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ORIGINAL PAPER

Co-occurring risk behaviors among White, Black, and Hispanic US high school adolescents with suicide attempts requiring medical attention, 1999–2007: Implications for future prevention initiatives

Juan B. Pena · Monica M. Matthieu · Luis H. Zayas · Katherine E. Masyn · Eric D. Caine

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Abstract
Purpose To identify subtypes of adolescent suicide attempters by examining risk profiles related to substance use, violent behavior, and depressive symptoms. To examine the relationship between these subtypes and having had two or more suicide attempts during the past year. To explore race and gender differences across subtypes of suicide attempters.
Methods Data were combined from five nationally representative cohorts of the US Youth Risk Behavior Surveillance System (YRBSS) and focused on a subpopulation of youth who reported a suicide attempt requiring medical attention. Latent class analysis was used to identify subtypes of suicide attempters.
Results Analysis yielded three classes of youth who attempted suicide, distinguishable by their levels of substance use and violent behaviors: low substance use and violent behaviors, high substance use and violent behaviors, and extreme substance use and violent behaviors. All three classes had a high propensity for endorsing depressive symptoms. The proportion of youth with two or more suicide attempts during the past year increased across subgroup of attempters with higher levels of substance use and violent behaviors. Racial and gender differences were found across subtypes of suicide attempters.
Conclusions Preventing and treating the co-occurrence of substance use and violent behaviors may serve as essential strategies for reducing suicide attempts, especially among male youth. The use of public health strategies for suicide prevention should take into account the different needs of youth at risk for suicide.

Keywords Suicide attempted · Adolescent · Prevention · Health status disparities · Risk-taking

Introduction

Prevention of suicide attempts among adolescents has been identified as an urgent priority in the United States (US) [1]. An attempt to kill oneself is associated with an increased risk for future attempts [2], is a leading cause of hospitalization [3], and is a powerful predictor of eventual death by suicide or increased risk for early mortality [4, 5]. Despite the public health significance and national funding initiatives (e.g., PL 108–355: The Garrett Lee Smith Memorial Act), preventing suicide attempts among adolescents has not yet garnered desired results. The rate for teen suicide attempts requiring medical attention in 2007 (2.0%) remained approximately twice as high as the target goal of Healthy People 2010 (1.0%) [1]. Moreover, the Healthy People 2010 goal of reducing racial and gender disparities for health outcomes [1] also remains unrealized with rates of suicide attempts requiring medical attention varying from 0.9% for White males to 3.9% for Latina females in 2007 [6].

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J. B. Pena (✉) · M. M. Matthieu · L. H. Zayas
Washington University in St. Louis, One Brookings Drive, CB 1196, St. Louis, MO 63130, USA
e-mail: JPena@wustl.edu

K. E. Masyn
Harvard University, Graduate School of Education, Cambridge, USA

E. D. Caine
Department of Psychiatry, University of Rochester Medical Center, Rochester, USA

Exploring apparent heterogeneity based on risk factors or co-morbidities serves as the foundation for the work that we report in this paper. For heuristic purposes as well as for potential practical application we examine whether there are distinct subgroups among youth who report a suicide attempt requiring medical attention—a classification for suicide attempt that *requires medical attention* is more definable and likely of greater severity than suicide ideation or a suicide attempt without injury. We focus on person-centered factors related to risk for suicide attempts to define our subgroups of attempters: depressive symptoms, substance use, and violent behaviors. We chose these risk factors for three reasons.

First, there is increasing evidence that the problems of substance use, violent aggression, and depressive symptoms co-occur in a large proportion of youth who attempt or die by suicide [7–25]. However, despite the robust relationship between these risk factors and suicide behavior, there is a paucity of research identifying how these factors may cluster into subtypes of suicide attempters.

Second, there are a growing number of evidence-based programs that have been shown to prevent depressive symptoms, substance use, and violence-related behaviors among adolescents [26]. Basic epidemiological data about subtypes of attempters with these co-occurring risk factors can help to inform and increase the number of prevention programs available for suicide prevention efforts.

Third, each risk factor, in its own right, is associated with high morbidity and mortality that separately and collectively pose significant public health burdens [1]. Understanding how these risk factors co-occur among adolescent attempters provides opportunities for prevention approaches to reduce multiple negative outcomes among youth.

We have three study aims. First, using latent class analysis (LCA) we identify how depressive symptoms, substance use, and violent behaviors co-occur in subtypes of teens who made a suicide attempt requiring medical attention.

Second, to verify the utility of our subgroups and to distinguish those with the highest level of suicide risk among attempters, we examine the association of each type of attempter with having multiple suicide attempts during the past year. A previous suicide attempt is the most powerful predictor of suicide and those with repeat suicide attempts have greater risk for death by suicide than those with only a single attempt [17, 27].

Third, we explore the socio-demographic differences of these subtypes—based upon ethnicity, race, and gender—potentially providing vital data needed to appropriately shape suicide prevention initiatives tailored for different adolescent populations.

