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ABSTRACT

Objectives: To determine the prevalence of suicidal ideation (SI) and non-suicidal self-injury
(NSSI) among Vermont high schoolers and examine their relationship with health-behavior and
demographic variables.

Methods: We used responses to the 2019 Centers for Disease Control and Prevention Youth Risk
Behavior Surveillance survey from Vermont high schoolers (n = 18 613) to perform bivariate
logistic regression analyses of variables thought to predict SI and NSSI.

Results: In 2019, 14.8% of Vermont high schoolers reported SI in the past year, and 18.9%
reported NSSI. Lower grade level, LGBT identity, self-perception as over- or underweight, being
bullied, alcohol use, smoking, and female sex were all associated with higher odds of reporting
SI and NSSI.

Conclusions: SI and NSSI are prevalent problems among adolescents that would be amenable to
school-based public health interventions. Certain groups face higher risk for SI and NSSI, such
as girls and LGBT adolescents.

INTRODUCTION

Half of American adolescents diagnosed with a mental illness have not received treatment.[1] The lack of treatment may explain why suicide was the second leading cause of mortality among Americans aged 10-24.[2] A related source of morbidity among adolescents is non-suicidal self-injury (NSSI), with 17.6% of high schoolers (17.5% for Vermont) engaging in NSSI at least once per year.[3] Other prevalent morbidities among adolescents include obesity and substance use, but unlike suicidal ideation (SI) and NSSI, public health interventions to address these problems are implemented in American schools.[4]

One method to address obesity and substance use is implementation of health-promoting behaviors. Previous research has identified behavioral risk factors associated with SI and NSSI, suggesting targets for intervention such as low physical activity,[5,6] negative weight perception and disordered eating,[7] high amounts of screen time,[8] and other mental illness-related and extrinsic factors.[9] As these associations are based on cross-sectional studies with variable effect sizes and international populations, it remains unclear what aspects of adolescent health behavior to prioritize. Additional research is needed to understand the association between adolescent health behaviors and SI and NSSI to design prevention strategies that will be effective for American adolescents.

To increase our knowledge about the incidence of SI and NSSI among Vermont adolescents and inform public health programs, we used the Vermont 2019 Youth Risk Behavior Survey (YRBS) to explore demographic and health behavior variables' associations with SI and NSSI.

METHODS

This cross-sectional study used the 2019 Vermont YRBS. 18,613 students from 66 Vermont high schools participated. Appendix A contains the wording for specific YBRS questions and how they were coded for analysis. Analyses used SPSS Version 26 (IBM, Armonk, NY) and consisted of descriptive statistics (see Appendix B for demographic data) and two multivariate binomial logistic regressions with primary SI outcomes (indicating yes to either suicide attempt or suicide plan), and NSSI (indicating yes to NSSI). Regressions used the overall analysis weight variable. Regression models were created by maximizing goodness of fit among

variables of interest and were assessed for multicollinearity. BMI values showed considerable positive skew (1.33) so the upper 1% of data were trimmed. For predictor variables, we included weight perception, physical activity, and body mass index (BMI). BMI was calculated using subjective reporting of height and weight (kg/m^2). Meeting the recommended level of physical activity was identified using the Physical Activity Guidelines for Americans recommendation to perform 60 minutes of daily physical activity.[10] We also included bullying, alcohol and cigarette use, transgender identity, and demographic variables. This study was determined as exempt from review by the University of Vermont Institutional Review Board.

RESULTS

Vermont high school students reported SI or NSSI during the 12 months before the YRBS as follows: 5.4% reported SI without NSSI, 9.7% reported NSSI without SI, and 9.4% reported both SI and NSSI (Table 1). The odds ratios of SI and NSSI for predictor variables are also reported in Table 1. Students in lower grades had a statistically significant higher odds of reporting both SI and NSSI than students in higher grades ($P \leq 0.001$, see Table 1).

