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Psychosocial Syndemics and Sexual Risk Practices Among U.S. Adolescents: Findings from the 2017 U.S. Youth Behavioral Survey

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Abstract

Background The present study aims to (1) identify classes of psychosocial syndemics among adolescents in the U.S. based on psychological factors, such as depression and suicidal ideation, and social factors, such as binge drinking, alcohol use, and drug use; (2) identify correlates of psychosocial syndemics; and (3) examine the independent associations between psychosocial syndemic factors and sexual risk practices.

Method We used latent class analysis and a sample of 14,762 U.S. high school students who participated in the 2017 Youth Risk Behavior Surveillance System to examine youth population profiles based on shared characteristics of syndemics. Adjusting for sociodemographic factors, we conducted logistic regression to explore the connections between psychosocial syndemic factors and three sexual risk practices, namely, early initiation of sexual intercourse, condom use, and sex with multiple partners.

Results The study results indicate that three classes of risk exist among the sample: substance misuse (class 1, $n = 3872$, 26.2%), normative (class 2, $n = 8791$, 59.6%), and mental health problems (class 3, $n = 2099$, 14.2%). Class membership of psychosocial syndemics was significantly different by gender, age group, and race. The odds of initiating sexual intercourse before age 13 were positively associated with participants belonging in the substance misuse class and the mental health problem class. The odds of using condoms during the last sexual intercourse for currently sexually active adolescents were lower for participants classified in the substance misuse class. The likelihood of reporting having sex with four or more partners in a lifetime was higher among participants belonging to the substance misuse class.

Conclusion The study advances our understanding of the heterogeneity of class membership associated with psychosocial syndemic risk factors among adolescents and extends our understanding of syndemics in the area of adolescent health. Thus, practitioners and policymakers can design multicomponent and multilevel school-based HIV/STI prevention programs that meet the needs of adolescents.

Keywords Psychosocial syndemics · Sexual risk practices · Adolescents · School-based health · Latent class analysis · United States

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Introduction

In 2017, approximately 38,739 individuals were newly infected with HIV in the United States (U.S.), a stable number since 2012 [1]. Young people (aged 13–24) comprised 7% of the national population, yet accounted for 21% of all new HIV infections in 2016 [2]. The health burden of sexually transmitted infections (STIs) is disproportionately borne by young people who account for half of 20 million cases every year [3]. Psychological factors, such as depression, suicide ideation, and forced sex, and social factors, including binge drinking, alcohol use, and drug use, are identified as independent contributors to HIV/STI acquisition and transmission [4]. Collectively, these factors contribute to the psychosocial vulnerability of youth, predisposing young people to HIV and

other STIs [5–7]. Further, young people are less likely to seek HIV/STIs testing, which may increase their exposure to HIV infections and transmission [8, 9].

Adolescents are reported to engage in risky practices that increases their exposure to HIV and other STIs. According to the 2017 Youth Risk Behavioral Surveillance Survey (YRBSS), nearly half (46.2%) of sexually active adolescents reported engaging in condomless sex during their last sexual encounter [9]. Other sexual risk practices that adolescents report engaging in may include early initiation of sexual intercourse before the age of 13, sexual encounters with multiple partners, and sex under the influence of drugs or alcohol [10]. Efforts to combat HIV and STI vulnerabilities have become a national priority, thus necessitating a White House HIV national strategy [8]. This elevated attention at the policy level is expected to galvanize the needed resources and expertise to develop and implement effective programs [8] that address multiple psychological and social conditions, such as depression and substance use. As stakeholders delve into effective programs, there is a vital need for a nuanced understanding of these multiple psychological and social conditions because of emerging evidence that these psychosocial health problems may interact with one another synergistically or cumulatively ("syndemics") [11–17], thereby increasing exposure to HIV transmission and acquisition. There are a handful of national studies using diverse samples of adolescents to identify syndemics [18, 19].

