Exploring the Association Between Substance Use Disorder and Viral Suppression in South Carolina Counties

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948

BACKGROUND

The Southern US bears a disproportionate burden of HIV with suboptimal viral suppression (VS) rates, undermining health outcomes, transmission prevention, and progress toward Ending the HIV Epidemic. County-level VS rates, a key population-level indicator of HIV care performance, are used to assess geographic disparities and guide public health resource allocation. Substance use disorders (SUDs) are prevalent among people with HIV (PWH) and linked to poorer outcomes (including reduced ART adherence and lower VS) and may vary geographically.

Knowledge Gap: Prior studies have focused on individual-level dynamics, overlooking the role of broader influences of SUD prevalence on HIV outcomes. Assessing SUD rates at the county level provides a structural lens for understanding how geographic and contextual factors associate with HIV VS.

Research Objective: This study aims to explore the association between county-level SUD prevalence and VS rates across all 46 counties in South Carolina (SC).

METHODS

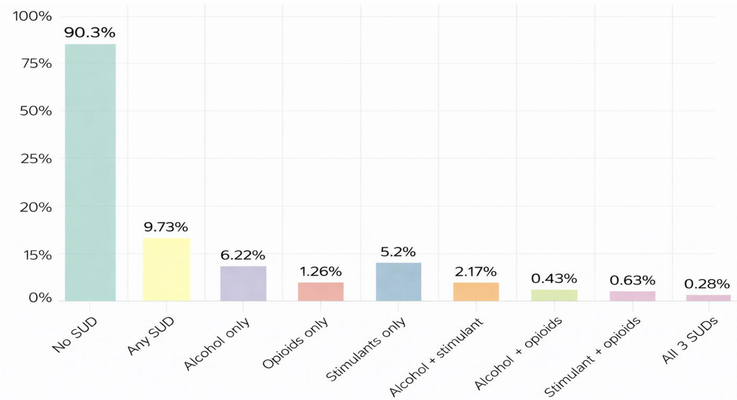
Data: This longitudinal cohort study used linked, statewide data from SC's enhanced HIV/AIDS Reporting System (e-HARS) linked to administrative health data (2013-2020)

Primary Outcome: Annual county-level viral suppression rate, defined as the percentage of PWH with viral load <200 copies/mL in the last reported test each year

Key exposures: Annual county-level prevalence of any of the three most commonly-diagnosed forms of SUD in SC (alcohol use disorder, opioid use disorder, and stimulant use disorder)

Analysis: Linear mixed-effects models with county random effects were used to assess associations between SUD prevalence and viral suppression, adjusting for demographic, socioeconomic, and health service factors.

Figure 1. Distribution of single and combination substance use disorders



MAJOR FINDINGS

Table 1. Demographic characteristics of Cohort participants of with and without SUD

Characteristic	Overall N = 11,237[1]	No SUD N = 10,144[1]	Any SUD N = 1,093[1]	p-value[2]
Age	34.0 (25.0, 46.0)	33.0 (25.0, 46.0)	41.0 (31.0, 49.0)	<0.001
Race				<0.001
Black	7,780 (69.2%)	7,039 (69.4%)	741 (67.8%)	
Hispanic	649 (5.8%)	622 (6.1%)	27 (2.5%)	
Others	320 (2.8%)	300 (3.0%)	20 (1.8%)	
White	2,488 (22.1%)	2,183 (21.5%)	305 (27.9%)	
Sex				<0.001
Male	8,553 (76.1%)	7,812 (77.0%)	741 (67.8%)	
Female	2,684 (23.9%)	2,332 (23.0%)	352 (32.2%)	
Region				0.189
Rural	1,882 (16.7%)	1,707 (16.8%)	175 (16.0%)	
Urban	9,138 (81.3%)	8,234 (81.2%)	904 (82.7%)	
Others/Unknown	217 (1.9%)	203 (2.0%)	14 (1.3%)	
Risk				<0.001
MSM	5,618 (50.0%)	5,265 (51.9%)	353 (32.3%)	
Heterosexual	2,109 (18.8%)	1,847 (18.2%)	262 (24.0%)	
Injecting	594 (5.3%)	431 (4.2%)	163 (14.9%)	
Others	2,916 (25.9%)	2,601 (25.6%)	315 (28.8%)	
CD4_category				0.019
<200	3,400 (31.2%)	3,023 (30.8%)	377 (35.2%)	
200-350	2,259 (20.8%)	2,053 (20.9%)	206 (19.3%)	
350-500	2,147 (19.7%)	1,958 (20.0%)	189 (17.7%)	
≥500	3,076 (28.3%)	2,778 (28.3%)	298 (27.9%)	

