Journal of Affective Disorders 266 (2020) 743–752

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Research paper

Co-occurring risk factors among U.S. high school students at risk for suicidal thoughts and behaviors

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ARTICLE INFO

Keywords:
Suicide
Adolescence
YRBS
Latent class analysis

ABSTRACT

Background: Suicidal thoughts and behaviors (STBs) are increasing among adolescents in the United States and are challenging to predict and prevent. The current study identifies subtypes of youth at risk for suicidal thoughts and behaviors (STBs) in school-based settings.

Method: Data are from the CDC's 2015 and 2017 National Youth Risk Behavior Survey of US high school students. Among students reporting depression symptoms, latent class analysis is used to identify subtypes at risk for STBs based on personal characteristics, risk behaviors and environments.

Results: Two distinct subtypes of youth were found to be at high risk for STBs: The first, larger subtype (22%) is predominately females in early high school, many of whom identify as bisexual, experienced past-year bullying, and are likely to have experienced sexual victimization. These students have low levels of externalizing risk behaviors making them difficult to detect. The second high-risk subtype (7%) is characterized by students with significant social integration challenges, with extremely high levels of substance abuse, fighting, physical and sexual victimization and poor academic performance. Many of these students have low English fluency, and identify as sexual minority.

Limitations: Due to attrition or language barriers, experiences of some students at high-risk for STBs may not have been captured by this survey.

Conclusion: Universal screening in clinical settings, and universally focused suicide prevention programs in school-based settings are needed and should be introduced early on. Interventions should be tailored to reach high-risk students with language, cultural and social integration challenges.

1. Introduction

Suicidal thoughts and behaviors (STBs) are widespread among adolescents in the United States, with rates increasing over time. Between 1999 and 2017 a 67% increase in deaths by suicide was observed among adolescents ages 13 to 17 years (CDC WISQARS, 2019). In addition, CDC's 2017 Youth Risk Behavior Survey indicates that 17.2% of high school students have seriously considered suicide in the past 12 months, 13.6% made a plan, and a staggering 7.4% attempted suicide one or more times in the past 12 months (Kann et al., 2018). Depression is the leading psychiatric risk factor for suicide attempts and death in youth (Hawton et al., 2013; Hawton and Van Heeringen, 2009), and over the last decade, a significant increase has been observed in the prevalence of depression among youth, particularly among females (NSDUH, 2016).

STBs not only impact the immediate victim, but can have significant emotional, medical and financial effects on family members, friends, colleagues, care providers and communities (Zechmeister et al., 2008). Further, suicide attempts, self-harm and suicidal ideation in youth are predictive of future suicide risk and other adverse psychopathological outcomes (Patton et al., 2012).

Recent in-depth reviews have highlighted severe deficiencies in our current ability to predict suicide attempts and deaths (Franklin et al., 2017; Nock et al., 2013), underscoring the need for new approaches for unraveling the complex interactions that result in STBs and identifying actionable opportunities. Some of the recommended approaches put forward to improve predictive accuracy include: Deconstruction of the pathway to suicide attempts in terms of progression to ideation and then progression from ideation to attempt and elucidating the risk and protective processes at each step in the pathway; application of risk

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https://doi.org/10.1016/j.jad.2020.01.177
Received 24 September 2019; Received in revised form 31 December 2019; Accepted 28 January 2020
Available online 29 January 2020
0165-0327/

Table 1
Sociodemographic characteristics and risk behaviors of 2015 & 2017 YRBS national high school student survey respondents by continuum of suicide-related thoughts and behaviors.

Question	Total Sample	Students with Prolonged Sadness/ Hopelessness	Students with Prolonged Sadness/Hopelessness & Suicidal Ideation	Students with Prolonged Sadness/Hopelessness, Suicidal Ideation & 1 or More Attempts	Students with Prolonged Sadness/Hopelessness, Suicidal Ideation & Multiple Attempts (2 or more)
Sample Size*	*N* = 30,394 Weighted%	*N* = 9421 Weighted%	*N* = 4230 Weighted%	*N* = 1542 Weighted%	*N* = 806 Weighted%
Demographics					
Female	49.7	65.7	69.1	73.4	71.6
Grade†					
9th	27.3	25.9	27.1	31.2	32.2
10th	25.7	26.1	26.1	29.9	30.6
11th	23.9	25.0	24.2	21.0	19.5
12th	23.1	23.1	22.7	17.9	17.7
Race‡					
White	54.0	51.8	54.4	48.8	45.9
Black/African American	13.5	11.9	9.9	9.8	10.2
Hispanic/Latino	22.6	25.4	23.9	28.2	30.0
Asian	3.6	3.1	3.2	3.2	3.1
Multiple - Non-Hispanic	5.1	6.5	7.1	8.5	9.2
Am Indian/Alaskan Native	0.5	0.6	0.7	0.7	0.8
Native Hawaiian/Other Pacific Islander	0.7	0.7	0.8	0.7	0.8
Sexual orientation					
Heterosexual	87.1	76.2	66.8	60.2	58.6
Gay/Lesbian	2.2	3.5	4.9	4.9	5.8
Bisexual	7.0	14.8	21.4	28.4	27.3
Unsure	3.7	5.4	6.9	6.5	8.3
Substance Abuse					
Current cigarette or cigar use§	13.3	20.2	25.0	31.6	35.2
Current electronic vapor product use	19.2	27.0	31.0	38.3	40.5
Currently used marijuana	20.8	30.6	35.0	43.1	45.7
Reported that the largest number of drinks they had in a row was 10 or more	4.4	6.3	8.0	11.0	14.2
Ever used cocaine, methamphetamine, heroin or ecstasy	7.2	12.2	15.6	20.9	24.5
Ever used inhalants	6.6	11.6	16.3	21.0	25.0
Ever took prescription drugs without a doctor's prescription‖	15.4	25.1	31.7	40.0	40.8
Violence Involvement					
Carried weapon school 1+ past 30 days	3.9	5.4	7.6	9.9	12.6
Threatened/injured w/weapon at school 1+ times 12 mos"	6.0	10.0	12.6	18.2	23.8
Fought 1+ times during past 12 mos	23.1	31.3	35.3	47.1	52.1
Forced to have sexual intercourse	7.1	15.2	22.5	31.1	36.0
Hurt by date 1+ times during past 12 mos (among dating and non-dating)	6.1	12.2	17.2	25.1	31.5
Social Factors					
Bullied at school during past 12 mos	19.6	35.1	45.6	53.9	58.1
Electronically bullied during past 12 mos	15.3	30.2	38.5	48.2	50.8
Did not go to school because they felt unsafe at school or on their way to or from school	6.1	11.5	15.1	20.8	27.3
Had sexual intercourse before age 13 years	3.7	5.0	7.1	10.8	16.3
Had sexual intercourse with four or more persons	10.6	13.9	17.1	21.1	26.6
Limited English fluency	1.8	2.5	3.3	4.7	7.3
Cognitive/Neurological Factors					
Made mostly A's or B's in school	73.4	66.4	62.2	57.0	55.0
Have serious difficulty concentrating, remembering, or making decisions	31.0	58.6	70.9	76.7	78.7
Had 4 or less hours of sleep per night	8.0	13.9	19.6	24.4	29.4
Health Maintenance					
Were physically active at least 60 min per day on 5 or more days	47.6	40.1	37.8	38.6	37.3
Did not participate in at least 60 min of physical activity on at least 1 day	14.8	17.8	19.3	19.1	21.5
Are Obese	14.4	15.3	17.2	17.1	17.8
Are Overweight	15.8	17.9	18.8	18.1	16.6