Methods

Sample

This study combines data from five national survey administrations of the Youth Risk Behavior Surveillance System (YRBSS; Centers for Disease Control and Prevention, 1999, 2001, 2003, 2005, 2007) to build a unique database, with a focus on youth who reported a suicide attempt requiring medical attention during the previous year. The YRBSS uses a stratified cluster design of all public and private high schools in the United States with a sampling method to ensure representativeness for youth attending high schools in the US. Hispanic and Black students are oversampled in the YRBSS. The design provides an adequate sample size for subgroup analysis by gender, grade, Hispanic ethnicity, and race ("Black" and "White"). YRBSS data collection occurs biennially during odd-numbered years and represents a cross section of students attending high school for the given year. Data are collected at school using self-administered anonymous surveys. The average response rate for this voluntary survey between the years 1999 and 2007 was 78% for schools, 84% for students, and 66% overall (overall = student response rate × school response rate). Sample weights are created based on gender, race/ethnicity, and grade to adjust for student nonresponse and oversampling of Black and Hispanic students. For more information, the methodology of the YRBSS has been described in detail elsewhere [28].

The YRBSS is also the national surveillance system for multiple risk behaviors and is the data source used by Healthy People 2010 [1] to set benchmarks for reducing teen suicide attempts and other risk behaviors (e.g. to reduce suicide attempts from 2.4% in 1999 to 1.0% by 2010). As in this study, the YRBSS question that Healthy People 2010 uses to monitor teen suicide attempts is, "If you attempted suicide during the past 12 months, did any attempt result in an injury, poisoning, or overdose that had to be treated by a doctor or nurse?" By combining data across samples and focusing on those respondents who described attempts that required medical attention, we sought to develop a sample that most closely matches the population of serious teen suicide attempters monitored by Healthy People 2010, while being mindful of limitations regarding generalization of results.

This sample ($N = 1{,}395$) includes Hispanic, White, and Black youth who self-identified as having received medical attention for a suicide attempt during the past year across five national survey administrations (1999, 2001, 2003, 2005, 2007). We were unable to include Asians, American Indians, multi-racial youth, or other racial groups in our analysis due to inadequate sample sizes. We did not use prior years of data due to inconsistencies in the survey

questionnaires. After adjusting for sample weights, these adolescents represented approximately 2.2% of the overall sample of 56,497 high school students.

Measures

Ethnicity, race, gender, grade, and survey administration year

Since ethnicity and race are consistent predictors of suicidal behaviors among youth, we included these variables in our study. Two questions were used to classify youth into ethnic and racial categories, "Are you Hispanic or Latino? What is your race?" For the latter question, responses include American Indian or Alaska Native Asian; Black or African American; Native Hawaiian or Other Pacific Islander; and White. For the present report, we first separated any self-identified Hispanic youth, regardless of racial category. We classified the remainder of the sample as either White or Black, multiracial youth or those from other racial categories were not included in the sample. The three resulting categories of Hispanic, White, or Black were mutually exclusive. Categorical variables were created for gender, for each grade level, and for each survey administration year.

Latent class indicators for attempter subtypes

We used seven latent class indicators (Table 1 summarizes response options and patterns for each latent class indicator). Suicide ideation during the previous year was measured by the question "During the past 12 months, did you ever seriously consider attempting suicide?" Although the YRBSS does not contain diagnostic criteria for major depressive episodes or for any mood disorders, it does include an indicator of a depressive symptom: "During the past 12 months, did you ever feel so sad or hopeless almost every day, for two weeks or more in a row that you stopped doing some usual activities?" The substance use variables included the amount of binge drinking (five or more drinks in a row) during past month, the amount of lifetime marijuana use, and the amount of lifetime other drug use. The "other drug use" variable was created using four questions regarding the amount of lifetime use of (1) heroin; (2) methamphetamines; (3) inhalants; or (4) cocaine (powder, crack, and freebase use). For each youth respondent, the highest level of drug use for any of these illicit substances was coded as their response for this variable. The violent behavior variables were measured using the amount of physical fights during past year and the amount of weapon carrying during past month. Weapon carrying included carrying a gun, knife, or club.

Repeat attempter during past year

Repeat attempter during the past year was measured by the question "During the past 12 months, how many times did you actually attempt suicide?" This question does not distinguish between suicide attempts that required or did not require medical attention; however, due to the inclusion criteria of our sample all had at least one attempt requiring medical attention. From this question, we created a binary categorical variable: attempted suicide two or more times versus a single time.

Statistical analysis

Mplus version 5.2 was used to conduct analyses. The stratified cluster design of the YRBSS was taken into account in our analysis by using the "Type = Complex" command in Mplus [29]. All analyses were adjusted using sample weights of the YRBSS to make results generalizable to high school students in the US with a suicide attempt. To avoid experimental-wise error from multiple group comparisons, we used the Bonferroni–Holm or Holm adjustment [30]. Missing data were handled using a maximum likelihood approach, which eliminates or reduces biases associated with missing data and is recommended over other ad-hoc approaches such as deleting cases with missing values [31].

To describe the differences between attempters and non-attempters for demographic and latent class indicators a LCA with known groups (attempters vs. non-attempters) was used.

To determine the number of latent classes or subtypes that exist among those youth with suicide attempts we used LCA to estimate the model fit across a set of models with increasing numbers of latent classes. A combination of criteria was used to determine the number of latent classes including (1) examination of fit indices (e.g., BIC, AIC, etc.) of which we weighed the values for the BIC and the sample adjusted BIC as most accurate given its superior performance for LCA models and (2) clinical judgment regarding the practical utility of classes for prevention or treatment efforts [32]. Consistent with the views of Nylund and Muthen [32], we first identified the point where our model fit indices start to plateau across the different LCA models we executed. This flattening effect suggests minimal or no improvement in model fit with the inclusion of additional classes. To decide whether to include additional classes after fit indices values start to plateau we considered the heuristic, theoretical, or the clinical value of adding additional classes and weighed this against the value of using more parsimonious solutions. We also considered the likelihood ratio test (LRT; Tech11–Vuong-Lo-Mendell-Rubin LRT test) and the bootstrap likelihood ratio test (BLRT; Tech14) provided by Mplus. Since the