HIV is a public health crisis that disproportionately affects adolescents [2]. To understand this crisis, syndemic theory, which incorporates multiple interrelated epidemics may be a valuable framework. A *syndemic* is "two or more afflictions, interacting synergistically, contributing to excess burden of disease in a population" [11]. Syndemics theory holds that psychosocial health problems, such as depression, victimization, and substance use, are differentially concentrated among marginalized population and may co-occur. These psychosocial problems may have a cumulative effect or interact synergistically, increasing vulnerability to HIV and other STIs [12–16, 20]. Studies conducted among sexual minorities (over 53%: [18]), for example, have found associations between syndemic factors of depression, childhood sexual abuse, victimization, polydrug use, sexual compulsivity, and HIV infections among adult populations [12–16]. Analyzing data from a large U.S. prospective epidemiologic cohort study among Black sexual minorities, Dyer and colleagues [13] found that greater psychosocial health conditions, including depressive symptoms and substance misuse, were associated with more condomless anal intercourse. Using pooled data of sexual minorities from the 2005 and 2007 U.S. YRBS, Mustanski et al. [16] identified syndemic factors of violence, substance use, and mental illness to be associated with condomless sex and suicide attempt. Evidence from a sample of sexual minorities shows that an increase in the number of psychosocial health conditions may correspond with an increase (additive or synergistic effect or cumulative effect) in HIV vulnerability factors, such as sexual risk behaviors [12–16, 20].

Insights gained from studies that use the syndemic approach may inform the development and implementation of interventions for marginalized populations where multiple co-occurring health disparities are differentially concentrated. For example, a global review conducted to identify a continuum of multilevel integrated interventions that target key substance abuse, violence, and AIDS syndemic mechanisms found that interventions were developed to address gender-based violence (GBV) among participants who were drug users [21]. Interventions were developed in response to research that had found that GBV increased the risk for HIV and other STIs among women and girls who used drugs [21]. Results from a randomized control trial testing the efficacy of a sexual risk intervention for male clients of female sex workers found that at 12 months, the adverse effect of syndemic problems on HIV risks reduced significantly [20]. The strength of syndemic theory is the ability for each study to identify co-occurring factors that exist within their population leading to the development and implementation of integrated and multidimensional interventions. Currently, studies have identified syndemic risks associated with HIV among adult key populations [18]. However, syndemic factors associated with HIV and STI vulnerabilities among a school-based sample of adolescents are still underexplored.

There is scant evidence related to syndemics among adolescents. For instance, a few studies that included adolescents have documented the presence of psychosocial health conditions among youth and their influence on HIV risk [22, 23]. Using a sample of 388 sexually active African-American youth, Newman and Zimmerman [22] found different HIV risk profiles, including alcohol and drug use and sex partner age. Analyzing the 2005 YRBSS data, Connell, Tamika, and Hansen [23] sought to understand the relationship between substance use and sexual risk behaviors. They found that substance use among adolescents was the strongest predictor of sexual risk behaviors. Though limited data are available on psychosocial syndemics among adolescents [18], current evidence shows that high levels of depression, suicidality, alcohol use and misuse, and use of illicit drugs are associated with increased exposure to HIV and STI [22–28]. Therefore, there is a need for research that identifies subgroups with distinct psychosocial syndemics to inform the development of targeted interventions aimed at combating HIV and STI among adolescents.

The present study employs latent class analysis (LCA), a dimensional person-centered perspective, and syndemic theory to identify psychosocial syndemic factors that potentially influence sexual risk practices among adolescents. A cumulative method of summing up factors that create syndemic influence remains the most commonly used method of assessing the syndemics theory [12–18]. This method, however,

