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Associations of Social and Health-Related Factors With Suicidal Ideation Among U.S. Adolescents

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Abstract. Adolescent suicidal ideation is well known to be a serious mental health concern. In this regard, this study aims to explore the relationship between broader social factors, such as bullying and sexual violence, and individual health-related factors, like the use of electronic cigarettes and obesity, and suicidal ideation. The data for this analysis were derived from the 2023 Youth Risk Behavior Survey, a cross-sectional survey-weighted data source. Logistic regression models were used to calculate the odds ratios of the important variables, and a random forest model was used to evaluate the importance of these variables. The findings suggest that adolescents who are both school and cyber victims of bullying have four times the odds of reporting suicidal ideation than their peers. Among all the variables considered, bullying victimization was found to be the most significant correlate, which highlights the importance of bullying prevention as a means of protecting the mental health of adolescents.

Keywords: U.S. Adolescents, Factors, Suicidal Ideation, Bullying Victimization

1. Introduction

Recently, there has been growing interest in finding factors that are linked to suicidal thoughts in adolescents. Nguyen found that both traditional bullying at school and cyber bullying were significantly associated with suicidal thoughts and attempts among high school students, while Sheng et al. found a significant positive association between school bullying victimization and suicidal thoughts [1,2]. With respect to sexual violence, Hashim et al. used a systematic review and meta-analysis of observational studies and found that childhood sexual abuse is strongly linked to suicidal ideation, self-harm, and suicide attempts during adolescence [3]. In the field of health-related behaviors, Abdelaziz A Awad found that current electronic cigarette use was linked to a higher risk of depressive symptoms and suicidal ideation, but the direction of causality is unclear [4]. Moreover, Graham C, proposed that body dissatisfaction and obesity may be risk factors for psychological problems and susceptibility to suicidal ideation in adolescents [5]. In general, the current literature suggests that social environmental factors and health-related behaviors are crucial in the development of suicidal ideation among adolescents, but many previous studies used earlier waves of data or examined risk factors separately [6-9].

Based on the current literature, this study uses 2023 YRBS data and survey-weighted logistic regression to examine associations between key factors and suicidal ideation. It also uses a random

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forest model to determine the most important predictors, providing an updated and integrated perspective on adolescent suicidal ideation.

2. Methods

2.1. Data description

The data was collected from the 2023 National Youth Risk Behavior Survey (YRBS), released by the Centers for Disease Control and Prevention (CDC). The YRBS is a cross-sectional survey targeting U.S. students in grades 9-12. It includes 107 core items addressing suicide behaviors, bullying, violence exposure, substance use, and weight-related items. Original survey variables begin with the letter "Q" while "QN" variables are recoded indicators created for analysis.

The survey employed a three-stage cluster sample design. Of the 311 schools selected for the survey, 155 (49.8%) schools participated, and 71.0% of the eligible students provided usable data, resulting in an overall response rate of 35.4% for the survey. The final sample included 20,103 students. The data used sampling weights to adjust for selection probability and nonresponse, and the weights were post-stratified to match demographic proportions to national standards. All analyses were weighted, stratified, and adjusted for primary sampling units (PSU).

2.2. Data selection

As the primary outcome measure in this study, suicidal ideation was defined as whether the student seriously considered attempting suicide during the past 12 months and was modeled as a binary outcome (yes/no) consistent with CDC recoding recommendations.

The key explanatory variables were chosen to capture social factors and individual health-related behaviors, as Table 1 showed. Bullying exposure was created as a four-category variable combining school and cyber bullying, distinguishing students who reported no bullying, school bullying only, cyber bullying only, or both. Exposure to sexual violence was defined as having ever been physically forced to have sexual intercourse. Individual health-related behaviors included current e-cigarette use and weight status, defined as overweight or obese using body mass index percentiles.

Demographic factors were included as covariates in all multivariable models, including sex, grade level (restricted to grades 9-12), and race/ethnicity, as defined by the national YRBS target population.

