015d, 2016; United States Department of Health and Human

Services. Substance Abuse and Mental Health Services Administration. Office of Applied Studies, 2015a, 2015b):

$$(We) = \frac{\text{Person} - \text{Level Analysis Weight}}{\text{Number of Years of Combined Data}} \\ = \frac{\text{Final Person} - \text{Level Sample Weight}}{7}$$

We tabulated all variables and presented their frequencies. We tested for multicollinearity between variables by using Pearson's bivariate correlation test. We then conducted bivariate analyses for the independent and control variables with the dependent variable. The associations were measured using the adjusted F test, a variant of the χ^2 -test adjusted for complex samples. We set statistical significance at the α -level cutoff of 0.83% after using Bonferroni's correction method to adjust for multiple testing. We then entered the independent variable in a multivariate logistic model with the set of control variables that were significant in bivariate analyses, and we adjusted the models to reach the best fit for each analysis. We then calculated the adjusted odds ratio (aOR) and its corresponding 95% confidence interval (CI) for committing different forms of aggression on each category of our independent variable.

3 | RESULTS

3.1 | Sample characteristics

The total sample of adults in the NSDUH surveys from 2008 through 2014 includes 270,227 adults (population size estimate [PSE] = 232,414,058), distributed across survey years almost evenly as shown in Supporting Information Material 2.

A total of 6.8% of the population surveyed had an AUDa, 2.7% had DUDa, and 1.7% had both disorders (ADUD). More than half of the respondents with AUDa were 26–49-year olds and more than half of those who had ADUD were 18–25-year olds. Two-thirds of each group of users were male. Non-Hispanic Blacks were significantly more prevalent among DUDa and ADUD subgroups. A significant proportion of users had “never been married” at the time of questioning. Around 16% of respondents in DUDa and ADUD were college graduates, less so than respondents in AUDa and NSUD. A higher proportion of positive substance use disorder respondents had intermittent employment over the past year and more than 40% of respondents in DUDa and ADUD had low-income levels. Past-year tobacco use and juvenile substance use were preponderant among all positive substance use categories. Between 30% and 50% of substance use disorder respondents were estimated to have a psychiatric disorder over the past year and more than a quarter of those diagnosed with DUDa or ADUD received mental health treatment over the same time frame.

As shown in Figure 1, more than 80% of respondents with any substance use disorder were classified as nonaggressive (NA) over the past year. However, aggression is more prevalent in those who have a positive substance use disorder compared with those who do

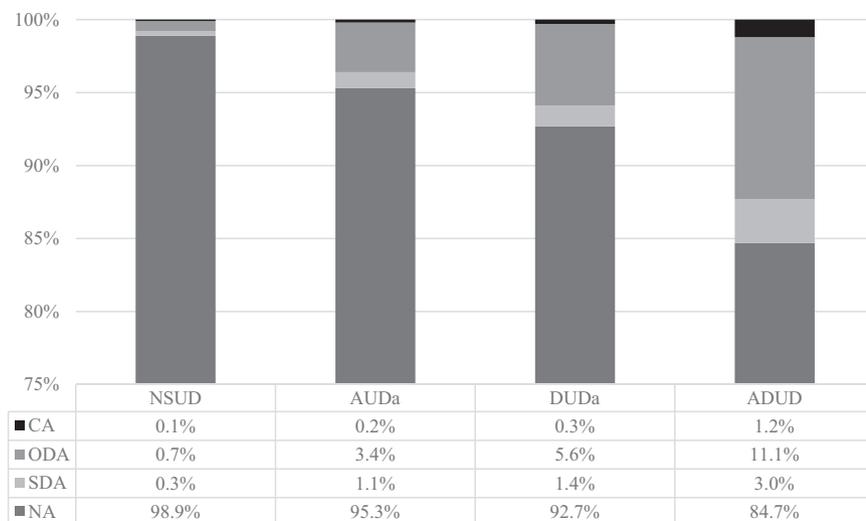


FIGURE 1 Weighted distribution of forms of aggression by substance use disorder categories. Abbreviations: ADUD, alcohol and drug use disorder; AUDa, alcohol use disorder alone; CA, combined aggression; DUDa, drug use disorder(s) alone; NA, nonaggressive; NSUD, no substance use disorder; ODA, other-directed aggression; SDA, self-directed aggression

not. Although the prevalence of aggression is increased among AUDa and DUDa, it is even higher in ADUD: 11.1% reported ODA, 3.0% reported SDA, and 1.2% reported CA.