* Detailed table with sample sizes for each variable after accounting for missing data is available in Online Supplement 3.
† 9th & 10th grades and 11th & 12th grades combined for LCA analysis.
‡ Asian, Mulitple Non-Hispanic, American Indian/Alaskan Native and Native Hawaiian/Other Pacific Islander racial and ethnic groups were aggregated for LCA analysis to allow for adequate sample size.

[§] Due to a high degree of overlap and to improve model efficiency, responses to survey questions about cigarette and cigar use were combined into a single variable, as were responses to questions about cocaine, methamphetamine, heroin and ecstasy.

[‖] Responses to the question about prescription drug misuse were combined for 2015 and 2017 even though there were modifications to the question: 2015 question was "During your life, how many times have you taken a prescription drug (such as OxyContin, Percocet, Vicodin, codeine, Adderall, Ritalin, or Xanax) without a doctor's prescription?" and 2017 question was "During your life, how many times have you taken prescription pain medicine without a doctor's prescription or differently than how a doctor told you to use it?(Count drugs such as codeine, Vicodin, OxyContin, Hydrocodone, and Percocet.)"

stratification (such as focusing on a cohort with depression or anxiety) to improve predictive accuracy and improve clinical relevance; larger sample sizes; innovative statistical approaches for understanding relationships between large combinations of risk factors using noisy, complex, "real world data" (Franklin et al., 2017; Walsh et al., 2017; Nock et al., 2013; Nock, 2012; Klonsky and May 2013; Ribiero et al., 2017).

This study advances these recommendations to identify subtypes of youth at high risk for suicidal behavior in school-based settings. Specific study aims are as follows: First, among high school (HS) students with depression symptoms, identify subtypes of students at risk for suicidal ideation and attempts. Depression is the leading psychiatric risk factor for suicide attempts and death in youth (Hawton et al., 2013; Hawton and van Heeringen, 2009), and over the last decade, a significant increase has been observed in the prevalence of depression among youth, particularly among females (NSDUH, 2016). Second, among HS students with both depression symptoms *and* suicidal ideation, identify subtypes of students at risk for suicide attempts. Consistent with modern ideation-to-action theories of suicide which view suicide ideation and attempts as distinct processes with distinct explanations (Joiner, 2005; O'Conner, 2011; O'Conner and Kirtley, 2018; Klonsky and May, 2015; Rudd, 2006), the intent for this objective is to discern whether different risk and protective factors come into play in predicting suicidal attempts among adolescents known to be further along the risk continuum.

To accomplish these aims, this study leverages the nationally representative data from the CDC's 2015 and 2017 Youth Risk Behavior Surveys to enable exploration of co-occurrence of substance abuse, violence involvement, social factors, cognitive/neurological factors, health issues, and demographic characteristics in relation to suicide-related behaviors. Using latent class analysis, distinct subtypes or "classes" of HS students with differing levels of risk for STBs are identified for both a cohort of adolescents with depression, and a cohort of adolescents with depression plus suicidal ideation.

2. Method

2.1. Data source

Data for this study comes from the 2015 and 2017 administrations of the CDC's National Youth Risk Behavior Survey (YRBS). The YRBS consists of self-report data from a representative sample of U.S. HS students (grades 9–12) on priority health behaviors and characteristics including prolonged sadness and/or hopelessness, suicide ideation and suicide attempts during the past 12 months. Details about the National YRBS surveys, sampling procedures and datasets are available at www.cdc.gov/yrbss.

For the current analysis, data from 2015 and 2017 were selected from the 2017 YRBS Combined Dataset and combined to increase analytic sample size and power to detect less prevalent, but potentially key, risk factors while reflecting recent HS student attitudes, experiences and behaviors. Participating schools were selected through a multistage cluster sampling procedure. For 2015, the school response rate was 69% and the student response rate was 86% yielding an overall response rate of 60% and 15,624 completed surveys. For 2017 the school response rate was 75% and the student response rate was 81% yielding an overall response rate of 60% and 14,765 completed surveys (ref: 2015 & 2017 YRBS Data User's Guides p3 (2015) & p6 (2017) www.cdc.gov/yrbss).