Table 1. Definitions of study variables (2023 National YRBS)

Category	Variable	YRBS Code	Operational Definition	Coding in Analysis	Role in Model
Outcome	Suicidal ideation	QN27	Seriously considered attempting suicide during the past 12 months	1 = Yes; 0 = No	Primary outcome
	School-based bullying	QN24	Bullied on school property	1 = Yes; 0 = No	Component variable
	Electronic bullying	QN25	Bullied electronically	1 = Yes; 0 = No	Component variable

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Table 1. (continued)

Social Exposures	Bullying pattern (combined)	QN24 + QN25	Combined exposure to school-based and/or electronic bullying	Four categories: none; school only; cyber only; both	Primary exposure
	Forced sexual intercourse	QN19	Ever physically forced to have sexual intercourse	1 = Yes; 0 = No	Primary exposure
Health-Related Behaviors	Current electronic cigarette use	QN36	Used e-cigarettes during the past 30 days	1 = Yes; 0 = No	Primary exposure
Weight-Related Indicators	Overweight	QNOWT	Classified as overweight based on BMI percentile	1 = Yes; 0 = No	Covariate
	Obesity	QNOBESE	Classified as obese based on BMI percentile	1 = Yes; 0 = No	Primary exposure
Demographic Characteristics	Sex	Q2	Student sex	1 = Female; 2 = Male	Covariate
	Grade	Q3	School grade (9–12)	Four-category variable	Covariate
	Race/Ethnicity	RACEETH	Race/ethnicity classification	Categorical variable	Covariate
Survey Design Variables	Sampling weight	WEIGHT	Final survey weight	Continuous	Design variable
	Stratum	STRATUM	Sampling stratum identifier	Categorical	Design variable
	Primary sampling unit	PSU	Cluster identifier	Categorical	Design variable

2.3. Analytic strategy

To investigate the associations between the chosen factors and suicidal ideation, this study began by fitting survey-weighted logistic regression models with a progressive adjustment approach. The basic model included demographic factors (sex, grade, and race/ethnicity), to which social factors (bullying type and exposure to sexual violence) were added. The fully adjusted model also included individual health-related behaviors and weight status (electronic cigarette use, overweight, and obesity). This stepwise modeling procedure enabled the evaluation of the robustness and independence of the observed relationships.

To provide additional information from a predictive point of view, a random forest classifier was developed based on the same sample and set of predictors. Survey weights were used as case weights during model fitting. Model discrimination was assessed using the area under the ROC curve (AUC) on a test set, and permutation importance was used to assess predictor contributions.

3. Results

To explore the association between demographic, social, and health-related variables and suicidal ideation, three successively adjusted logistic regression models were developed.The results showed

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below in Table 2.

Table 2. Survey-weighted logistic regression models for suicidal ideation

Variable	Model 1 OR (95% CI)	p-value	Model 2 OR (95% CI)	p-value	Model 3 OR (95% CI)	p-value
Race: Multiracial (vs White)	0.46 (0.23–0.91)	0.028	0.71 (0.37–1.34)	0.297	0.67 (0.34–1.34)	0.266
Race: Black (vs White)	0.48 (0.25–0.90)	0.023	0.72 (0.40–1.28)	0.268	0.74 (0.37–1.46)	0.383
Sex: Female (vs Male)	0.44 (0.37–0.51)	2.75×10^{-15}	0.56 (0.46–0.67)	1.20×10^{-7}	0.57 (0.47–0.69)	5.80×10^{-7}
School bullying only (vs None)	—	—	2.84 (2.36–3.41)	6.52×10^{-15}	2.83 (2.26–3.53)	6.41×10^{-12}
Electronic bullying only (vs None)	—	—	3.01 (2.30–3.94)	1.92×10^{-10}	2.70 (2.00–3.65)	5.10×10^{-8}
Both types of bullying (vs None)	—	—	4.79 (4.11–5.58)	2.88×10^{-25}	4.45 (3.66–5.42)	3.26×10^{-19}
Forced sexual intercourse (Yes vs No)	—	—	3.42 (2.76–4.24)	4.05×10^{-15}	2.77 (2.15–3.57)	4.18×10^{-10}
Overweight (vs Normal weight)	—	—	—	—	1.44 (1.19–1.75)	5.95×10^{-4}
Current e-cigarette use (Yes vs No)	—	—	—	—	2.19 (1.87–2.55)	4.55×10^{-13}