Table 1 Sociodemographic characteristics and risk behaviors of the youth risk behavior surveillance system by attempter status

	Weighted percent (unweighted frequency)			
	Total sample $N = 56,497$	Attempters 2.2% ($N = 1,395$)	Non-attempters 97.8% ($N = 55,102$)	p
Gender				
Female	50.3 (29,364)	61.3 (871)	50.1 (28,493)	≤0.001
Male	49.7 (27,133)	38.7 (524)	49.9 (26,609)	≤0.001
Race/ethnicity				
Black	13.6 (13,113)	17.0 (327)	13.5 (12,786)	≤0.021
Hispanic	14.9 (15,635)	22.4 (511)	14.7 (15,124)	≤0.001
White	71.5 (27,749)	60.6 (557)	71.8 (27,192)	≤0.001
Grade				
9	28.7 (13,477)	37.8 (410)	28.5 (13,067)	≤0.001
10	26.1 (14,089)	28.3 (372)	26.1 (13,717)	≤0.233
11	23.5 (14,516)	20.3 (343)	23.5 (14,173)	≤0.034
12	21.7 (14,415)	13.6 (270)	21.9 (14,145)	≤0.001
Suicide ideation				
No	83.5 (47,206)	11.1 (158)	85.2 (47,048)	≤0.001
Yes	16.5 (9,224)	88.9 (1,231)	14.8 (7,993)	≤0.001
Sadness/hopelessness				
No	72.2 (39,690)	19.0 (258)	73.4 (39,432)	≤0.001
Yes	27.8 (16,649)	81.0 (1,127)	26.6 (15,522)	≤0.001
Other drug use				
0 times	80.6 (45,880)	37.8 (582)	81.6 (45,298)	≤0.001
1 or 2 times	8.8 (4,654)	14.4 (190)	8.7 (4,464)	≤0.001
3–9 times	4.7 (2,492)	14.3 (143)	4.5 (2,349)	≤0.001
10–19 times	2.1 (1,141)	8.4 (108)	1.9 (1,033)	≤0.001
20–39 times	1.4 (783)	5.6 (89)	1.3 (694)	≤0.001
40 or more times	2.4 (1,397)	19.5 (274)	2.0 (1,123)	≤0.001
Marijuana use				
0 times	58.4 (31,721)	24.4 (353)	59.1 (31,368)	≤0.001
1 or 2 times	9.1 (5,596)	8.3 (128)	9.1 (5,468)	≤0.001
3–9 times	8.2 (4,887)	11.6 (144)	8.1 (4,743)	≤0.001
10–19 times	4.7 (2,772)	7.8 (108)	4.6 (2,664)	≤0.001
20–39 times	4.6 (2,751)	7.4 (88)	4.5 (2,663)	≤0.001
40–99 times	4.9 (2,543)	6.0 (93)	4.9 (2,450)	≤0.001
100 or more times	10.1 (5,404)	34.6 (401)	9.6 (5,003)	≤0.001
Binge drinking				
0 days	70.7 (39,992)	38.9 (543)	71.4 (39,449)	≤0.001
1 day	9.2 (5,037)	12.0 (146)	9.1 (4,891)	≤0.001
2 days	6.9 (3,559)	14.5 (158)	6.7 (3,401)	≤0.001
3–5 days	6.8 (3,506)	14.3 (172)	6.6 (3,334)	≤0.001
6–9 days	3.8 (1,970)	6.3 (90)	3.8 (1,880)	≤0.001
10–19 days	1.9 (1,027)	5.3 (63)	1.9 (964)	≤0.001
20 or more days	0.7 (415)	8.6 (114)	0.5 (301)	≤0.001
Carried weapon				
0 days	82.8 (46,025)	59.0 (754)	83.3 (45,271)	≤0.001
1 day	3.5 (2,017)	6.5 (95)	3.5 (1,922)	≤0.001
2 or 3 days	4.0 (2,198)	7.9 (95)	3.9 (2,103)	≤0.001
4 or 5 days	1.5 (840)	2.9 (48)	1.5 (792)	≤0.001
6 or more days	8.2 (4,236)	23.7 (294)	7.8 (3,942)	≤0.001

Table 1 continued

	Weighted percent (unweighted frequency)			
	Total sample $N = 56,497$	Attempters 2.2% ($N = 1,395$)	Non-attempters 97.8% ($N = 55,102$)	p
Physical fight				
0 times	66.0 (36,722)	30.7 (424)	66.8 (36,298)	≤0.001
1 time	15.3 (8,673)	19.1 (226)	15.2 (8,447)	≤0.001
2 or 3 times	11.3 (6,249)	18.7 (236)	11.2 (6,013)	≤0.001
4 or 5 times	3.0 (1,699)	6.6 (88)	3.0 (1,611)	≤0.001
6 or 7 times	2.0 (1,155)	7.9 (102)	1.8 (1,053)	≤0.001
8 or 9 times	0.3 (202)	1.6 (22)	0.3 (180)	≤0.001
12 or more times	2.1 (1,130)	15.5 (191)	1.8 (939)	≤0.001

BLRT test is currently not available when using the "Type = complex" and because there is little guidance in the literature regarding how and if to use these test for complex survey designs we examine the LRT with and without the "Type = complex" command and the BLRT without using the "Type = complex" command.