2.2. Identification of sub population cohorts

Students who answered affirmatively to the question, "During the past 12 months, did you ever feel so sad and hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities?", were classified as the "prolonged sadness/hopeless" (P-S/H) cohort for the first study aim. Prolonged sadness and hopelessness that interferes with daily activities is a symptom of depression (Kroenke et al., 2001), which is the leading psychiatric risk factor for suicide attempts and death in youth (Hawton et al., 2013; Hawton and Van Heeringen 2009).

Students in the P-S/H cohort who answered affirmatively to the question, "During the past 12 months, did you ever seriously consider attempting suicide?", were classified as the "prolonged sadness/hopelessness *plus* suicidal ideation" (P-S/H *plus* SI) cohort for the second study aim.

Two additional sub-population cohorts were identified for descriptive analyses presented in Table 1, which explores the frequency of risk behaviors and environments across a continuum of STBs: Students in the P-S/H *plus* SI cohort who indicated "one or more times" to the question, "During the past 12 months, how many times did you actually attempt suicide", were classified as the "suicide attempt" cohort, and those who indicated "two or more times" where classified as the "multiple suicide attempts" cohort.

2.3. Statistical analysis

SAS 9.4 was used to generate frequencies of each of the risk factors for each sub-population of interest. To account for YRBS's stratified cluster survey design and sample weights, the PROC SURVEYFREQ command was used.

Exploratory latent class analysis (LCA) was used to identify subtypes (i.e., "classes") of youth with similar patterns of behaviors or characteristics. The classes are latent in that the subtypes are not directly observed, but rather are inferred from multiple observed indicators (Henry and Muthén, 2010). In the context of suicide prevention, it is a useful tool for understanding how different risk-factors co-occur in teens who manifest low, moderate and high levels of suicide-related behaviors.

Candidate variables for LCA that were either known or hypothesized to be related to STBs were selected from the survey questions, and grouped into one of six domains: Substance abuse, violence involvement, social factors, cognitive & neurological factors, health maintenance and demographics. Next, logistic regression models were used to assess the statistical significance and magnitude of the relationship between each of the candidate variables from the first five domains and STBs, while adjusting for demographic domain variables of age, gender, race/ethnicity and sexual orientation. Variables found to have a significant odds ratio in relation to the outcomes (i.e. ideation vs no ideation, and attempt vs no attempt) were included in the LCA models. A full description of the logistic regression procedures is available in the supplementary materials (Online Supplement 1).

Mplus version 8.1 was used to conduct exploratory LCA to identify suicidal ideation classes or typologies in the sad/hopeless cohort, and suicide attempter typologies in the suicide ideation cohort. For the analysis, the command 'TYPE = COMPLEX MIXTURE' was used to enable adjustment for the YRBS's stratified cluster survey design and ensure data were properly weighted to be representative of high school students in the United States.

To determine the optimal number of latent classes within each

population, the LCA procedure was repeated seven times, starting with one class, and with each iteration increasing the number of classes until the final model with seven classes was generated. Clinical judgement, in combination with model fit statistics (Baysian Information Criterion (BIC) and Adjusted BIC) and the classification quality "entropy" indicator were applied to determine the optimal number of classes for understanding risk typologies within the study populations. More detail about the LCA procedure is available in the supplementary materials (Online Supplement 2).

3. Results

3.1. Sample characteristics

Table 1 describes sociodemographic characteristics and risk behaviors of the combined 2015 and 2017 cohorts of HS youth across a continuum of suicide-related behaviors. Of the 30,394 students in the sample, 9421 (30.6% (weighted)) reported experiencing past-year prolonged sadness or hopelessness (P-S/H), 4230 (13.6%) reported past-year prolonged sadness/hopelessness and suicidal ideation (P-S/H *plus* SI), 1542 (5.2%) reported past-year P-S/H *plus* SI and at least one suicide attempt, and 806 (2.7%) reported past-year P-S/H *plus* SI and two or more suicide attempts.

Across the continuum of STBs, the percentage of females was greater than males, and the percentage of sexual minority youth (gay/lesbian, bisexual or unsure) increased with each step in severity up to and including multiple attempts. Lower classmen (9th & 10th grade) were more likely to report having experienced suicide attempts compared to upper classmen (11th & 12th grade), and the percentage of Hispanics and multiple-race non-Hispanics was higher among students reporting attempts than observed in the overall HS cohort.

Substance abuse also increased across the continuum for STBs. For example, current cigarette/cigar use, vapor product use, and marijuana use were 13.3, 19.2 and 20.8%, respectively, among all HS students, and progressed to 35.2, 40.5 and 45.7% among students reporting multiple attempts. Reports of having ever used street drugs (i.e. cocaine, methamphetamine, heroin & ecstasy) increased from 7.2% in the total HS population, to 24.5% among students with multiple attempts. Similarly, the frequency of prescription drug misuse increased from 15.4% to over 40% across the continuum of STBs.

An increase in violence involvement, both physical and sexual, was also observed across the continuum: Rates ranged from 3.9% among all HS students to 12.6% for carrying a weapon to school in the prior 30 days; 6.0% to 23.8% for being threatened or injured with a weapon at school in the prior 12 months; 23.1% to 52.1% for engaging in a physical fight in the prior 12 months; 7.1% to 36.0% for being forced to have sexual intercourse during their lifetime; and 6.1% to 31.5% for being physically hurt by a date in the prior 12 months.

Social risk factors of bullying, feeling unsafe going to and from school, sexual intercourse before 13 years of age, multiple sex partners, and limited English fluency also increased in prevalence across the continuum. For being bullied at school, rates ranged from 19.6% among the general HS population to 58.1% for students reporting multiple attempts. Rates ranged from 15.3% to 50.8% for electronic bullying; 6.1% to 27.3% for missing school due to feeling unsafe; 3.7% to 16.3% for sexual intercourse before 13 years old; 10.6% to 26.6% for having sexual intercourse with four or more people during their lifetime; and 1.8% to 7.3% for reporting limited English fluency.

Cognitive and neurological factors such as difficulties with concentrating, remembering and making decisions increased from 31.0% among all students to 78.7% among students reporting multiple suicide attempts. Academic performance (i.e. grades mostly A's and B's) declined from 73.4% to 55.0%, as did the amount of nightly sleep, with 29.4% of students with multiple attempts reporting less than 4 h of sleep per night on average.