assumes that the syndemic factor is unidimensional [15, 16]. The use of LCA allows for the identification of unique combinations of risk factors. LCA recognizes the importance of evaluating each of the factors that contribute to the syndemic effect to avoid limiting our understanding of the complexity of the existing patterns. For instance, using a sample of African-American/Black and Hispanic heterosexual adults ($N = 2853$), Cleland and colleagues [29] identified risk and resilience profiles. Using a baseline survey of the Being Active and Connected study among people living with HIV and injection drug users in Baltimore, Maryland, USA ($N = 383$), Robinson and colleagues [30] identified four classes of substance use, mental illness, and familial non-negotiation. Though there is debate on how researchers measure syndemic theory without detecting interactions between factors [17, 18], LCA avoids these limitations by maintaining utility while measuring syndemics. Therefore, the present study aims to address this gap by (1) identifying classes of psychosocial syndemics among adolescents in the U.S. based on psychological factors (e.g., depression and suicidal ideation) and social factors (e.g., binge drinking, alcohol use, and drug use), (2) identifying the correlates of psychosocial syndemics, and (3) examining the independent effect of psychosocial syndemics factors with sexual risk practices.

Methods

Sampling and Recruitment

Data for this study were obtained from the 2017 Centers for Disease Control and Prevention (CDC) YRBSS. YRBSS survey is conducted biennially as part of an epidemiological assessment aimed at understanding the state of youth health in the U.S. The survey is administered in high schools (9th to 12th grades) in all 50 states and the District of Columbia (excluding all other territories). Using a three-stage cluster sampling design, a nationally representative sample of adolescents was chosen for the study. Detailed information about the YRBSS, including the objectives, methodology, and sampling procedure, is available at www.cdc.gov/yrbss and in other publications [42]. There were 14,765 respondents in the 2017 YRBSS.

Measures

Psychosocial Syndemic Risk Indicators

We used two psychological factors (depression and suicide) and five social factors (alcohol and binge drinking, cocaine, methamphetamine, and marijuana) as syndemic indicators. All variables were dichotomized with a *yes* (1) and *no* (0) response option so that a score of 1 represented a clear problematic level of the syndemic indicator. We assessed *depressive symptomatology* using an item that asked, "*During the past 12 months, did you ever feel so sad or hopeless almost every day for 2 weeks or more in a row that you stopped doing some usual activities?*" Suicide ideation was assessed by asking participants, "*Have you made a plan about how you would attempt suicide in the last 12 months?*" Binge drinking, which was defined as "*5 or more drinks of alcohol in a row, that is, in a couple of hours*," was measured as number of days in the prior 30 days. We coded individuals as positive for regular binge drinking if they reported 3 or more days of binge drinking. We assessed other substance use variables, such as lifetime use of alcohol, cocaine, methamphetamine, or marijuana. Details of the validity and reliability of these variables are documented elsewhere [9, 42].

Sexual Risk Practices

For the main outcome variables, we assessed *consensual early initiation* of sexual intercourse, *condom use* among sexually active adolescents, and *lifetime number of sexual partners*. *Consensual early initiation of sexual intercourse* was derived from a question asking participants if they had sex before the age of 13. This variable was coded as yes = 1 and no = 0. *Condom use* was assessed among participants who reported to be currently sexually active with a single question asking whether they used a condom during their last sexual intercourse. Participants who reported using condoms during their last sexual intercourse were coded as "1" and participants who indicated not using condoms during their last sexual intercourse were coded as "0." *Lifetime number of sexual partners* was assessed using a single question, "have you *had sexual intercourse with four or more persons during their life?*" Participants reporting more than four sex partners were classified as having lifetime sexual partners. Evidence shows that early initiation of sexual intercourse, condomless sex, and sex with multiple partners are indicators of HIV and STI vulnerabilities [24–28, 31]. These measures have shown good reliability among adolescents in the U.S. [9, 42].

Statistical Analyses

Descriptive statistics for psychosocial syndemic risk indicators, sexual risk practices, and socio-demographic characteristics were analyzed by examining the distributions, including frequencies for categorical variables. Analyses were conducted on complete cases due to acceptable missingness (less than 10%; [32]).