To examine the relationship between subtypes of attempters and repeat attempt status we used the Mplus "Auxiliary (e)" command. The auxiliary e command uses posterior probability-based multiple imputations to determine differences in a given outcome across latent classes without using that outcome to define latent classes. We also used the posterior probability-based multiple imputations to explore the socio-demographic differences across subtypes of suicide attempters.

Results

Sample characteristics

Table 1 describes the youth with suicide attempts ($N = 1,395$) and their non-attempting counterparts ($N = 55,102$). Comparatively, those with attempts were disproportionately female (61.3 vs. 50.1%, $p \leq 0.001$), Black (17.0 vs. 13.5%, $p = 0.021$), and Hispanic (22.4 vs. 14.7%, $p \leq 0.001$). A smaller proportion of attempters were in grades 11 (20.3 vs. 23.5%, $p = 0.0.34$) and 12 (13.6 vs. 21.9%, $p \leq 0.001$) than non-attempters. Significant differences emerged between attempters and non-attempters for all our LCA indicators: suicide ideation; sadness/hopelessness; marijuana use; other drug use, binge drinking; weapon carrying; and physical fights (see Table 1).

Rates of suicide attempts

When examining different combinations of race, ethnicity, and gender, we found that Hispanic females had higher rates of suicide attempts (4.5%) than other subpopulations except for Black males whose rates (3.2%) were only trending towards being significantly lower than Hispanic females ($p = 0.10$). White males had lower rates of suicide attempts (1.4%) than other subpopulations.

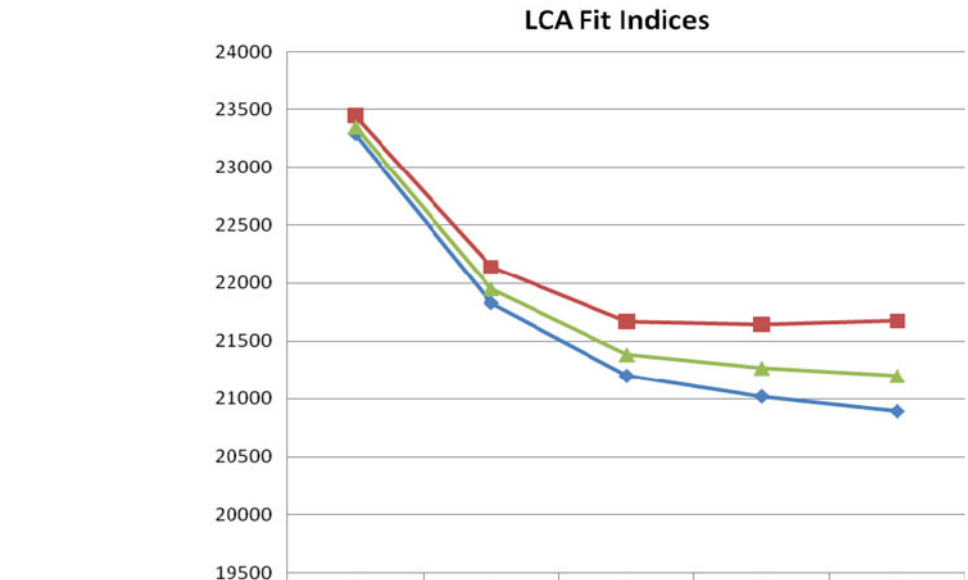
The overall trend of suicide attempts appear to be curvilinear with a peak during the 2001 (2.6%) and 2003 (2.5%) survey administration years and the lowest rates found for 1999 (2.2%) and 2007 (1.8%). However, using 1999 as the baseline, we found no significant pairwise comparisons with other survey administration years (2001, 2003, 2005, 2007), nor was the overall model significant (Adjusted Wald $F = 2.10$, $df = 4$, $p = 0.082$).

Number and description of subtypes

As illustrated by Fig. 1, all the model fit indices begin to plateau after a three-class solution and bottom at a four-class solution for the BIC. The LRT test indicated that the four-class solution did not have a better model fit than the three-class solution. We also reran the data without using the "Type = complex". This analysis replicated the same overall pattern with the model fit indices having a flattening effect between the three-class and four-class solution, especially for the BIC. Again, according to the LRT test the four-class solution was not statistically better than the three-class solution. We were unable to get the BLRT test to converge even after using large values for the LRTstarts option in Mplus (i.e. 100,000). Difficulties getting the BLRT test to converge may indicate too many classes are being extracted. Based on these results we compare the differences between the three- and four-class solutions.

For the three-class solution, we observed a high propensity for suicidal ideation and depressive symptoms among all attempters. The degree of reported substance use and violent behavior largely accounted for the heterogeneity among attempters (see Table 2). Based on these

Fig. 1 LCA model fit indices



	1	2	3	4	5
Akaike (AIC)	23293.894	21828.757	21198.765	21020.171	20891.874
Bayesian (BIC)	23445.873	22137.955	21665.183	21643.809	21672.731
Sample Size Adjusted BIC	23353.751	21950.534	21382.463	21265.791	21199.415

differences, we identified three subgroups: (1) attempters with a low propensity for substance use (SU) and violent behaviors (VB) (low SU-VB); (2) attempters with a high propensity for substance use and violent behaviors (high SU-VB); and (3) attempters with a high propensity for substance use and violent behaviors, who reported extreme levels of substance use and engagement in violent behaviors (extreme SU-VB). Approximately half of the attempters (53.4%) had high SU-VB. The next largest subtype of attempters had low SU-VB (28.9%) and the smallest subtype had extreme SU-VB (17.8%).