Females reported 1.54 times the odds of SI (95% CI = 1.41, 1.67) and 2.65 times the odds of NSSI (95% CI = 2.45, 2.87) than males, but when controlling for sexual identity, those odds decreased to 1.27 (95% CI = 1.16, 1.38) and 2.23 (95% CI = 2.05, 2.42), respectively. Gay or lesbian adolescents had 3.59 times the odds of SI (95% CI = 2.94, 4.39) and 4.00 times the odds of NSSI (95% CI = 3.29, 4.87) than heterosexual adolescents. Bisexual adolescents had 3.81 times the odds of SI (95% CI = 3.41, 4.26) and 4.30 times the odds of NSSI (95% CI = 3.87, 4.78) than heterosexual adolescents.

Adolescents who perceived themselves to be underweight had 1.43 times the odds of SI (95% CI = 1.27, 1.60) and 1.23 times the odds of NSSI (95% CI = 1.11, 1.37) than those who perceived themselves to have a normal weight. When controlling for sex and sexual identity, the odds of NSSI in those perceiving themselves as underweight increased to 1.38 (95% CI = 1.23, 1.54). Adolescents who perceived themselves as overweight had 2.19 times the odds of SI (95% CI = 2.01, 2.39) and 1.73 times the odds of NSSI (95% CI = 1.59, 1.87), and when controlling for sex and sexual identity, those odds decreased to 1.92 (95% CI = 1.76, 2.11) and 1.47 (95% CI =

1.35, 1.60), respectively. Adolescents who did not meet physical activity guidelines had 1.25 the odds of SI (95% CI = 1.13, 1.39) and 1.40 the odds of NSSI (95% CI = 1.27, 1.54) than those who did meet physical activity guidelines. When controlling for sex and sexual identity, the difference in odds of both SI and NSSI among adolescents who did and did not meet physical activity guidelines was no longer significant. Additional variables contributing to the model were bullying, alcohol use, cigarette use, and transgender identity (see Table 1).

DISCUSSION

In 2019, 14.8% of Vermont high schoolers reported SI and 18.9% NSSI. The odds of SI and NSSI were higher among those who reported a negative weight perception, being bullied, substance use, non-heterosexual identity, and female sex. We identified no statistical significance predicting SI or NSSI for insufficiently physically active adolescents. In contrast with our findings, a 2019 study on school environment, physical activity, and sleep shows adolescents who met daily physical activity guidelines had 38% lower odds of SI than adolescents who did not.[6] Consistent with our study, research on weight, eating disturbances, and body dissatisfaction among adolescents reports higher prevalence of SI and NSSI in females than males.[7] Our findings suggest no improvement in the percentage of Vermont high schoolers reporting NSSI, with a 1.5% increase compared to 2015.[3]

Studies of school-based interventions on suicide prevention show the impact of suicide-related behaviors on adolescents. One study shows that lesbian, gay, and bi (LGB) youth living in states and cities with protective school environments, characterized by percentage of schools with Gay-Straight Alliances, safe spaces, and curricula or services that address the unique concerns of LGB youth, are less likely to report SI than LGB youth in less-protective school environments.[11] Another study assessing the relationship between school environment and suicide risk found that school engagement and involvement were significantly associated with SI and NSSI.[12]

Our primary study limitation is lack of generalizability, as data are only on Vermonters. Another limitation is that the 2019 YRBS questions provided answers to specific pre-categorized questions, which were not always specific to our desired predictor variable. Other limitations

include cross-sectional design factors such as non-response bias and difficulty making causal inferences.

PUBLIC HEALTH IMPLICATIONS

Mental health prevention and management programs targeting weight perception in female teens may help prevent SI and NSSI. Creating protective school environments for females and students of sexual minorities in conjunction with anti-bullying initiatives in Vermont high schools could help prevent SI and NSSI in adolescents.