For the main aims, we used LCA to identify the risk profiles of psychosocial syndemics empirically. LCA is a

person-centered analytical approach in which categorical data are used to explore the heterogeneity of a sample. LCA models estimate unmeasured profiles or classes of individuals indirectly using multiple direct measures completed by a sample. Within LCA, the number of latent classes is tested iteratively beginning with a one-class solution and testing subsequent ones incrementally to tests model fit. The current analyses used log-likelihood values, Akaike's information criterion (AIC), the Bayesian information criterion (BIC), and a BIC value adjusted for sample size [33–36]. Each of these fit indices compares the likelihood goodness of fit with the number of latent classes within the overall sample [34–36]. Nylund, Asparouhov, and Muthén [36] have reported that the BIC is the most reliable of these information criteria indices as the AIC has been found to overestimate the number of latent classes in the model. For these information criteria, lower values indicate better fit. The number of classes is increased to the point where there is a minimal or negligible decrease or even an increase in the BIC and AIC. The Lo-Mendell-Rubin test (LMR) compares a latent class model with k classes to that of a model with $k-1$ classes. The obtained p value then indicates if the additional class significantly improves model fit. Lastly, an entropy score was calculated per model, which indicates how well indicators predict class membership. Entropy scores closer to 1.0 indicate better class prediction [35, 36]. In addition, chi-square tests were conducted to assess the association between the classes and demographic factors and sexual risk practices. Finally, multivariate logistic regression was conducted to examine the independent association between the psychosocial syndemic factors and sexual risk practices. The LCA was conducted with Mplus 7.3. Other analyses were completed using SPSS 25.0.

Results

Study Participants

Of the 14,765 respondents examined, 3.7% ($n = 490$) reported having initiated sex at an early age of 13; 9.6% ($n = 1261$) reported having sex with four or more sexual partners in their lifetime, and 45.6% ($n = 1655$) of sexually active adolescents reported engaging in condomless sex during their last sexual intercourse (Table 1). Slightly over half of the participants were female (51.4%, $n = 7526$). Most of the participants identified as heterosexuals (85.1%; $n = 12{,}012$). Compared with other syndemic risk factors, most participants reported lifetime alcohol use (60%, $n = 8251$). About 32% ($n = 4631$) of the respondents reported feeling sad or hopeless. For suicidal ideation, 14% ($n = 2030$) of the respondents reported considering suicide in the last 12 months. About 36% ($n = 5122$) reported lifetime marijuana use, 5% ($n = 719$) reported lifetime cocaine use, and 2.7% ($n = 384$) reported lifetime methamphetamine use.

Table 1 Socio-demographic characteristics, psychosocial syndemic risk factors, and sexual risk practices among U.S. high school students ($N = 14{,}672$)

Variable	*n* (%)
Socio-demographic factors	
Age (12,678)	
15 years old	3584 (28.3)
16 years old	3688 (29.1)
17 years old	3610 (28.5)
18 years old or older	1796 (14.2)
Gender ($n = 14{,}635$)	
Female	7526 (51.4)
Male	7109 (48.6)
Sexual orientation ($n = 14, 108$)	
Sexual minorities	1494 (10.6)
Heterosexual	12,012 (85.1)
Not sure	602 (4.3)
Race ($n = 14{,}425$)	
Black or African American	2794 (19.4)
White	6261 (43.4)
Hispanic/Latino	1542 (10.7)
Multiracial	2927 (20.3)
Other	901 (6.2)
Psychosocial syndemic risk factors	
Lifetime alcohol use ($n = 13{,}779$)	
No	5528 (37.4)
Yes	8251 (59.9)
Currently binge drinking ($n = 13{,}675$)	
No	11,903 (87)
Yes	1772 (13)
Lifetime marijuana use ($n = 14{,}282$)	
No	9160 (64.1)
Yes	5122 (35.9)
Lifetime cocaine use ($n = 14{,}508$)	
No	13,789 (95)
Yes	719 (5)
Lifetime methamphetamine ($n = 14{,}378$)	
No	13,994 (97.3)
Yes	384 (2.7)
Depression ($n = 14{,}527$)	
No	9896 (68.1)
Yes	4631 (31.9)
Suicide ideations ($n = 14{,}541$)	
No	12,511 (86)
Yes	2030 (14)
Sexual risk practices	
Early initiation of sexual intercourse ($n = 13{,}205$)	
No	12,715 (96.3)
Yes	490 (3.7)
Sex with multiple partners (13,178)	
No	11,917 (90.4)
Yes	1261 (9.6)
Condom use ($n = 3627$)	
No	1655 (45.6)
Yes	1972 (54.4)