For the four-class solution, we found three groups similar to those described above. However, there was an additional small subgroup of attempters similar to those with low SU-VB, but with a lower propensity for suicide ideation and depressive symptoms. However, their rates of suicide ideation remained elevated compared to non-attempters.

Although we considered inclusion of this fourth class, we concluded that this fourth class would offer little to the development of public health approaches beyond that already offered by the three-class solution due to its small size and its similarities with the low SU-VB class (i.e., attempters with little substance use or violent behaviors but with elevated rates of ideation compared to non-attempters). Moreover, the plateauing of model fit indices, especially the BIC, between the three- and four-class solution as well as the LRT test suggest that the model fit of the four-class solution is not significantly better than the three-class solution.

In order to illustrate the different combination of risk behaviors across the three subgroups of attempters, we combined two line charts in Fig. 2a, b. Figure 2a uses a line chart to show the propensity for each subtype of attempter to endorse any level of the seven latent class indicators (e.g., had a fight during past year). Figure 2b also uses a line graph to show the propensity of each subtype of attempter to endorse the highest level of the seven latent class indicators (e.g., over 12 fights during past year). Each line in the graph represents a pattern of behaviors rather than a linear progression of risk.

Class 1: Attempters with low SU-VB

The majority of attempters with low SU-VB endorse no problem behaviors and almost none of them endorse the highest levels of problem behavior. Approximately half (49.4%) of this subgroup reported having two or more attempts during the past year, significantly less than the other two groups ($p < 0.001$).

Socio-demographic characteristics

Approximately 66% of attempters with low SU-VB are females. Females were significantly more likely to be attempters with low SU-VB than attempters with extreme

Table 2 Results of latent class analysis of youth who attempted suicide

	Percentage of risk factors in members of each class		
	Class 1 low SU-VB (28.9)	Class 2 high SU-VB (53.4)	Class 3 extreme SU-VB (17.8)
Suicide ideation			
No	19.3	6.3	12.4
Yes	80.7	93.7	87.6
Sadness/hopelessness			
No	33.8	13.2	12.4
Yes	66.2	86.8	87.6
Other drug use			
0 times	85.5	24.0	1.3
1 or 2 times	9.3	21.4	1.5
3–9 times	3.6	21.8	9.2
10–19 times	0.1	13.7	5.9
20–39 times	0.5	6.7	10.6
40 or more times	1.1	12.4	71.4
Marijuana use			
0 times	67.5	8.5	1.0
1 or 2 times	17.9	5.8	0.0
3–9 times	7.6	17.4	0.1
10–19 times	4.1	11.6	1.8
20–39 times	2.6	11.9	1.1
40–99 times	0.2	10.2	2.9
100 or more times	0.1	34.6	93.0
Binge drinking			
0 days	84.4	24.9	3.7
1 day	5.6	16.2	10.1
2 days	6.6	23.5	0.0
3–5 days	2.5	21.3	13.1
6–9 days	0.3	7.0	14.7
10–19 days	0.0	6.5	11.0
20 or more days	0.6	0.7	47.5
Carried weapon			
0 days	86.5	59.4	11.6
1 day	4.8	9.4	0.0
2 or 3 days	4.6	10.6	5.0
4 or 5 days	0.1	3.6	5.2
6 or more days	4.0	17.0	78.2
Physical fight			
0 times	60.1	24.6	4.6
1 time	17.0	25.7	2.2
2 or 3 times	10.3	28.0	3.4
4 or 5 times	6.4	7.3	4.7
6 or 7 times	1.6	9.1	13.5
8 or 9 times	0.8	0.5	6.1
12 or more times	3.6	4.8	65.5

SU-VB substance use and violent behaviors

SU-VB. As illustrated by Table 3, racial characteristics are also statistically different by suicide attempter subtype. While whites comprise approximately 60% of all attempters, they are less than half of this subgroup (47.5%). Black and Hispanic females had particularly high proportions of attempters with low SU-VB. For instance while

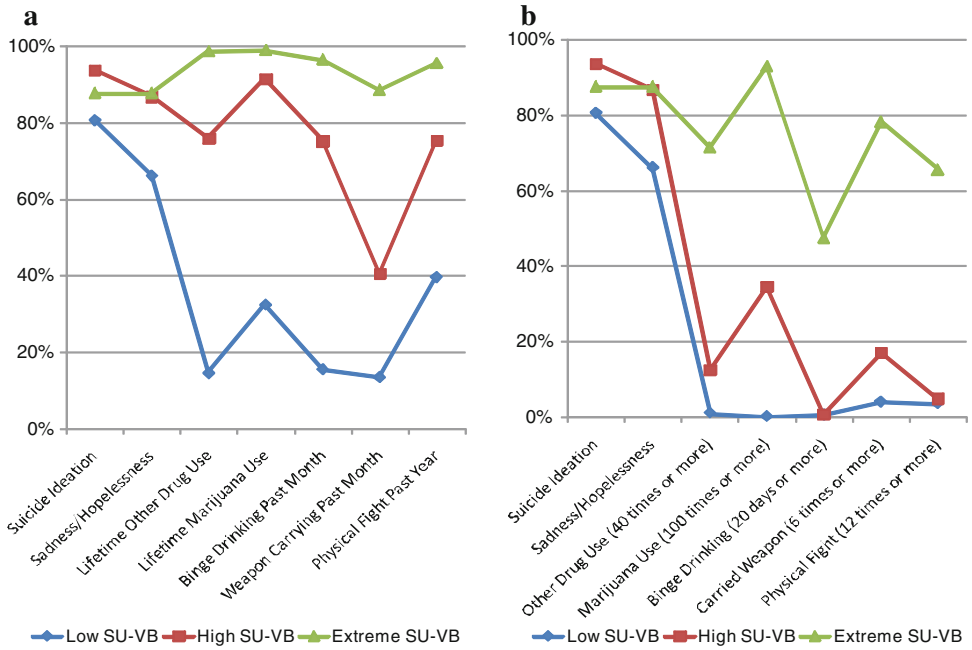


Fig. 2 **a** The three attempter group's estimated propensity to endorse each of the seven risk factors (*x* axis). **b** The three attempter group's estimated propensity to endorse the most extreme value of the seven risk factors (*x* axis). *SU-VB*: substance use and violent behaviors