3.2 | Comparison between aggressive and nonaggressive subgroups

3.2.1 | Self-directed, other-directed, and combined aggression versus none

The exclusion of missing values led to the inclusion of a subsample of 268,839 adults (PSE = 231,365,447) as shown in Table 1. Compared with NA, the SDA ($P = 33.2\%$), ODA ($P = 47.5\%$), and CA ($P = 55.6\%$) subgroups included significantly higher proportions of 18–25-year olds. Substance use disorders were significantly more prevalent across SDA, ODA, and CA subgroups (adjusted $F = 727.397$; $p < .001$). In the SDA subgroup, 17.7% had AUDa, 8.4% had DUDa, and 11.6% had ADUD. Proportions were higher in the ODA subgroup with 18.9% having AUDa, 12.4% DUDa, and 15.2% ADUD, and even higher in the CA subgroup: 18.3% had AUDa, 15.1% had DUDa, and 33.2% had ADUD. Finally, a higher proportion of respondents in SDA, ODA, and CA were estimated to have had a psychiatric disorder in the past year.

3.2.2 | Self- versus other-directed aggression

Adjusted bivariate analyses have revealed a few differences in characteristics between the SDA and ODA subgroups. The proportion of 18–25-year olds was significantly higher among ODA. The male-to-female ratio was 0.7:1 in SDA and 1.7:1 in ODA. There were no distribution differences in race/ethnicity between the two subgroups. The prevalence of AUDa, DUDa, and ADUD was similar between the SDA and ODA subgroups. In addition, significantly higher proportions of SDA respondents were estimated to have had a psychiatric disorder and to have sought mental health treatment over the past year.

3.3 | Association of substance use disorders and forms of aggression

As detailed in Table 2, AUDa and DUDa significantly increased the odds of perpetrating SDA, ODA, and CA, even after adjusting for controls.

A positive drug use disorder was associated with significantly higher crude odds of committing ODA versus SDA ($OR_{DUDa} = 1.71$, 95% CI = [1.29–2.27]), whereas a positive alcohol use disorder diagnosis was not ($OR_{AUDa} = 1.24$, 95% CI = [0.95–1.63]). Comorbid ADUDs also yielded significantly higher odds of committing ODA: $OR_{ADUD} = 1.51$, 95% CI = (1.21–1.90). All three associations were maintained in the adjusted best-fit model (McFadden's $R^2 = 0.190$): ($aOR_{AUDa} = 1.20$, 95% CI = [0.90–1.61]), ($aOR_{DUDa} = 1.46$, 95% CI = [1.04–2.05]), ($aOR_{ADUD} = 1.34$, 95% CI = [1.03–1.75]).

4 | DISCUSSION

The overarching goal of this study was to examine the association between substance use disorders and SDA and ODA within an integrated model of aggression that is based on a stress–diathesis model. Our analyses showed that even after adjusting for confounders, AUDa, DUDa, and combined ADUDs were significantly associated with SDA, ODA, and CA, with differing effect margins. We hypothesized that by using this conceptualization, we can identify differential effects of substances on the directionality of aggression (self vs. other), which are independent of the effects of other key risk factors. The results supported our hypothesis: individuals with DUDa were up to two times more likely to commit ODA compared with SDA, while individuals with AUDa were not likely to commit one over the other. We were therefore able to identify a “force of direction” toward ODA by using an integrated model of aggression.

Our 12-month prevalence of alcohol use disorder was lower compared with another US general population survey (Grant et al., 2015), while the prevalence of drug use disorders was similar (Grant et al., 2016). The socio-demographic and clinical characteristics of

TABLE 1 Weighted prevalence estimates in percent of sample characteristics by aggression category