Overall, students with STBs were less likely than the overall population to engage in physical activity and were somewhat more likely to be overweight.

3.2. Risk and protective factors for suicide ideation and attempts

Table 2 lists odds ratios and associated confidence intervals for risk and protective factors that met the criteria for inclusion in the LCA models. The health maintenance variables did not have significant, elevated odds ratios and consequently were excluded. In addition, use of hallucinogens was also excluded due to a large number of missing observations. All odds ratios were adjusted for demographic characteristics of gender, grade, race/ethnicity and sexual orientation. Since it was not possible to adjust this analysis for severity of depression, it's acknowledged that the presence of some risk or protective factors may be more of a reflection of the intensity of depression, rather than independent risk factors for suicidal ideation and attempts.

Substance abuse of any kind was associated with an elevated odds of engaging in suicide ideation among HS students with depression symptoms, and when comparing students with one or more attempts with those who experienced ideation only, the magnitude of the odds ratios were even greater for most indicators. Similarly, physical and sexual violence involvement was also associated with an elevated odds of HS students experiencing suicidal ideation, compared to experiencing depression only, and for most indicators, the magnitude was greater when comparing students with a suicide attempt versus those who had depression symptoms and suicidal ideation only.

Social factors associated with an increased odds of experiencing both ideation only and ideation and attempts included having been bullied at school or electronically, not going to school because of safety concerns to and from school, sexual intercourse before 13 years of age, and limited English proficiency.

Other significant risk factors associated with STBs included getting four or fewer hours of sleep and having serious difficulty concentrating, remembering or making decisions. In terms of protective factors, getting good grades (mostly A's and B's) was associated with a reduction in ideation and attempts.

3.3. LCA results—prolonged sadness/hopelessness (P-S/H) cohort

Distinct profiles of four classes of youth with differing risk for suicide ideation and attempts, and differing co-occurring risk and protective factors, emerged from the LCA analysis of the P-S/H cohort. The proportion of youth in each class, as well as the probability of youth being exposed to the identified risk factors (expressed in percentages) are presented in Table 3.[1]

3.3.1. Class 1: moderate risk for suicide ideation & attempts (Baseline class)

The first class (Class 1) of youth was the largest group, comprising 52% of the P-S/H population. This class had the lowest risk for both suicide ideation and attempts, but rates were still moderate at 27.8% and 4.7%, respectively. This group was similar to the P-S/H cohort as a whole in terms of gender, grade and race/ethnicity. Students in this cohort were more likely to identify as heterosexual (82.1%), far less likely to engage in substance abuse, be involved in violence or struggle with social issues than the overall P-S/H cohort. The first class also had lower rates of other depression symptoms including impaired academic performance, decreased sleep, and decreased concentration, remembering and decision making capacity. Therefore, it's possible that overall levels of depression within this group may have been less intense than that observed in other groups.

[1] Statistical hypothesis tests of differences across classes were not done since the LCA analysis was foundationally exploratory, rather than confirmatory, in nature.

Table 2
Variables meeting criteria for LCA model inclusion and associated odds ratios of suicidal ideation and suicide attempts in study populations.

Question	Adjusted[†] Odds Ratios of HS Students reporting Sadness/Hopelessness + Ideation vs. HS Students reporting Sadness/Hopelessness Only (N = 9330[‡])			Adjusted[†] Odds Ratios of HS Students reporting Sadness/Hopelessness + Ideation + Attempt(s) vs. HS Students reporting Sadness/Hopelessness + Ideation Only (N = 3316[§])		
	Adjusted OR	LCL	UCL	**Adjusted OR**	LCL	UCL
Current cigarette or cigar use	**1.63**	1.37	1.95	**2.53**	1.94	3.29
Currently used electronic vapor products	**1.42**	1.23	1.64	**2.16**	1.71	2.74
Largest number of drinks in a row was 10 or more	**1.63**	1.18	2.26	**2.18**	1.44	3.30
Currently used marijuana	**1.43**	1.25	1.65	**2.04**	1.67	2.50
Ever used inhalants	**2.15**	1.70	2.72	**1.99**	1.55	2.54
Ever took prescription drugs without a doctor's prescription	**1.82**	1.58	2.10	**2.17**	1.69	2.78
Ever used cocaine, heroin, meth or ecstasy	**1.71**	1.44	2.03	**2.60**	2.09	3.23
Carried weapon school 1 + past 30 days	**2.28**	1.77	2.92	**2.02**	1.39	2.94
Fought 1 + times during prior 12 mos	**1.54**	1.31	1.82	**2.46**	2.00	3.01
Threatened or injured w/weapon at school 1 + times 12 mos	**1.71**	1.38	2.11	**2.98**	2.18	4.07
Forced to have sexual intercourse	**2.56**	2.19	3.01	**2.29**	1.87	2.80
Hurt by date 1 + times past 12 mos	**2.35**	1.90	2.91	**2.35**	1.86	2.99
Bullied at school 12 mos	**2.13**	1.87	2.42	**1.80**	1.46	2.22
Electronically bullied 12 mos	**1.86**	1.62	2.14	**2.28**	1.82	2.86
Did not go to school because they felt unsafe at school or on their way to or from school	**1.90**	1.52	2.37	**2.37**	1.74	3.22
Had sexual intercourse before age 13 years	**2.23**	1.69	2.96	**2.63**	1.80	3.83
Had sexual intercourse with four or more persons	**1.67**	1.37	2.02	**1.95**	1.49	2.55
How well speak English	**1.74**	1.09	2.77	**5.49**	2.57	11.72
Made mostly A's or B's in school	**0.69**	0.61	0.79	**0.66**	0.55	0.81
Have serious difficulty concentrating, remembering, or making decisions	**2.41**	2.11	2.74	**1.46**	1.21	1.76
Had 4 or less hours of sleep per night	**2.36**	1.99	2.81	**1.67**	1.23	2.25

[†] Adjusted for gender, grade, race/ethnicity and sexual orientation, as well as survey weights, clusters and strata.