Table 3 Sociodemographic characteristics by subgroups of suicide attempters

	Total attempters	Class 1 low SU-VB (%)	Class 2 high SU-VB (%)	Class 3 extreme SU-VB (%)
Female	61.3% (871)	66.1[a]	67.7[a]	34.1[b]
Male	38.7% (524)	33.9[a]	32.3[a]	65.9[b]
Black	17.0% (327)	23.7[a]	12.9[b]	18.1[c]
Hispanic	22.4% (511)	28.8[a]	19.8[b]	19.8[b]
White	60.6% (557)	47.5[a]	67.3[b]	62.1[c]
9th	37.8% (410)	37.1[a]	36.2[a]	43.5[b]
10th	28.3% (372)	27.0[a,b]	30.2[a]	24.7[b]
11th	20.3% (343)	20.4	21.3	17.5
12th	13.6% (270)	15.5	12.3	14.3
Females				
Black	7.7%	14.2[a]	5.3[b]	4.1[c]
Hispanic[1]	14.4%	19.0[a]	14.2[b]	7.8[c]
White	39.2%	32.9[a]	48.2[b]	22.3[c]
Males				
Black	9.3%	9.5[a]	7.6[a]	14.0[b]
Hispanic	8.0%	9.8[a]	5.6[b]	12.1[c]
White[2]	21.5%	14.6[a]	19.1[b]	39.8[c]

Cells that do not share the same superscripts within a row are statistically different from each other

SU-VB substance use and violent behaviors

only making up 7.7% of all attempters, Black females consisted of 14.2% of the low SU-VB subgroup.

Class 2: Attempters with high SU-VB

The majority of attempters with high SU-VB endorsed engagement in all the behavior problems except for carried a weapon (40% endorsed); however, the majority of them did not endorse the highest level for any of the seven problem behaviors. Sixty-one percent of the high SU-VB subgroup reported having two or more suicide attempts during the past year, significantly higher than the low SU-VB subgroup ($p < 0.001$), but significantly lower than the extreme SU-VB subgroup ($p < 0.001$).

Socio-demographic characteristics

Approximately 68% of attempters with high SU-VB are females, significantly greater than attempters with extreme SU-VB. This subtype of attempters had the largest

proportion of Whites compared with other subtypes: 67.7%. Almost half of this group was White females, although they made up only 39.2% of all attempters.

Class 3: Attempters with extreme SU-VB

Most attempters with extreme SU-VB endorsed all the problem behaviors, with the majority also endorsing the most extreme or highest levels of behavioral problems, except for binge drinking. Yet even binge drinking was high in this group, with the majority reporting binge drinking more than 10 days during the past month. Over 80% of the youth in this subgroup also report having two or more attempts during the past year (84.6%), significantly more than the other two groups ($p < 0.001$).

Socio-demographic characteristics

Unlike the other two subtypes of attempters, males made up the majority of this subtype, approximately 66%. Unlike other racial/ethnic groups, Black attempters were more likely to be in this subtype than they were the high SU-VB group. White males made up approximately 40% of this subtype of attempter, a much higher proportion than their representation as attempters (21.5%). As illustrated by Table 3, the ninth grade was the only time where attempters with extreme SU-VB subtype were in greater proportion than the other two subtypes. Moreover, between grades 9 and 10 there was a large drop-off of attempters in this subtype, from 43.5 to 24.7%.

Discussion

Before discussing what we see as an array of important findings, we want to consider potential limitations of our data, such that any conclusions we draw are viewed cautiously. YRBSS uses self-reported measures, which may not be accurate despite previous studies suggesting that such items have produced valid responses [33, 34]. Results do not generalize to youth suicide attempters not requiring medical attention. We acknowledge the gravity of any suicide attempt, including those not resulting in the need for medical attention. However, our focus on attempts requiring medical attention was chosen to focus on youth with the highest risk for injury and to be consistent with the definition of suicide attempt for youth used by Healthy People 2010. Also, YRBSS collects its surveys in schools; the evident differences in distribution of attempters across the four years of high school strongly suggest that the data may reflect substantial attrition of those students (especially males) bearing the highest burdens of risk in the 11th and 12th grades due to drop-out, arrest, incarceration, death by suicide, homicide, absenteeism, participation refusal or other causes. Thus, we are careful to interpret differences based on ethnicity, race, and gender since rates and reasons for attrition are likely to vary by these factors [35, 36]. While the YRBSS is anonymous, such that a single student might reappear across survey administrations, the probability for such a sampling anomaly is low since a new sample of schools is used for each survey administration. Last, while substance use and depression are common risk factors for suicidal behavior and not the inverse, we are unable to know the temporal sequencing of risk behaviors as reported by adolescents, (e.g. did youth start using substances only after a suicide attempt?).