Latent Class Solutions

The LCA resulted in a three-class solution, supported by the fit statistics shown in Table 2. The one-class model

Table 2 Model fit indices

Class	AIC	BIC	Sample size-adjusted BIC	Entropy	LMR LRT *p* value
2	74,678.1	78,246.9	74,792.1	0.68	< 0.001
3	72,546.2	72,721.0	72,647.9	0.80	< 0.001
4	71,219.8	71,455.4	71,356.8	0.76	< 0.001
5	70,845.9	71,142.3	71,018.4	0.76	< 0.001
6	70,738.1	71,095.3	710,945.9	0.77	< 0.001

Notes: *LCA* = latent class analysis; *BIC* = Bayesian information criterion; *LMR LRT* = Lo-Mendell-Rubin likelihood ratio test *p* value for $(k-1)$ classes; a significant *p* value indicates that the $(k-1)$ class model should be rejected in favor of a model with at least *k* classes

did not fit the data in a statistically significant way and was not better than the two-class model, suggesting that the syndemic risk indicators could be more appropriately modeled as related within latent subgroups. Compared with a four-, five-, or six-class model, the three-class solution demonstrated the best fit to the observed data and was more parsimonious. Although the AIC and BIC continued to decrease through the six-class solution, the four-, five-, or six-class solutions were empirically unidentified models, further indicating that the three-class solution was the best-fitting solution for this data. The three-class solution was a significantly better fit than the previous class solution, as indicated by the Lo-Mendell-Rubin adjusted likelihood ratio test. Entropy for this solution was high (.80), indicating that the three classes were distinct. The smallest class within the three-class solution was a class that represented 13.5% of the sample and can be interpreted as meaning a pattern of psychosocial health problems. Interpretation of item response probabilities for each class within the three-class solution was therefore warranted.

The estimated class prevalence of psychosocial syndemic risk indicators given class membership in the three-class model is presented in Fig. 1. Based on patterns of syndemics, the three classes were substance misuse (class 1, $n = 3872$, 26.2%), normative (class 2, $n = 8791$, 59.6%), and mental health problems (class 3, $n = 2099$, 14.2%).

Demographic Factors Across Psychosocial Syndemic Factors

More than half (51.7%, $n = 1984$) of participants classified in the substance misuse class were male compared with 48.3% ($n = 1852$) of females ($\chi^2(2) = 306.52$, $p < .001$). The proportion of females classified in the mental health problems class (69.4%, $n = 1431$) were significantly greater than the proportion of males (30.6%, $n = 632$). Class membership was significantly different across races: χ^2 (df = 8, $n = 14{,}425$) = 142.64, $p < .001$). White participants, in particular, had the highest percentage of mental health problems (45.3%, $n = 923$) followed by multiracial (23.9%, $n = 488$), Blacks (15.4%, $n = 313$), Hispanics/Latino (8.8%, $n = 180$), and other races (6.6%, $n = 134$). Additionally, class membership of psychosocial syndemics was significantly different by age group: χ^2(df = 6, $n = 12{,}678$) = 305.36, $p < .001$. Specifically, older adolescents were more likely to be in the substance-misuse class (17 years old [33.6%, $n = 1196$]) compared with younger adolescents (16 years olds [28.7%, $n = 1022$]; 15 years olds [18.8%, $n = 671$]).