[‡] Adolescents who reported prolonged sadness/hopelessness (n = 9421), who also answered questions about ideation (n = 9330); Detailed table with sample sizes for each variable after accounting for missing data is available in Online Supplement 3.

[§] Adolescents who reported prolonged sadness/hopelessness & suicidal ideation (n = 4230), who also answered questions about attempts (n = 3316); Detailed table with sample sizes for each variable after accounting for missing data is available in Online Supplement 3.

Table 3
Results of latent class analysis of youth reporting prolonged sadness/hopelessness in 2015 and 2017 YRBS national survey.

	All HS Students With Prolonged Sadness/ Hopelessness	CLASS 1: Moderate risk for ideation & attempts	CLASS 2: Moderately high risk for ideation and attempts	Class 3: Highest risk for ideation, high risk for attempts	CLASS 4: High risk for ideation & highest risk for attempts
N (% of Total)	9421 (100%)	4891 (52%)	1746 (19%)	2079 (22%)	706 (7%)
	% of Total	% of Class 1	% of Class 2	% of Class 3	% of Class 4
Seriously considered attempting suicide in prior 12 months	45.1%	27.8%	34.7%	82.1%	76.5%
Attempted Suicide in Prior 12 Months	20.8%	4.7%	11.3%	52.3%	63.1%
FEMALE	65.7%	66.4%	53.1%	80.4%	49.1%
GRADE					
9th-10th	52.0%	54.4%	32.5%	63.3%	50.2%
11th-12th	48.1%	45.6%	67.5%	36.7%	49.8%
RACE[†]					
White	51.8%	50.0%	53.1%	56.6%	45.8%
Black/African American	11.9%	12.7%	12.8%	9.2%	11.9%
Hispanic/Latino	25.4%	26.6%	25.7%	21.4%	28.7%
Other[†]	11.0%	10.7%	8.4%	12.8%	13.5%
SEXUAL ORIENTATION					
Heterosexual	76.2%	82.1%	85.8%	60.5%	58.4%
Gay/Lesbian	3.5%	3.1%	2.7%	3.6%	8.5%
Bisexual	14.8%	9.7%	8.1%	30.2%	20.7%
Unsure	5.4%	5.1%	3.4%	5.7%	12.4%
Current cigarrette or cigar use[‡]	20.2%	1.5%	54.5%	15.8%	83.3%
Current vapor product use	27.0%	7.1%	63.3%	26.2%	78.1%
Currently used marijuana	30.6%	9.3%	72.4%	26.5%	87.6%
Reported that the largest number of drinks they had in a row was 10 or more	6.3%	0.4%	16.3%	1.0%	41.4%
Ever used cocaine, meth, heroin or ecstasy[‡]	12.2%	0.4%	27.5%	4.8%	77.5%
Ever used inhalents (sniffed glue, breathed aerosols, paints, etc.)	11.6%	4.0%	10.2%	14.9%	57.6%
Ever took prescription drugs without a doctor's prescription[§]	25.1%	8.1%	43.9%	28.5%	82.9%
Carried weapon school 1+ past 30 days	5.4%	1.7%	6.1%	4.0%	33.9%
Threatened/injured w/weapon at school 1+ times 12 mos	10.0%	3.1%	6.9%	16.3%	46.4%
Fought 1+ times during past 12 mos	31.3%	17.4%	43.0%	36.7%	82.7%
Forced to have sexual intercourse	15.2%	4.3%	13.5%	29.5%	52.2%
Hurt by date 1+ times during past 12 mos (among dating and non-dating)	16.4%	4.9%	13.7%	27.0%	54.4%
Bullied at school during past 12 mos	35.1%	22.1%	14.9%	74.0%	56.9%
Electronically bullied during past 12 mos	30.2%	16.7%	16.9%	64.4%	52.4%
Did not go to school because they felt unsafe at school or on their way to or from school	11.5%	5.0%	5.9%	22.0%	38.1%
Had sexual intercourse before age 13 years	5.0%	0.9%	6.9%	5.7%	29.6%
Had sexual intercourse with four or more persons	13.9%	2.5%	31.7%	12.1%	59.2%
Limited English fluency	2.5%	1.4%	1.1%	1.3%	17.8%
Made mostly A's or B's in school	66.4%	76.1%	54.6%	61.7%	43.8%
Have serious difficulty concentrating, remembering, or making decisions	58.6%	48.2%	53.1%	82.3%	71.3%
Had 4 or less hours of sleep per night	13.9%	7.8%	13.3%	20.6%	37.2%

[†] Asian, Multiple-Non Hispanic, American Indian/Alaskan Native and Native Hawaiian/Other Pacific Islander racial and ethnic groups were aggregated for LCA analysis to allow for adequate sample size.

[‡] Due to a high degree of overlap and to improve model efficiency, responses to survey questions about cigarette and cigar use were combined into a single variable, as were responses to questions about cocaine, methamphetamine, heroin and ecstasy.

[§] Responses to the question about prescription drug misuse were combined for 2015 and 2017 even though there were modifications to the question: 2015 question was "During your life, how many times have you taken a prescription drug (such as OxyContin, Percocet, Vicodin, codeine, Adderall, Ritalin, or Xanax) without a doctor's prescription?" and 2017 question was "During your life, how many times have you taken prescription pain medicine without a doctor's prescription or differently than how a doctor told you to use it?(Count drugs such as codeine, Vicodin, OxyContin, Hydrocodone, and Percocet.)"