Table 2. Linear mixed models for county-level viral suppression rates with history of **any SUD rates** among people living with HIV across 46 counties in South Carolina from 2013 to 2020

Variable	Beta (95%CI)_Crude	Beta (95%CI)
AnySUD_Rate	-0.166 (-0.748, 0.413)	**-0.543 (-1.075, -0.013)**
Black(%)	-0.068 (-0.145, 0.008)	-0.060 (-0.202, 0.058)
Female(%)	0.156 (-0.543, 0.888)	0.465 (-0.588, 1.273)
Rural(%)	0.028 (-0.024, 0.081)	0.025 (-0.102, 0.135)
Unemployed (%)	-0.998 (-1.274, -0.713)	-0.481 (-0.887, 0.047)
100*Gini index	0.232 (-0.227, 0.692)	0.093 (-0.404, 0.642)
Ryan White HIV centers	-0.194 (-1.052, 0.665)	-0.478 (-1.581, 0.624)
Mental health centers	-0.567 (-1.574, 0.439)	-0.404 (-1.770, 0.964)
100*Spatial Proximity	-0.109 (-0.502, 0.282)	0.147 (-0.347, 0.554)
100*Delta	0.022 (-0.064, 0.109)	-0.043 (-0.238, 0.107)
Disability (%)	0.094 (-0.254, 0.444)	0.611 (-0.032, 1.154)
Uninsured (%)	-1.046 (-1.307, -0.781)	**-0.648 (-1.138, -0.258)**
100*SVI_Household characteristics and disability	-0.044 (-0.097, 0.007)	**-0.100 (-0.166, 0.000)**
100*SVI_Minority status and language	-0.122 (-0.218, -0.027)	0.021 (-0.109, 0.146)
100*SVI_Housing type and transportation	0.009 (-0.005, 0.022)	0.007 (-0.005, 0.020)
Black/White dissimilarity index	0.002 (-0.133, 0.137)	0.002 (-0.179, 0.186)
Community_health	1.477 (-0.195, 3.149)	1.080 (-0.918, 3.012)
Religious adherence (%)	0.119 (0.008, 0.231)	0.085 (-0.059, 0.231)
primary care providers	-0.003 (-0.014, 0.009)	-0.008 (-0.026, 0.013)
Collective efficiency	-0.000 (-0.005, 0.005)	0.001 (-0.006, 0.009)

Table 3. Linear mixed models for county-level viral suppression rates and **SUD subtypes** among people living with HIV across 46 counties in South Carolina from 2013 to 2020

Variable	Crude Beta(95% CI)	Adjusted Beta(95% CI)
Any SUD	-0.166 (-0.748, 0.413)	**-0.543 (-1.075, -0.013)**
Alcohol+ stimulants	**-1.551 (-2.980, -0.134)**	**-1.486 (-2.795, -0.222)**
Alcohol + opioids	1.007 (-3.158, 5.163)	0.305 (-3.504, 4.127)
Stimulants+ opioids	0.720 (-2.458, 3.881)	-0.844 (-3.731, 2.137)
All 3 SUDs	-0.185 (-5.308, 4.910)	-0.602 (-5.324, 4.071)
Alcohol only	-0.229 (-0.992, 0.529)	-0.434 (-1.157, 0.226)
Opioids only	-0.007 (-1.767, 1.753)	-1.037 (-2.566, 0.711)
Stimulants only	-0.563 (-1.450, 0.320)	**-1.021 (-1.814, -0.206)**

IMPLICATIONS

- Geographically-tailored interventions that integrate evidence-based stimulant use disorder treatment within HIV care are needed to improve viral suppression.
- Community-level integration of HIV and substance use disorder services may be critical for advancing Ending the HIV Epidemic goals in South Carolina.

CONCLUSIONS

- Elevated county-level prevalence of SUDs, particularly stimulant use, is associated with lower viral suppression rates across South Carolina.
- These findings highlight the combined influence of substance use patterns and structural factors on population-level HIV care outcomes.

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