Characteristic	SDA (N = 1,944; PSE = 1,014,525; P = 0.4%)	ODA (N = 6,571; PSE = 2,836,342; P = 1.2%)	CA (N = 410; PSE = 141,203; P = 0.1%)	NA (N = 259,914; PSE = 227,373,377; P = 98.2%)	Test statistic (Pearson's adjusted F)	p-value
	P (SE)	P (SE)	P (SE)	P (SE)		
Age in years	a,b,c	c	c		318.258	<.001
18–25	33.2 (1.5)	47.5 (1.2)	55.6 (3.7)	14.2 (0.1)		
26–49	42.1 (1.9)	36.3 (1.1)	32.1 (4.0)	42.6 (0.2)		
50 or above	24.7 (2.0)	16.2 (1.1)	12.3 (3.8)	43.2 (0.2)		
Sex					73.830	<.001
Male	41.6 ^a (2.0)	62.8 ^c (1.0)	46.1 (3.6)	48.0 (0.2)		
Female	58.4 (2.0)	37.2 (1.0)	53.9 (3.6)	52.0 (0.2)		
Race/ethnicity		c	c		40.763	<.001
Non-Hispanic White	60.2 (2.0)	51.9 (1.1)	53.2 (3.4)	67.3 (0.2)		
Non-Hispanic Black	14.9 (1.2)	22.9 (0.8)	24.7 (2.7)	11.4 (0.2)		
Hispanic	15.9 (1.3)	18.6 (1.0)	13.9 (2.3)	14.3 (0.1)		
Other	9.0 (1.6)	6.6 (0.6)	8.2 (1.7)	6.9 (0.1)		
Marital status	a,c	c	c		143.629	<.001
Married	26.6 (1.9)	20.3 (1.0)	11.1 (2.4)	53.7 (0.2)		
Widowed	4.0 (0.9)	3.8 (0.7)	3.3 (2.1)	6.0 (0.1)		
Divorced or separated	22.4 (2.1)	12.3 (1.0)	22.0 (3.7)	13.9 (0.1)		
Never been married	47.0 (2.0)	63.7 (1.2)	63.7 (3.7)	26.4 (0.2)		
Household type	c	c	c		28.646	<.001
Single person	14.0 (1.7)	9.7 (0.9)	6.6 (1.8)	12.5 (0.1)		
Family	68.8 (1.9)	73.1 (0.9)	72.6 (4.1)	78.9 (0.2)		
Nonfamily	9.6 (1.1)	9.7 (0.7)	8.9 (2.5)	4.8 (0.1)		
Mixed	7.6 (1.2)	7.5 (0.5)	11.9 (3.1)	3.8 (0.1)		
Education level	c	c	c		93.498	<.001
Less than high school	23.3 (1.7)	29.7 (1.2)	36.6 (3.8)	14.1 (0.1)		
High school graduate	34.5 (1.6)	36.3 (1.0)	36.0 (3.6)	30.0 (0.2)		
Some college	28.1 (1.9)	25.1 (1.0)	24.9 (3.7)	26.2 (0.2)		
College graduate	14.1 (1.6)	8.9 (0.7)	2.5 (0.9)	29.7 (0.2)		
Past-year employment	c	c	c		121.944	<.001
Continuous	33.4 (1.9)	39.4 (1.1)	24.9 (3.2)	57.6 (0.2)		
Intermittent	16.0 (1.5)	17.6 (0.8)	19.6 (2.5)	7.7 (0.1)		
Not in labor force	50.5 (2.0)	43.0 (1.2)	55.5 (3.8)	34.7 (0.2)		
Personal income level in USD	c	c	c		178.878	<.001
Less than 10,000	47.3 (2.1)	45.9 (1.1)	57.5 (3.3)	23.9 (0.1)		
10,000–29,999	34.9 (2.1)	36.7 (1.0)	30.1 (3.1)	33.1 (0.2)		
30,000 or above	17.7 (1.6)	17.4 (0.9)	12.4 (3.0)	43.1 (0.2)		

(Continues)

TABLE 1 (Continued)