3.3.2. Class 2: moderately high risk for suicide ideation & attempts

The second class (Class 2) of youth, comprising 19% of the P-S/H cohort, had a higher percentage of students engaging in ideation (34.7%) and attempts (11.3%) relative to class 1 (baseline), but had a much lower percentage than classes 3 and 4. This group had a larger percentage of males (46.9%) than classes 1 and 3, and had the most upper classmen (67.5% juniors/seniors) of all the classes. In terms of race and sexual orientation, classes 1 and 2 were fairly similar, although students in class 2 were somewhat more likely to identify as heterosexual and less likely to identify as bisexual. Substance abuse of all kinds was prevalent in class 2, and current marijuana use was especially high at 72.4%. Past year fighting (43.0%) was also common among students in this class, and just over half of students in this class reported performing well academically (i.e., making mostly A's & B's). However, relative to the higher risk classes 3 and 4, social victimization in the form of bullying at school or online, feeling unsafe at school or on their way to and from school, being physically hurt by a date or forced to have sexual intercourse was far less pronounced in class 2.

3.3.3. Class 3: highest risk for ideation and high risk for attempts

Class 3 comprised 22% of the P-S/H cohort. The proportion of students with suicidal ideation was highest in this class (82.1%), but the proportion of attempts, while still high, was lower than that observed in class 4 (52.3% vs 63.1%). Relative to the other classes, this group had the highest proportion of students who were female (80.4%), lower classmen (63.3% in 9th or 10th grade), White (56.6%) and identify as bisexual (30.2%). The percentage of members of this class engaging in substance abuse was lower than observed in classes 2 and 4, but still higher than the baseline class 1. Physical and sexual violence involvement was elevated in this group, but still much lower than the levels observed in Class 4. This group was most likely to report having been bullied, both at school (74.0%) and electronically (64.4%). Twenty-two percent also reported having missed school due to feeling unsafe at school, or on their way to and from school. Relative to Classes 2 and 4, this group was less likely to report having had early sexual intercourse or multiple sex partners, and only 1.3% indicated limited English proficiency. Class 3 also reported increased rates of other depressive symptoms including difficulty concentrating, decreased memory, and difficulty making decisions (82.3%), which may represent a higher rate of underlying major depression within this cohort.

3.3.4. Class 4: high risk for suicide ideation & highest risk for attempts

The fourth class (Class 4) of youth had high risk of ideation (76.5%) and the highest risk of attempts (63.1%) among the four classes. This was the smallest group, comprising 7% of the P-S/H cohort. This group had the highest proportion of males (50.9%), and was evenly distributed between lower and upper HS classmen. This group also had the highest proportion of Hispanics (28.7%) and students in the "Other' race/ethnicity category (13.5%). The vast majority of students in this class reported engaging in substance abuse and this group had the highest percentage of students experiencing physical and sexual violence involvement, early sexual intercourse and multiple sex partners, sleep deprivation, and poor academic performance. Of note is that 17.8% of this cohort also reported limited English fluency.

3.4. LCA results—prolonged sadness/hopelessness plus suicidal ideation (P-S/H plus SI) cohort

Similar to the first cohort, four distinct classes of youth emerged from the LCA analysis of the second cohort of youth reporting P-S/H *plus* SI. The proportion of youth in each class, as well as the probability of youth being exposed to the identified risk factors (expressed in percentages) are presented in Table 4. In general, similar patterns emerged across the four classes for the P-S/H *plus* SI cohort as was observed in the P-S/H only cohort, but with higher intensity in risk-taking behaviors and socially-challenging environments. For example, Class 3 of this cohort was again characterized by lower-classmen females who struggled with intense social victimization, with 90.7% experiencing past-year bullying at school, and 80.9% experiencing past-year bullying online. Class 4 manifested more extreme social integration and safety challenges, with 30.9% reporting limited English proficiency, 69.5% having been threatened or injured with a weapon at school in the past 12 months, 59.6% reporting missing school due to feeling unsafe, less than 40% reporting making good grades, and the vast majority of students reporting multiple types of substance use in the prior year.

4. Discussion

This study identified four subtypes of HS students with differing levels of risk for suicidal behaviors among a cohort of students with depression symptoms (i.e. P-S/H cohort), and then among a cohort of students with both depression symptoms and suicidal ideation (i.e. P-S/H *plus* SI cohort). For both cohorts, two subgroups were found to have particularly high risk of ideation and attempts, but very different profiles: The smaller subgroup (Class 4) was comprised of more male students than the other groups (although females still accounted for about half the group), and included students with acute social integration challenges, many of whom identify as racial/ethnic minorities, sexual minorities, have poor English fluency, lower academic performance and problems with sleep. Risk-taking behaviors of substance abuse, violence involvement and multiple sex partners were pervasive within this subgroup. The second larger subgroup (Class 3) was characterized by younger female students, who were significantly less likely to engage in externalizing risk-taking behaviors, but had poor social support as was evidenced by high levels of bullying both at school and electronically. Many students within this group also identified as sexual minority. Of note, students in these highest risk subgroups reported very high rates of depressive symptoms including difficulty concentrating, decreased memory, and difficulty making decisions, which may represent a higher rate of underlying major depression.

4.1. Public health significance

Understanding the profile of adolescents at risk for suicidal behaviors can help academic institutions, public health officials, healthcare providers, parents, community leaders and child welfare advocates understand how to better target adolescents at risk for experiencing suicidal ideation and attempts and develop appropriate policies and programs. For example, these findings highlight that many students at highest risk for suicide attempts are English learners with acute social integration challenges, so it is important that interventions be tailored to address the language, cultural and social needs of these extremely high-risk students. At the same time, a large percentage of students at risk for STBs do not exhibit any obvious externalizing risk behaviors (e.g. young females who do not engage in high levels of substance abuse or fighting, but rather struggle with intense bullying, concentration difficulties and other social issues), and absent screening for STBs, may be difficult to detect. Given these challenges, and the high prevalence of depression and STBs among adolescents, universally focused suicide prevention programs in school-based settings, and universal screening in clinical settings are needed.