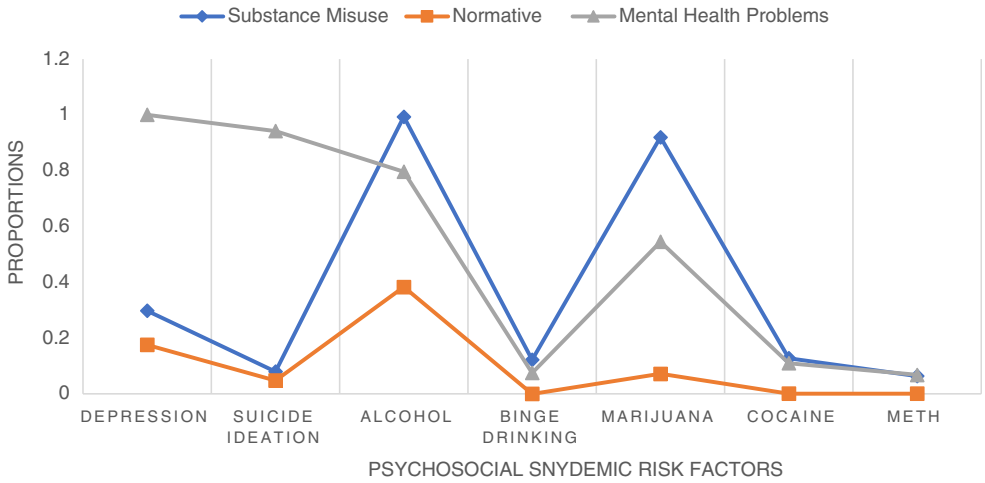

Fig. 1 Differences between latent classes on psychosocial syndemic risk factors

Differences Between Psychosocial Syndemics Factors and Sexual Risk Practices

Class membership was significantly different across early initiation of sexual intercourse: χ^2(df = 2, n = 13,205) =228.04, p < .001. Particularly, 44.5% (n = 218) of the adolescents in the substance-misuse class reported to have initiated sex before the age of 13 years, compared with those in the mental health problem class (28.8% n = 141) and the normative class (26.7%, n = 131). More than half (57.8%, n = 729) of participants in the substance misuse class reported lifetime multiple sexual partners compared with 22.3% (n = 281) of adolescents in the mental health problems class and the normative class (19.9%, n = 251): χ^2 (df = 2, n = 13,178) = 945.39, p < .001. Among adolescents who are currently sexually active, the proportion of adolescents who engaged in condomless sex and were classified in the substance misuse class (53%, n = 877) were significantly greater than the proportion of adolescents in the mental health problems class (23.4%, n = 391) and the normative class (23.6%, n = 391): χ^2 (df = 2, n = 3627) = 85.29, p < .001.

Associations Between Psychosocial Syndemics Profiles and Sexual Risk Practices

Table 3 presents the results (adjusted odds) of the logistic regression models for three sexual risk practices: early initiation of sexual intercourse, condom use, and lifetime number of sexual partners. All regression models adjusted for age, gender, and race. The odds of initiating sexual intercourse before the age of 13 years were positively associated with participants belonging in the substance misuse class (adjusted odds ratio, AOR = 6.64, 95% confidence interval [CI] [4.98, 8.86]), mental health problem class (AOR = 1.71, CI [1.34, 2.24]), male gender (AOR = 3.70, CI [2.93, 4.67]) and negatively associated with Hispanic/Latino race (AOR = 0.41, CI [0.24, 0.68]). The odds of using condoms during the last sexual intercourse for currently sexually active adolescents were lower for participants classified in the substance misuse class (AOR = 0.47, CI [0.39, 0.58]), among adolescents who were 16 years (AOR = 0.60, CI [2.98, 4.60]) and 17 years old (AOR = 2.29, CI [0.59, 0.89]) and higher among male respondents (AOR = 1.73, CI [1.49, 1.98]). The likelihood of reporting having sex with four or more partners in a lifetime was higher among participants belonging to the substance misuse class (AOR = 6.26, CI [5.1, 7.61]), ages 16 (AOR = 3.70, CI [2.98, 4.60]), 17 (AOR = 2.29, CI [1.91, 2.76]), and 18 or older (AOR = 1.71, 95% CI [1.22, 1.72]) and lower for participants who identified as Hispanic/Latino (AOR = 0.39, CI [0.28, 0.57]).