Summary of results

Mindful of these limitations, we see that our analyses point to three subtypes of youth with a past-year history of suicide attempts requiring medical care: those with low SU-VB, those with high SU-VB, and those with extreme SU-VB. Depressive symptoms were high across all three risk factor profiles. Moreover, the probability of having two or more suicide attempts during the past year increased with the severity of substance use and violent behaviors, as high as 84.6% for those in the extreme SU-VB subgroup compared with 49.4% for those in the low SU-VB subgroup. The results of the LCA are consistent with the growing body of evidence suggesting that the co-occurrence of depressive symptoms, substance use, and violent behaviors need to be salient priority areas for adolescent suicide prevention [7–25]. As far as we know, ours is the first study to use these risk factors to identify distinct subtypes of attempters using nationally representative samples of youth who attempted suicide. Although not conclusive, the differences among the three profiles may suggest distinct and important variations in the risk factors associated with suicidal behavior and the severity of suicide risk across different types of attempters.

Substance misuse

Substance misuse may be a risk factor for suicidal behavior among attempters with extreme SU-VB. This is not to suggest that substance use is the initial or primary factor leading to suicidal behavior among these types of attempters even as it may serve as a powerful contributing factor for some [24]. There are at least three mechanisms to consider when planning preventive interventions [37]. First, the strain that often results from problematic substance use, such as legal problems, relational problems, family conflict, and school problems, may increase the likelihood of suicidal behavior. While it may be more common with attempters in the extreme SU-VB group, this

is an empirical question worthy of further exploration. Second, there is increasing evidence that over time the misuse of substances impairs the parts of the brain associated with judgment, impulse-control, and can lead to dysphoria due to damaged brain receptors that help to regulate mood [37–40]. We would expect to find the most evidence of such effects among attempters with extreme SU-VB. A third mechanism involves the increased risk for suicidal behavior due to the immediate disinhibiting effects of intoxication [41, 42] that would be evident in both SU groups. Given these three mechanisms, the co-occurrence of drug and or alcohol use with depression may serve as a powerful risk factor for a suicide attempt.

Violent behaviors

Other important etiological differences that need further exploration across subtypes of attempters include violent behaviors. Like substance misuse, weapon carrying and fighting is likely to contribute to stressful life events such as legal problems, psychological trauma, injury, or being concerned over physical safety, which increases strain [43]. Moreover, genetic and environmental differences in these youth need further exploration. Although we were unable to explore gang affiliation in our study, the severe and multiple problems those attempters with extreme SU-VB exhibit is consistent with those described for gang members or violent chronic juvenile offenders [44]. Bossarte and colleagues [21], found a similar cluster of "high violence" youth with co-occurring behaviors of violence perpetration and suicidal behavior; the majority of these youth reported fighting as part of a group, often an indication of gang affiliation. Current brain research also suggests that parts of the brain that control compulsive and impulsive behaviors, such as aggression, addiction, or suicidal behavior, may be less developed among individuals with these problems [45, 46]. More research is needed to understand the interaction between brain development and the engagement of problematic behaviors such as drug misuse or violent behaviors on the risk for suicide behavior among youth. For instance, to what extent does differences in brain development predate and account for the development of problematic behaviors among youth, to what extent does problematic behaviors such as drug misuse and violence change the brain, and how does the combinations of these two dynamics relate to future risk for suicide behavior?

Gender differences

The gender differences found among extreme SU-VB suicide attempters is also critically important for advancing prevention efforts in the US. Males represented the majority of these in the extreme SU-VB attempter subgroup. The greater likelihood of extreme externalizing behaviors among male attempters is consistent with previous research that has found high levels of disruptive and substance use disorders among male suicide attempters [9, 47]. Although males have lower rates of suicide attempts, they have higher rates of death by suicide. Future research should investigate if males' higher rates of co-occurring problems partially account for this apparent contradiction. Moreover, our findings raise the question—would a reduction of attempters of this most pathological subgroup of attempters have the most potential for preventing a future attempt or even reducing deaths by suicide? A recent longitudinal study by Sourander and colleagues [15] found that co-occurrence of conduct and internalizing problems as young as 8 years old for males predicted suicide or a serious suicide attempt by adolescence or early adulthood. Although not conclusive, our findings, that the extreme SU-VB subgroup had the highest rates of repeat suicide attempts during the past year, provides further evidence that early intervention among youth with co-occurring problems may be a promising approach for suicide prevention, especially for males.

Racial and ethnic differences

In terms of racial and ethnic disparities, Black and Hispanics have higher proportions of youth in the low SU-VB subtype of attempters. We offer two potential explanations. First, higher levels of treatment for mood disorders occur among Whites [48], which may lead to lower rates of suicide attempts among youth who do not experience co-occurring problems with substance use or violent behavior. This disparity may in part be due to disparities in access to care as well as differences in cultural perspectives on mental health treatment. Second, strain caused by contextual problems, such as discrimination and institutional racism, family poverty, community stigma related to mental illness, and community violence, may lead to higher rates of suicide attempts among Hispanic and Black youth without co-occurring problems. Further investigation is needed to verify these potential explanations.

Finally, our results verified that Hispanic females are heavily burdened in terms of attempt-related morbidity; they have the highest suicide attempt rate overall. Research is needed to focus on factors that increase risk among Hispanic females including acculturation [49] and other socio-cultural factors [50, 51].