Characteristic	SDA (N = 1,944; PSE = 1,014,525; P = 0.4%)	ODA (N = 6,571; PSE = 2,836,342; P = 1.2%)	CA (N = 410; PSE = 141,203; P = 0.1%)	NA (N = 259,914; PSE = 227,373,377; P = 98.2%)	Test statistic (Pearson's adjusted F)	p-value
	P (SE)	P (SE)	P (SE)	P (SE)		
Area of residence					1.342	.244
Large metro	50.9 (2.1)	52.1 (1.0)	49.6 (3.6)	53.6 (0.3)		
Small metro	30.7 (1.7)	30.9 (0.9)	34.2 (3.7)	30.3 (0.3)		
Nonmetro	18.4 (1.6)	17.0 (0.7)	16.2 (2.3)	16.1 (0.2)		
Religiosity	61.2 ^c (1.9)	56.4 ^c (1.1)	54.5 ^c (3.8)	71.6 (0.1)	102.132	<.001
Past-year tobacco use	58.5 ^c (2.1)	66.0 ^c (1.1)	74.7 ^c (2.9)	33.3 (0.2)	445.181	<.001
AUD	29.3 ^c (1.7)	34.1 ^c (0.9)	51.4 ^c (4.3)	8.0 (0.1)	925.277	<.001
DUD	20.0 ^{b,c} (1.2)	27.5 ^{b,c} (1.0)	48.2 ^c (4.1)	4.0 (0.1)	1609.268	<.001
CUD	10.4 ^{a,b,c} (0.9)	17.9 ^c (0.7)	32.2 ^c (3.7)	2.2 (0.0)	1370.889	<.001
Other DUD	14.5 ^{b,c} (1.0)	16.1 ^c (0.9)	33.7 ^c (3.9)	2.3 (0.0)	991.781	<.001
Substance use disorders (U)	^{b,c}	^{b,c}	^c		727.397	<.001
NSUD	62.3 (1.7)	53.6 (1.1)	33.5 (3.4)	89.4 (0.1)		
AUDa	17.7 (1.6)	18.9 (0.7)	18.3 (3.5)	6.6 (0.1)		
DUDa	8.4 (0.8)	12.4 (0.7)	15.1 (2.9)	2.5 (0.0)		
ADUD	11.6 (0.9)	15.2 (0.6)	33.2 (3.6)	1.4 (0.0)		
Psychiatric disorder	69.3 ^{a,c} (2.1)	44.6 ^{b,c} (1.3)	84.5 ^c (2.4)	15.8 (0.1)	928.269	<.001
Past-year mental health treatment	55.6 ^{a,c} (2.2)	24.3 ^{b,c} (1.1)	61.6 ^c (3.5)	13.8 (0.1)	458.551	<.001
Past-year substance use treatment						
Alcohol	7.0 ^c (1.2)	4.0 ^c (0.5)	11.3 ^c (2.8)	0.6 (0.0)	269.347	<.001
Drugs	6.0 ^c (0.9)	4.7 ^c (0.5)	8.0 ^c (2.4)	0.5 (0.0)	359.795	<.001
Juvenile alcohol use	63.6 ^c (2.0)	69.2 ^c (1.2)	78.3 ^c (3.1)	49.0 (0.2)	140.699	<.001
Juvenile drug use	50.5 ^{b,c} (1.8)	60.7 ^c (1.1)	75.9 ^c (3.3)	27.0 (0.1)	582.511	<.001
Cannabis	42.8 ^c (1.9)	55.0 ^c (1.1)	65.0 ^c (3.9)	24.6 (0.1)	441.653	<.001
Any other drug	31.4 ^c (1.7)	37.8 ^c (1.1)	55.9 ^c (4.2)	12.3 (0.1)	588.051	<.001

Abbreviations: ADUD, alcohol and drug use disorders; AUD, alcohol use disorder; AUDa, alcohol use disorder alone; CA, combined aggression; CUD, cannabis use disorder; DUD, drug use disorder(s); DUDa, drug use disorder(s) alone; N, unweighted sample size; NA, nonaggressive; NSUD, no substance use disorder; ODA, other-directed aggression; P, prevalence in percent; PSE, population size estimate; SDA, self-directed aggression; SE, standard error in percent.

^aSignificantly different from "ODA" after adjusting for multiple comparisons ($p < .0083$).

^bSignificantly different from "CA" after adjusting for multiple comparisons ($p < .0083$).

^cSignificantly different from "NA" after adjusting for multiple comparisons ($p < .0083$).

our substance user subsamples AUDa, DUDa, and ADUD are similar to those reported in the literature (Stinson et al., 2005). AUDa, DUDa, and ADUD subgroups had, in increasing order, higher percentages of respondents with a psychiatric disorder, who reported juvenile alcohol and drug use, and who sought mental health and substance use treatment. These findings are in line with

previous reports in the literature regarding higher comorbidity with psychiatric disorders (Compton, Thomas, Stinson, & Grant, 2007; Hasin, Stinson, Ogburn, & Grant, 2007), higher likelihood of juvenile substance use (Peiper, Ridenour, Hochwalt, & Coyne-Beasley, 2016) and higher likelihood of seeking treatment (Arnaout & Petrakis, 2008; Stinson et al., 2005).