Discussion

This study explored whether different classes of psychosocial syndemic risks can be identified and how these syndemic classes influence sexual risk practices among high school students, controlling for sociodemographic characteristics. Three different classes of syndemics emerged with adolescents reporting multiple syndemic exposure of normative, substance misuse, and mental health problems. For instance, substance misuse syndemics were associated with having a higher risk for early initiation of sexual intercourse, engaging in condomless sex, and having sex with four or more sexual partners than those who have none to low exposure to syndemics. Adolescents with mental health syndemics reported initiating sexual intercourse before the age of 13 years. Psychosocial health problems occur in different ways for different adolescents, and these findings indicate that differences in experiences provide insights into the development and implementation of targeted multicomponent and multilevel interventions.

Our results are generally consistent with previous studies with adults and sexual minorities, suggesting that adolescents who experience syndemics, such as substance misuse, may have a higher number of sexual partners, may engage in condomless sex, and may initiate sexual intercourse at an early age compared with adolescents who have no syndemic risk or who experience a single type of risk [12–16, 20, 22]. In our sample, adolescents who were in both the substance misuse and mental health problem classes are the most worrisome group from a clinical perspective. Studies show that mental health problems, such as depression and substance misuse, are highly associated with lower condom use [4, 37] and higher rates of having multiple partners [4, 38]. This finding shows that different psychosocial health problems contribute differently to the syndemic. For instance, in the substance misuse class, alcohol and marijuana use had a more significant impact on the syndemic than binge drinking. We found that older adolescents reported higher proportions of substance misuse syndemics compared with other participants. Therefore, harm reduction interventions need to target both adolescents experimenting with alcohol or marijuana and those who currently use substances [39–41].

Similar to other syndemic studies that utilized LCA to identify classes of risk among individuals [23, 29, 30], our study identifies a combination of psychological and social health problems to inform intervention development. Our LCA findings show that mental health problems and substance misuse are associated with HIV exposure factors, such as sexual risk practices. A Canadian-based cross-sectional study found that syndemics of depression and substance misuse where associated with multiple sexual partners among Northern Indigenous adolescent girls [38]. A U.S. study found that syndemics of peer victimazation were associated with an

Table 3 Adjusted logistic regression of early sexual initiation, condom use, and life time sexual partners on psychosocial syndemics among U.S. adolescents

Indicators	Early sexual initiation AOR (95 CI)	Condom use AOR (95 CI)	Lifetime number of sexual partners AOR (95 CI)
Psychosocial syndemic factors (normative)			
Substance use	6.64 (4.98, 8.86)***	0.47 (0.39, 0.58)***	6.26 (5.14, 7.61)***
Mental health problems	1.73 (1.34, 2.24)***	0.93 (0.77, 1.12)	0.93 (0.79, 1.09)
Sociodemographic factors			
Age (15)			
16	0.79 (0.57, 1.09)	0.60 (0.48, 0.77)***	3.70 (2.98, 4.60)***
17	0.87 (0.63, 1.19)	0.73 (0.59, 0.89)**	2.29 (1.91, 2.76)***
18 and older	1.18 (0.85, 1.64)	0.83 (0.0.69, 1.01)	1.45 (1.22, 1.72)***
Gender (Female)			
Male	3.70 (2.93, 4.67)***	1.73 (1.49, 1.98)***	1.95 (1.7, 2.23)***
Race (White)			
Black	1.41 (0.84, 2.35)	1.12 (0.74, 1.69)	0.77 (0.54, 1.09)
Hispanic/Latino	0.41 (0.24, 0.68)***	1.18 (0.79, 1.81)	0.39 (0.28, 0.57)***
Multiracial	1.14 (0.63, 2.07)	1.28 (0.81, 2.02)	0.91 (0.61, 1.35)
Others	0.72 (0.43, 1.21)	0.96 (0.62, 1.47)	0.71 (0.49, 1.02)
Model fit indices			
Block chi-square (sig)	380.72 (<.001) df = 10	177.44 (<.001) df = 10	1151.36 (<.001) df = 10
Percentage correctly classified	96.5	54.4	88.0
Nagelkerke *R* square	.13	.07	.20