In Model 1, where only demographic variables were entered into the model, gender was the most salient variable. Male students had significantly lower odds of experiencing suicidal ideation than females (OR = 0.437, 95% CI: 0.374-0.510, $p < 0.001$), representing a 56% reduction in odds [10]. Certain racial/ethnic groups differed from White students at this point; however, the strength of these associations was small. After introducing social variables in Model 2, the structure of associations changed markedly. Bullying emerged as the strongest correlate. Compared with students who reported no bullying, those exposed to school-based bullying had an odds ratio of 2.84 (95% CI: 2.26–3.53, $p = 6.41\times10^{-12}$), those exposed to cyberbullying had an odds ratio of 3.01 (95% CI: 2.23–4.07, $p = 1.03\times10^{-8}$), and those exposed to both forms had substantially elevated odds (OR = 4.79, 95% CI: 3.94–5.82, $p = 5.64\times10^{-23}$). Forced sexual intercourse was also strongly associated with suicidal ideation (OR = 3.42, 95% CI: 2.76–4.24, $p = 4.05\times10^{-15}$). Following adjustment for these social factors, previously observed racial/ethnic differences were attenuated and largely no longer statistically significant.

In Model 3, further adjustment for health-related behaviors and weight status slightly reduced the magnitude of several associations but did not alter the overall pattern. The odds ratio for forced sexual intercourse decreased from 3.42 to 2.77 (95% CI: 2.15–3.57, $p = 4.18\times10^{-10}$), and the estimate for combined bullying exposure decreased from 4.79 to 4.45 (95% CI: 3.66–5.42, $p = 3.26\times10^{-19}$). Current e-cigarette use remained independently associated with suicidal ideation (OR = 2.19, 95% CI: 1.87–2.55, $p = 4.55\times10^{-13}$), as did obesity (OR = 1.44, 95% CI: 1.19–1.75, $p = 5.95\times10^{-4}$), whereas overweight status was not statistically significant (OR = 1.15, 95% CI: 0.97–1.37, $p = 0.121$).

Crucially, the relationship between sex and suicidal ideation remained significant in all three models. In the fully adjusted model, males again had lower odds than females (OR = 0.571, 95% CI:

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0.472-0.690, $p = 5.80\times10^{-7}$), showing that the difference between the sexes was not entirely accounted for by social adversity or health-related behaviors.

The random forest model had fair discriminative power (AUC = 0.745) in Figure 1, suggesting that it performed reasonably well in distinguishing between students with and without suicidal ideation. The importance values were generally in line with the regression results in Figure 2. Bullying had the highest importance value (0.028), followed by current e-cigarette use (0.016) and sex (0.013). Forced sexual intercourse (0.010) and obesity (0.009) were also important, while grade level, race/ethnicity, and overweight had relatively lower importance values. Taken together, the agreement between the importance values of the random forest model and the regression results suggests that the findings are robust, and the key role of social violence exposure stands out.

The agreement between the two models' findings further supports the key role of social violence exposure, specifically bullying, as the most important factor related to suicidal ideation, and health behavior factors as additional explanatory variables.