TABLE 2 Odds ratios from multinomial logistic regression analyses of committing different forms of aggression on substance use disorders

Substance use disorders (U)	Commission of violence (A)											
	SDA vs. NA			ODA vs. NA			CA vs. NA			ODA vs. SDA		
	Unadjusted model OR (95% CI)	Best-fit ^a model aOR (95% CI)	Best-fit ^a model aOR (95% CI)	Unadjusted model OR (95% CI)	Best-fit ^a model aOR (95% CI)	Best-fit ^a model aOR (95% CI)	Unadjusted model OR (95% CI)	Best-fit ^a model aOR (95% CI)	Best-fit ^a model aOR (95% CI)	Unadjusted model OR (95% CI)	Best-fit ^a model aOR (95% CI)	Best-fit ^a model aOR (95% CI)
NSUD (reference)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AUDa	3.84 (3.07–4.81)	1.93 (1.50–2.49)	2.32 (2.07–2.61)	4.78 (4.30–5.32)	2.01 (1.70–2.37)	2.78 (1.66–4.65)	7.40 (4.56–12.02)	2.73 (1.60–4.67)	2.78 (1.66–4.65)	1.24 (0.95–1.63)	1.71 (1.29–2.27)	1.20 (0.90–1.61)
DUDa	4.76 (3.79–5.97)	1.38 (1.06–1.79)	2.01 (1.70–2.37)	8.13 (6.99–9.46)	3.50 (3.09–3.96)	2.73 (1.60–4.67)	15.87 (10.19–24.70)	7.93 (4.87–12.92)	2.73 (1.60–4.67)	1.52 (1.21–1.90)	1.46 (1.04–2.05)	1.34 (1.03–1.75)
ADUD	11.51 (9.56–13.86)	2.62 (2.08–3.30)	3.50 (3.09–3.96)	17.49 (15.70–19.48)	3.50 (3.09–3.96)	7.93 (4.87–12.92)	61.15 (41.97–89.11)	7.93 (4.87–12.92)	7.93 (4.87–12.92)	1.52 (1.21–1.90)	1.34 (1.03–1.75)	1.34 (1.03–1.75)

Abbreviations: ADUD, alcohol and drug use disorders; aOR, adjusted odds ratio; AUDa, alcohol use disorder alone; CA, combined aggression; DUDa, drug use disorder(s) alone; NA, nonaggressive; SDA, self-directed aggression; NSUD, no substance use disorder; ODA, other-directed aggression; OR, odds ratio; 95% CI, 95% confidence interval.

^aAdjusted for age, sex, race/ethnicity, survey year, marital status, education level, past-year employment, personal income level, religiosity, past-year tobacco use, presence of a psychiatric disorder, juvenile drug use, past-year mental health treatment, and past-year substance use treatment. Significantly different from “NSUD” in bold ($p < .05$).

We found that drug use disorders and alcohol use disorder had an equally strong association with aggression (across all subtypes), even though alcohol is more widely available, and drug use disorders have a lower prevalence in the sampled population. This effect could be explained by a larger potency of illicit drugs to induce aggressive behavior or by the added exposure to drug markets, which is a known risk factor for violence (Pulay et al., 2008). Although previous research underlined the association of co-occurring alcohol and drug use disorders with suicide (Arnaout & Petrakis, 2008) and ODA (Korcha et al., 2014), our findings suggest that alcohol and drug use might have a synergistic effect on the production of aggression.

Previous research using the integrated model of aggression led to different results. Harford and his team (Harford, Yi, & Grant, 2013) found that alcohol use disorders and drug use disorders were both associated with increased likelihood of ODA versus SDA among adults; however, that study did not explore the risk associated with alcohol and drug use combined, and did not control for psycho-social confounders. A second study by Harford et al. (2016) used NSDUH data and showed an increased risk of ODA versus SDA for alcohol use disorder per DSM-5 criteria and a lower risk for drug use disorders (also per DSM-5 criteria) among 12–17-year olds. This study was also limited by the lack of controlling for psycho-social factors as well as psychiatric diagnoses.