Implications for prevention

While our results reinforce the need for identifying youth having significant symptoms of distress and possible mood

disorders [52], they highlight the need for addressing the co-occurrence of multiple risk behaviors for many of the youth who attempt suicide. By acknowledging the need for substance abuse treatment and violence prevention for youth with co-occurring problems into suicide prevention initiatives, we believe a more comprehensive and well-integrated public health approach is possible. Building on the prevention framework articulated by the Institute of Medicine (IOM) report on reducing suicide, we recommend three ways to strengthen national public health strategies [53].

Universal approaches

First, including universal or population-based prevention programs that target substance use and violence may reduce the number of youth with co-occurring problems in the population—those with some of the highest risk for suicide attempt. Lubell and Vetter recommend a similar strategy of incorporating evidence-based violence prevention programs into the suicide prevention framework [18]. It is important to emphasize that while there are no published, evidence-based programs that have been demonstrated to reduce suicide among youth, there are an array of well-documented, intensively scrutinized programs that have served to powerfully reduce violence, in particular, as well as substance misuse [26]. At least one such effective program, designed to reduce aggressive and conduct-related problems among primary school aged children, also resulted in fewer suicide attempts as the participants became adolescents and young adults, in addition to the intended goal of decreasing the emergence of conduct problems and substance misuse [54]. Indeed a promising line of future research may be to examine the effects of population-based interventions for preventing substance use or violent behaviors on reducing suicidal behaviors among youth and young adults. Challenges to overcome in implementing and researching such a strategy include a paradigm shift to include programs that do not explicitly target depression or suicide ideation within a suicide prevention framework.

Gatekeeper training and other case identification programs

Success for any case identification program hinges on the ability to identify cases at risk and to effectively refer these cases to appropriate care in a timely manner. Case identification programs for prevention of suicide behavior among youth usually focus on identifying and referring dysphoric youth expressing suicide intention for psychiatric or mental health services. However, data from Wyman et al. reveal that the most troubled and suicidal youth in school avoid talking with adults [55]. Moreover, many youth labeled with "conduct disorders" or "antisocial behaviors" and who are at risk for suicide behavior (i.e. extreme SU-VB subtype of attempter) are probably more likely to have contact with teachers and other school officials due to conduct problems at school than expressions of suicide intention. Narrowly defining prototypes of cases in these programs may lead to many of the highest risk youth not being identified or referred for appropriate services. Inversely, universal case identification approaches that rely on identify youth with relatively common risk factors run the risk of overwhelming systems especially when done without proper planning or infrastructure [56, 57].

In this vein, we recommend the use of case identification programs that help to identify diverse case types and that develop tailored responses to address the needs of different types of at risk youth using evidence-based programs. For instance, gatekeeper training programs may be enhanced by including a description of different subtypes of adolescent attempters (e.g. depressive youth with no co-occurring problems, depressed youth with multiple co-occurring problems, etc.) of diverse races and genders. In addition, the inclusion of role playing activities with these subtypes may be particularly important to sensitize trainees to the variety of ways a suicidal youth may present themselves to a gatekeeper. Moreover, case identification programs need not only focus on youth at imminent risk for suicide, but also be used to reduce the number of potential at risk youth in a population. Once cases are identified, predetermined referral options addressing the unique needs of each case type can be made using evidence-based programs. Although there are examples of others effectively using differential responses within the context of a case identification program for adolescent suicide prevention [58], research is needed to test the efficacy of a differential response approach using a menu of predetermined evidence-based programs. Just as vital, research is needed on how to best implement and disseminate such a strategy within real world settings, such as schools, courts, or hospitals [57].

Indicated and selective approaches

Selective and indicated suicide prevention strategies must encompass the diversity of the youth who bear the greatest burden of risk behaviors. We would argue that the needs of youth with depression and serious suicidal thoughts and plans, but no history of substance use or violence, will differ greatly from those with robust, co-occurring substance use and violent behavior. While both types of youth may need a referral for a psychiatric evaluation and mental health services, the latter likely will benefit from community-based drug and violence reduction programs that work across multiple dimensions of a youth's life (e.g. Multisystemic Therapy [59, 60]), or psychiatric and mental

health services (inpatient or outpatient) that specialize in the treatment youth with co-occurring problems. For youth with burgeoning but less severe substance use or violence-related problems, family or school-based prevention programs for these problems may be more appropriate (e.g. Brief Strategic Family Therapy [61]). Moreover, public health approaches focusing on reducing access to lethal weapons may be particularly important among attempters with extreme SU-VB, as *the majority report carrying a weapon including a gun, knife, or club more than 6 days during the past month*. Besides being a danger to others, weapons such as a gun, can provide a lethal means to die by suicide.

Conclusion

Our study is unique in that it uses a national sample of teen attempters attending school to identify heuristic and clinically practical subgroups of suicide attempters based on co-occurrence of depressive symptoms, substance use, and violent behaviors. We found three subtypes of youth with a past-year history of suicide attempts requiring medical care with varying levels of substance use and violent behavior. Depressive symptoms, high across all three risk factor profiles, did not differentiate the groups. The probability of having two or more suicide attempts during the past year increased with the severity of substance use and violent behaviors among attempter subtypes. Our study indicates that treatment of depressive symptoms remain an important goal for teen attempter. However, public health strategies need to incorporate substance use and violence prevention and treatment programs in order to be responsive to the needs of many teen attempters. Greater attention must be paid to race, ethnicity, and gender in suicide prevention programs, so that targeted efforts can reach diverse youth with co-occurring violent behaviors and psychiatric symptoms.

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Conflict of interest None.

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