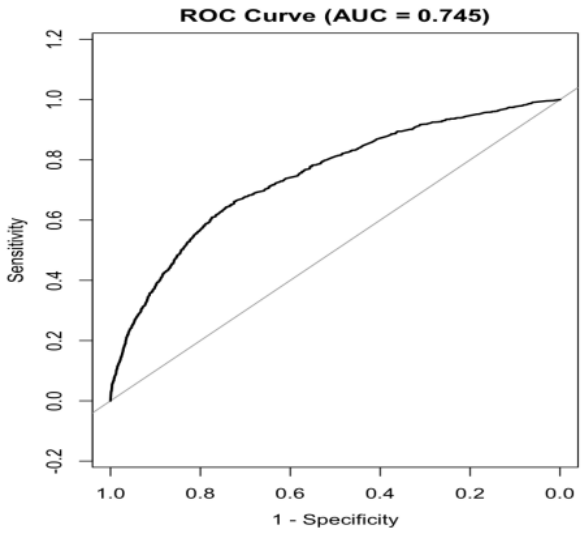

Figure 1. Receiver Operating Characteristic (ROC) curve for random forest model

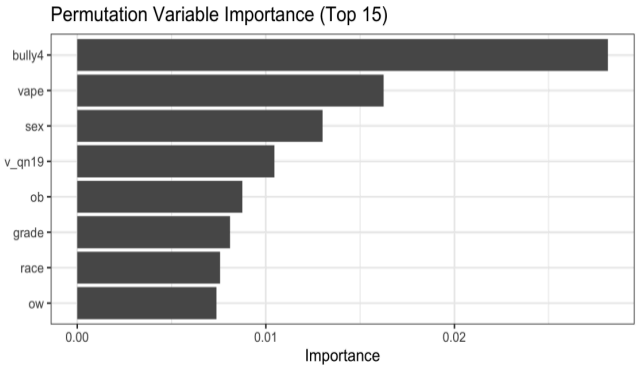

Figure 2. Relative importance of predictors in random forest model

4. Discussion

This study revealed that bullying victimization, especially co-exposure to both school-based and electronic bullying, was found to be the most salient predictor of suicidal ideation. The strength of

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the association was found to remain large even after controlling for demographic variables and individual health-related behaviors, thus reiterating the pivotal role of social violence in adolescent mental health. Exposure to sexual violence was also found to have a strong and independent association with suicidal ideation, thus again reiterating the psychological toll of interpersonal violence during adolescence. In addition, current e-cigarette use and obesity were also found to have an independent association with suicidal ideation, thus suggesting that health-related behaviors may co-exist or even represent the psychosocial vulnerability of the adolescents. The consistency between the results of the regression models and the random forest analysis increases the validity of the findings. In both models, bullying was found to be the most important predictor, followed by the use of electronic cigarettes and exposure to sexual violence.

However, there are some limitations that should be noted. YRBS is a cross-sectional study, suggesting that there is no way to determine the temporal relationship between variables or causation. Even though strong correlations were found, it is impossible to determine whether bullying, sexual violence, or e-cigarette use occurred before suicidal ideation or whether adolescents with psychological distress were more likely to be exposed to these variables. Residual confounding may also be a problem because some variables, such as family environment, previous diagnosis of mental illness, or access to support resources, were not controlled for in the analysis. In addition, all variables were self-reported and may be vulnerable to recall or reporting bias. Despite these limitations, the study adds new national data to the literature, showing that exposure to social violence, especially bullying, is the most significant factor related to suicidal ideation in adolescents.

5. Conclusion

Using nationally representative data from the 2023 YRBS, this study demonstrates that social factors, specifically bullying victimization, are the strongest predictors of suicidal ideation among adolescents in the U.S. Youth who experienced both traditional and cyberbullying had the highest risk, followed by youth who experienced sexual violence. Health-related behaviors, such as current e-cigarette use and obesity, were also significant predictors of suicidal ideation, although their impact was relatively smaller.

These results highlight the central importance of social environmental stressors in the etiology of suicidal ideation among adolescents and suggest that prevention programs should focus on minimizing violence exposure and improving supportive social environments in schools and online. Further research is needed to better understand the underlying causal mechanisms and to inform the development of targeted prevention programs for high-risk youth groups.

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