So far, explanatory theories of the directionality of aggression have relied on psychological constructs such as personality traits and attributional styles. Recent research has identified associations between specific attributional biases and SDA (van Heeringen & Mann, 2014) and ODA behavior (Dodge, 2006), which have consequently been correlated with distinct brain regions (Choe, Shaw, & Forbes, 2015; Seidel et al., 2012). Alcohol and drugs might regulate these circuits (acutely and chronically) and differentially affect the directionality of aggressive urges. However, to better understand the role of substances in promoting aggressive behavior, research should focus on substance-specific associations rather than lump all substances in one or two (alcohol and drugs) categories, as there is evidence supporting substance-specific alterations of gene expression patterns (Lehrmann & Freed, 2008).

Our work has several strengths. We used pooled cross-sectional weighted data from a nationally representative survey of the US general population, to maximize our sample size and raise confidence in our findings. We used homogeneous definitions of SDA (i.e., attempted suicide) and ODA (i.e., assault), to increase comparability of categories within our outcome variables. Although NSDUH data used DSM-IV criteria to define substance use disorders, we coded exposure variables that are closer to DSM-5 criteria and are thus more scientifically relevant. Furthermore, our work was able to detect associations between specific substance use disorders and specific subtypes of aggressive behaviors within an integrated model of aggression, and after controlling for a wide array of relevant socio-demographic, psycho-social, and clinical factors. Using the integrated model of aggression has allowed us to quantify and compare these associations in the same population and therefore has provided more solid information on the burden of specific substance use disorders

and argued for the potential benefits of substance-specific research, in the same vein as research on alcohol. Additionally, the integrated model has shown its benefits in its ability to identify common risk factors for SDA and ODA.

However, our work also has a number of limitations. First, although we coded our exposure variables to further resemble DSM-5 criteria, they do not fully comply: the NSDUH did not include a “withdrawal criterion” for some substances, including cannabis. This might have led to an underestimation of the prevalence and the impact of substance use disorders in our population, and might explain differences in prevalence with other studies that relied on validated DSM-5 diagnostic tools (Grant et al., 2015; Grant et al., 2016). The drug use disorder(s) alone category in our independent variable included individuals who had one and/or multiple drug use disorders. Future research should assess drug-specific effects to further understand their contribution to the burden of violence.

Second, although the categories of our variable (A) had homogeneous constructs in terms of the intentionality of the behavior and the physical nature of the act, there were several relevant missing factors pertaining to the self- and other-directed violent behaviors. We did not include aggression of a strictly sexual or psychological nature, and neglect was not evaluated. Also, we were unable to assess the social context of the behavior, or whether it was pre-meditated or impulsive, or what means were used to commit it. Hence, our results have limited generalizability and might only apply to impulsive physically aggressive behaviors given the shared diathesis with substance use disorders. Furthermore, we did not have information regarding adverse childhood experiences, which are known to be a predisposing factor to commit aggressive behavior (Krug et al., 2002).

Third, our assessment for the presence of a psychiatric disorder relied on an equation derived from two scores of psychological distress (K6 scale) and functional impairment (WHODAS scale) rather than on structured diagnostic tools for psychiatric disorders. Our tool had moderate agreement (Cohen's $\kappa = 0.450$) with the full NSDUH tool (refer to Supporting Information Material 1 for further details). Given its low sensitivity, it is highly possible that we underestimated the prevalence of psychiatric disorders in our sample and therefore we could not fully account for their potential confounding effect on displaying aggressive behavior.

Fourth, survey data are subject to several biases, most important of which is recall bias as participants were asked symptoms and behaviors over the past 12 months. Poor recall might explain the finding that respondents who did not fulfill substance use disorder criteria reported having had substance use treatment over the past year. Selection bias also limits the generalizability of our results, because the NSDUH is a household survey and excludes institutionalized and homeless individuals.

Finally, as our work relied on pooled cross-sectional data, it is unable to establish causality between substance use disorders and aggression.

An integrated model of aggression based on the stress–diathesis model is a scientifically relevant model to establish the nature and

the magnitude of risk factors for aggression. Further research is needed to identify longitudinal predictors of directionality of aggression. Such studies would need to not only rely on self-report of aggressive events (self-directed or other-directed), but also on standardized measurement tools of aggression and impulsivity, and validated diagnostic tools of substance use and psychiatric disorders. Prospective studies including genetic and brain imaging data, as well as data about adverse childhood events are needed, to construct a stress–diathesis model for production and direction of aggression. Additional research is also required to design better preventive and therapeutic strategies targeting specific aggressive behaviors.

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CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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