A recent review of suicide prevention programs in educational settings found that school-based programs can have a positive impact on STBs (Robinson et al., 2018). Schools, with their universal access to youth, are optimally positioned to provide prevention programming for at-risk behaviors and suicide. Universal school-based programs ensure access to the program for the majority of students, mitigate stigmatizing targeted groups, and can potentially benefit large numbers of recipients who may not be symptomatic at the time of the intervention. School personnel can deliver the intervention under "real-world" conditions (in health education class) where students will be expected to attend and participate in the same manner as with other lessons. Further, programs are more likely to be sustainable when they use classroom teachers (Calear and Christensen, 2010), so this model of delivery increases the durability of the program and the schools' investment in the material.

One particularly promising approach, the Youth Aware of Mental Health Programme (YAM), was shown in a multicenter, cluster-randomized control trial in Europe to significantly reduce incident cases of suicide attempts, severe suicidal ideation and incident cases of moderate to severe depression (Wasserman et al., 2015; Wasserman, 2016). Other types of school-based programs, such as The Adolescent Depression Awareness Program (ADAP), can also be leveraged to address the public health crisis of adolescent suicide while concurrently addressing the morbidity associated with unrecognized and untreated adolescent depression (Swartz et al., 2017, 2010). Such programs help destigmatize mental illnesses and their treatment, while stressing that the behavior of suicide is a serious consequence of an underlying psychiatric illness (Swartz et al., 2010).

It should be noted that many school-based programs have

Table 4
Results of latent class analysis of youth reporting prolonged sadness/hopelessness AND suicidal ideation in 2015 and 2017 YRBS national survey.

	All HS Students With Prolonged Sadness / Hopelessness & Ideation	CLASS 1: Moderate risk for attempts	CLASS 2: Moderately high risk for attempts	CLASS 3: High risk for attempts	CLASS 4: Very high risk for attempts
N (%)	**4230 (100%)** % of Total	**1895 (45%)** % of Class 1	**917 (22%)** % of Class 2	**1155 (27%)** % of Class 3	**263 (6%)** % of Class 4
Attempted Suicide in Prior 12 Months	44.0%	26.4%	47.9%	61.6%	81.7%
FEMALE	69.1%	66.0%	64.8%	83.5%	42.0%
GRADE					
9th-10th	53.1%	52.2%	39.2%	66.0%	52.8%
11th-12th	46.9%	47.8%	60.8%	34.0%	47.2%
RACE[†]					
White	54.4%	51.8%	55.8%	61.9%	35.4%
Black/African American	9.9%	11.5%	9.1%	6.7%	15.1%
Hispanic/Latino	23.9%	24.1%	26.4%	19.3%	33.2%
Other[†]	11.8%	12.6%	8.8%	12.1%	16.2%
SEXUAL ORIENTATION					
Heterosexual	66.8%	71.4%	72.0%	58.4%	50.5%
Gay/Lesbian	4.9%	4.8%	4.9%	4.0%	10.0%
Bisexual	21.4%	16.1%	18.9%	32.7%	19.2%
Unsure	6.9%	7.8%	4.2%	4.8%	20.3%
Current cigarette or cigar use[‡]	25.0%	3.2%	65.7%	16.5%	82.9%
Current vapor product use	31.0%	8.2%	67.7%	28.1%	76.9%
Currently used marijuana	35.0%	12.0%	79.6%	25.5%	90.7%
Reported that the largest number of drinks they had in a row was 10 or more	8.0%	1.1%	19.6%	0.8%	51.2%
Ever used cocaine, meth, heroin or ecstasy[‡]	15.6%	0.4%	39.9%	4.1%	89.2%
Ever used inhalents (sniffed glue, breathed aerosols, paints, etc.)	16.3%	6.6%	21.1%	15.0%	73.8%
Ever took prescription drugs without a doctor's prescription[§]	31.7%	11.3%	61.1%	29.0%	85.4%
Carried weapon school 1+ past 30 days	7.6%	3.5%	8.0%	3.8%	54.8%
Threatened/injured w/weapon at school 1+ times 12 mos"	12.6%	3.9%	6.8%	18.1%	69.5%
Fought 1+ times during past 12 mos	35.3%	16.6%	52.3%	39.6%	92.8%
Forced to have sexual intercourse	22.5%	7.7%	29.8%	32.4%	60.6%
Hurt by date 1+ times during past 12 mos (among dating and non-dating)	22.6%	7.6%	25.8%	29.1%	67.4%
Bullied at school during past 12 mos	45.6%	23.5%	26.3%	90.7%	73.3%
Electronically bullied during past 12 mos	38.5%	15.3%	24.8%	80.9%	65.7%
Did not go to school because they felt unsafe at school or on their way to or from school	15.1%	4.8%	8.3%	27.1%	59.6%
Had sexual intercourse before age 13 years	7.1%	1.2%	8.4%	7.4%	52.4%
Had sexual intercourse with four or more persons	17.1%	3.2%	37.9%	13.3%	68.9%
Limited English fluency	3.3%	1.3%	2.1%	1.4%	30.9%
Made mostly A's or B's in school	62.2%	69.5%	50.1%	65.9%	38.1%
Have serious difficulty concentrating, remembering, or making decisions	70.9%	63.8%	68.8%	82.9%	74.0%
Had 4 or less hours of sleep per night	19.6%	13.2%	23.1%	21.8%	42.5%

[†] Asian, Multiple-Non Hispanic, American Indian/Alaskan Native and Native Hawaiian/Other Pacific Islander racial and ethnic groups were aggregated for LCA analysis to allow for adequate sample size.

[‡] Due to a high degree of overlap and to improve model efficiency, responses to survey questions about cigarette and cigar use were combined into a single variable, as were responses to questions about cocaine, methamphetamine, heroin and ecstasy.