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Table 1. Summary of Logistic Regression for Variables Predicting Suicidal Ideation and NSSI[a] in Adolescents

Characteristic	Suicidal Ideation			NSSI		
	Model 1, OR[b] (95% CI[c])	Model 2, OR (95% CI)	Model 3, OR (95% CI)	Model 1, OR (95% CI)	Model 2, OR (95% CI)	Model 3, OR (95% CI)

Grade (reference: 12th grade)
  9th grade
  10th grade
  11th grade
	1.38 (1.23 - 1.56)
	1.37 (1.22 - 1.54)
	1.22[d] (1.09 - 1.37)
		1.39 (1.24 - 1.57)
		1.36 (1.21 - 1.52)
		1.21[d] (1.08 - 1.36)
			1.44 (1.27 - 1.62)
			1.37 (1.22 - 1.54)
			1.23[d] (1.09 - 1.39)
				1.66 (1.49 - 1.85)
				1.62 (1.46 - 1.80)
				1.35 (1.21 - 1.50)
					1.67 (1.50 - 1.86)
					1.62 (1.45 - 1.80)
					1.35 (1.21 - 1.50)
						1.76 (1.57 - 1.97)
						1.66 (1.49 - 1.85)
						1.38 (1.24 - 1.55)

Transgender (reference: No)
  Yes
  Not sure
	5.33 (4.20 - 6.76)
	2.52 (1.92 - 3.30)
		5.37 (4.18 - 6.88)
		2.40 (1.82 - 3.15)
			2.24 (1.73 - 2.91)
			1.17 (0.89 - 1.56)
				7.21 (5.65 - 9.29)
				3.71 (2.88 - 4.79)
					7.98 (6.17 - 10.34)
					3.55 (2.73 - 4.61)
						3.06 (2.34 - 4.00)
						1.65 (1.25 - 2.17)

Physical Activity, Meets Guidelines (reference)	1.25 (1.13 - 1.39)	1.16 (1.04 - 1.29)	**1.05** (0.95 - 1.17)	1.40 (1.27 - 1.54)	1.17[d] (1.06 - 1.28)	**1.06** (0.96 - 1.17)

Weight Perception (reference: Normal)
  Underweight
  Overweight
	1.43 (1.27 - 1.60)
	2.19 (2.01 - 2.39)
		1.52 (1.35 - 1.71)
		2.15 (1.97 - 2.35)
			1.46 (1.30 - 1.65)
			1.92 (1.76 - 2.11)
				1.23 (1.11 - 1.37)
				1.73 (1.59 - 1.87)
					1.44 (1.29 - 1.61)
					1.68 (1.55 - 1.82)
						1.38 (1.23 - 1.54)
						1.47 (1.35 - 1.60)

Bullied in the past 30 days (reference: 0 days)	3.01 (2.76 - 3.29)	2.83 (2.59 - 3.09)	2.71 (2.47 - 2.97)	3.41 (3.14 - 3.70)	3.03 (2.79 - 3.30)	2.94 (2.70 - 3.21)
Alcohol use within past 30 days (reference: 0 days)	1.82 (1.67 - 1.99)	1.80 (1.65 - 1.97)	1.85 (1.69 - 2.02)	2.10 (1.94 - 2.28)	2.07 (1.91 - 2.25)	2.16 (1.99 - 2.35)

Cigarette use within past 30 days (reference: 0 days)	2.63 (2.31 - 3.00)	2.76 (2.42 - 3.15)	2.46 (2.15 - 2.82)	2.48 (2.18 - 2.81)	2.85 (2.50 - 3.24)	2.57 (2.25 - 2.95)
Sex (reference: Male)		1.54 (1.41 - 1.67)	1.27 (1.16 - 1.38)		2.65 (2.45 - 2.87)	2.23 (2.05 - 2.42)

Sexual Identity (reference: Heterosexual)
    Gay or lesbian
    Bisexual
    Not sure
			3.59 (2.94 - 4.39)
			3.81 (3.41 - 4.26)
			2.17 (1.84 - 2.56)
						4.00 (3.29 - 4.87)
						4.30 (3.87 - 4.78)
						2.15 (1.85 - 2.51)

[a] Non suicidal self-injury

[b] Odds ratio

[c] 95% confidence interval

[d] Statistical significance of $0.001 \leq P < 0.05$.

NB: Roman text indicates statistical significance of $P < 0.001$; bold text indicates statistical significance of $P > 0.05$.