Reference categories are identified in brackets

OR, odds ratios; *AOR*, adjusted odds ratio; df, degrees of freedom

*$p < .05$

**$p < .01$

***$p < .001$

increase in the number of sexual partners among adolescents [27]. It is plausible that adolescents who have mental health problems and misuse substances are more likely to make impulsive decisions about when and how to engage in sexual intercourse, thus increasing their susceptibility to HIV/STI [37, 38]. There is need for multicomponent interventions that consider substance misuse and mental health problems within HIV and STI prevention programing. These interventions can provide motivational activities, including empowering adolescents on self-control, safer sexual practices, help-seeking behaviors, and decision-making strategies.

Results from this study must be viewed with several limitations. The data used in the study were collected from self-reported behaviors among adolescents, and it is possible that social desirability might have influenced the participants' responses. The use of cross-sectional data limits our ability to test temporality that would allow us to understand how psychosocial syndemics impact HIV vulnerability across time. Although the single items used by the YRBSS are adequately reliable [42], the use of lifetime questions limits our understanding on whether the participants were experimenting with specific practices or have continued engaging in the risky practices. There is a need for further studies that use multicomponents and longitudinal data to assess whether the classes identified in this study hold over time. Although using LCA to identify syndemic classes is a strength of our study, our low entropy is a limitation. Follow-up studies would benefit from mixed modeling frameworks that account for errors in class assignment. Also, limiting the number of psychological and social factors might have missed out on important indicators of syndemic. Future studies should consider including social, structural, and psychological factors, such as violence, poverty, and discrimination omitted in the current study. Finally, though we considered mental health indicators drawn from the syndemics literature, these indicators are limited in scope. Therefore, further research with adolescents is needed to more carefully examine other internalizing (e.g., anxiety) and externalizing (e.g., impulsivity) symptoms relevant to engagement in sexual risk practices.

Results of the current study demonstrate that psychological and social factors are not only connected but also function synergistically to amplify sexual risk practices (e.g., early initiation of sexual intercourse, condomless sex, and lifetime number of sexual partners). However, we did not determine the function by which each of these indicators interacts synergistically (e.g., additive, multiplicative) [18]. Further studies

are needed to consider the syndemic associated with vulnerability at first sex [26] using longitudinal data. A deeper understanding of these interactions using gender and age-based analysis and novel methods, such as social network analysis, mixed methods [19], and systems dynamics, would further inform programs looking to prioritize resources when targeting multiple factors.

Despite these limitations, the use of a nationally representative dataset of high schoolers is a strength of this study, as it is generalizable to high school students nationwide. Also, using syndemic approach to understand how psychological and social factors are related to sexual risk practices highlights the importance of exploring multicomponent interventions [18, 19]. These integrated interventions may provide adolescents with mental health and substance misuse screening services, life skills educations, and empowerment groups within adolescent HIV and STI prevention programming in both non-traditional (e.g., schools) and traditional (medical) settings. In addition, before implementing multilevel interventions [18], adolescent health providers, school social workers, and school psychologists need to be equipped on how to ensure adolescents' privacy as a way of mitigating HIV and STI vulnerabilities. In addition, these multilevel interventions should also provide parents and teachers with skills on how to discuss with adolescents syndemic factors identified in this study. Therefore, to reduce HIV and STI exposure among adolescents, there is a need for multicomponent and multilevel interventions that address sexual risk practices in conjunction with the psychosocial syndemics of substance misuse, and mental health problems.

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Compliance with Ethical Standards

The data for this study were collected by the U.S. Centers for Disease Control and Prevention (CDC).

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Conflicts of Interest All authors listed on this study certify that we have no affiliations with or involvement in any organization or entity with any financial or non-financial interests in the subject matter or materials discussed in this manuscript.

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