[§] Responses to the question about prescription drug misuse were combined for 2015 and 2017 even though there were modifications to the question: 2015 question was "During your life, how many times have you taken a prescription drug (such as OxyContin, Percocet, Vicodin, codeine, Adderall, Ritalin, or Xanax) without a doctor's prescription?" and 2017 question was "During your life, how many times have you taken prescription pain medicine without a doctor's prescription or differently than how a doctor told you to use it?(Count drugs such as codeine, Vicodin, OxyContin, Hydrocodone, and Percocet.)"

traditionally been designed for HS students. Since many students enter HS already at high risk for STBs, program planners may want to consider whether programs can be implemented, and adapted as needed, for younger students. For example, Class 4 in particular may benefit from evidence-based programs that address aggressive and disruptive behavior in early elementary school, such as The Good Behavior Game (Wilcox et al., 2008) or Seattle Social Development Program (Hawkins et al., 2005), as well as programs that address substance abuse. For Class 3, introducing YAM, ADAP and/or Teen Mental Health First Aid in middle school could help students develop skills to navigate stressful situations early on, and understand where they can get help. Since students have different needs at different developmental points, developmentally timed evidence-based practices would ideally be nested so that all children get off to the best possible start by delivering programs in elementary, middle and high school as part of routine school-based practice.

In clinical settings, pairing screening with predictive analytics may be the most promising approach for identifying short- and long-term risk for suicidal behaviors. A recent study demonstrated that use of electronic health record data, in combination with PHQ-9 assessments, provided markedly superior accuracy in identifying people at high risk for suicide attempt and death compared to existing suicide risk prediction tools (Simon et al., 2018).

4.2. Strengths and limitations

This study has important limitations that should be borne in mind when interpreting findings. First, a significant limitation of this study is its cross-sectional design, which precludes being able to confirm temporal relationships between risk factors and suicide-related thoughts and behaviors and make inferences about causality. Also, although the YRBS is a well-validated instrument (Brener et al., 2004, 2003, 1995), there is still potential for recall bias resulting in over- and understating risk behaviors when completing the self-report survey.

Another important consideration is attrition, especially among upper classmen. As noted by Pena et al., experiences of students at high-risk for suicide-related behaviors, particularly males, may not have been captured by this survey due to refusal to participate, absenteeism, dropping out of HS, incarceration, death by suicide, homicide, etc. Consequently, care should be taken when interpreting differences based on age, ethnicity, race and gender (Pena et al., 2010). Further, in many states and cities the YRBS is only available in English language, so it's likely that some students with limited English fluency did not participate.

Another limitation is that data and results of this study are limited to HS students reporting feelings of prolonged sadness and hopelessness (P-S/H). A supplementary analysis of the 2015 & 2017 YRBS data revealed that 21% of students reporting suicidal ideation, and 18% of students reporting attempts, did not answer affirmatively to the question about experiencing P-S/H, and that these cohorts differed significantly with respect to demographics and some risk factors from the cohorts reporting P-S/H and suicide ideation and/or attempts. For example, the cohorts not endorsing P-S/H in conjunction with ideation and/or attempts had a higher percentage of male, black/African American and heterosexual students compared to the cohorts that did endorse P-S/H (Online Supplement 4). It's likely that some of these students suffered from anxiety or other mental and/or cognitive conditions as predisposing risk factors that were not captured by the YRBS. In addition, it is recognized that the question about prolonged sadness and hopelessness does not adequately assess for all depression symptoms, and consequently may not capture all students who experienced prior year depression. Further, since it was not possible to adjust this analysis for severity of depression, it's acknowledged that the presence of some risk or protective factors may be more of a reflection of the intensity of depression, rather than independent risk factors for suicidal ideation and attempts.

It should also be borne in mind when interpreting these results that conclusions are based on information from students who may have attempted, but did not die by suicide, and characteristics of those who attempt and those who die by suicide may be somewhat different. Although deliberate self-harm is the strongest predictor of subsequent suicide death, the majority of individuals who experience self-harm will not go on to die by suicide, and conversely, many suicide deaths are not preceded by self-harm (Bostwick et al., 2016; Simon et al., 2018; Jenkins, 2002; Patton et al., 2012; Owens et al., 2002). Consistent with other studies (CDC Division of Adolescent Health, 2018; CDC, 2019; CDC WISQARS, 2019), the majority of students with STBs in this analysis were female, yet males are far more likely to die by suicide. For example, in 2017 males between the ages of 14 and 18 died at almost three times the rate of females (CDC WISQARS, 2019).

Further, it's understood that not all relevant dimensions of risk were captured in this study, including socioeconomic data, quality of familial and social relationships, traumatic childhood events and clinical data. Finally, it's acknowledged that this is an exploratory analysis, and that the subgroups identified are specific to the data used. A confirmatory latent class analysis using future years of the YRBS would be useful for evaluating the stability of these subgroups.

Inherent in this study are several strengths enabling improved insights into why some adolescents with depression are more likely to experience suicidal ideation and/or attempts than others. First, this study was based on recent data from a large, representative sample of U.S. HS students that included information on a wide range of risk and protective factors. To improve predictive accuracy and improve clinical relevance, the analysis focused on an adolescent cohort with depressive symptoms, and then deconstructed the pathway to suicide attempts by exploring risk and protective factors at play in progression from depression to ideation, and then progression from ideation to attempts.

Another significant strength is the application of latent class analysis to identify distinct profiles of youth at risk for suicidal behavior within a large, nationally representative sample of high school students. Leveraging YRBS's extensive and diverse set of covariates, the subgroup profiles of co-occurring risk and protective factors are detailed and provide a good degree of specificity for identifying and better understanding at-risk youth so that appropriate interventions can be implemented.

Author statement

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- Jean Flores and Holly Wilcox conceived and designed the study with statistical methodology input from Elizabeth Stuart.
- Jean Flores analyzed the data and prepared the tables.
- Jean Flores and Holly Wilcox authored drafts with significant clinical input from Karen Swartz and methodological input from Elizabeth Stuart.
- Jean Flores, Holly Wilcox, Elizabeth Stuart and Karen Swartz reviewed drafts of the paper and approved the final draft.

Funding

This research did not receive any grants from funding agencies in the public, commercial, or not-for-profit sectors.

Declarations of Competing Interest

None

Acknowledgements

Donald Steinwachs, PhD, Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA: Reviewed drafts and provided valuable input.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2020.01.177.

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