The Association Between Suicide Attempts and Gender Among High-School Students in the United States

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Objective

There exists a serious risk of suicide among high school students in the United States (Kirchner, 2011). Those risk factor can be observed and used as a basis for intervention. The objective of this study is to quantify the relationship between suicide attempts within the last 12 months and gender, while controlling for drug use, current alcohol use, whether the minor exercises, and whether the minor has difficulty concentrating, remembering, or making decisions.

Introduction

Suicide in teenagers has been studied from many facets. Associations between suicidal intent, self-harm, and suicidal ideation are strong examples of studies that have been conducted (Kirchner, 2011). There have been studies that have identified associations between suicidal behavior and gender and culture sub-groups (Langhinrichsen, 2009). A study conducted in Korea has focused on suicidal ideation and found a connection with gender (Park, 2006). In terms of preventing suicide in teenagers the focus has been on intervention systems, such as hotlines and crisis services, education and training, as well minimizing opportunities for suicide imitation. However, there is little evidence that suggests the efficacy of these methods (Shaffer 1988). The current body of knowledge for suicide among teenagers is strong, however, variables such as ideation, and state of mind though quantifiable, are not always observable. We cannot read minds; we only know of a teenager's suicidal ideation if they report their ideation. We can, however, observe behavior.

By focusing on the associations between suicide in teenagers and behavior that can be observed, we can use observable and quantifiable data points for prevention and intervention. At the very least we will have the means to identify teenagers most at risk. In the best case, this type of analysis will provide immediate, and actionable model for the purposes of preventing suicide, and therefore saving teenagers' lives. The basis for this study is to analyze suicide attempts to identify associated behaviors that can be observed. Variables such as ideation, or intent are not considered, or any other variable that cannot be directly observed and does not require self-reporting. Adolescent females are twice as likely as adolescent males to report suicidal ideation (Beautrais, 2002). Drawing on this knowledge, this study shall analyze the association between suicide attempts and gender as a starting point. This study will use the Youth Behavior Surveillance System (YRBBS) – 2019 survey data to investigate this relationship and begin to identify a set of observable behaviors that are associated with suicide in teenagers as a model to assist in identifying teenagers at risk of attempting suicide. In short, we will test for behaviors in teenagers that have already attempted suicide as a basis to predict future suicide attempts in other teenagers.

Methods: Data

This study focuses on the relationship between suicide attempts and gender among teenagers in the United States, except for a few states as described below. Specifically, the population of interest is comprised of public, Catholic, and other private school students in grades 9 through 12 in the United States (excluding Washington, Oregon, Minnesota, and

Wyoming) and Guam, Northern Mariana Islands and Puerto Rico[1]. A sample of this population is drawn from YRBBS 2019 survey (YRBBS, 2019).

YRBBS is a system of surveys, developed in 1990, conducted by the CDC, as well as by state, territorial, tribal governments, and local and health agencies. They monitor six categories of health-related behaviors that contribute to causes of death and disability among youth and adults. The six categories monitored are: behaviors that contribute to unintentional injuries and violence, sexual behaviors related to unintended pregnancy and sexually transmitted diseases, including HIV infection, alcohol and other drug use, tobacco use, unhealthy dietary behaviors, and inadequate physical activity. Additionally, the YRBBS also monitors obesity and asthma and sexual identity (YRBBS, 2019). According to the YRBBS website, from 1991 to 2019 data from more than 4.9 million students has been collected in more than 2,100 separate surveys (YRBBS, 2019). In 2019 alone, data collected by the YRBBS has been used by the "American Journal of Preventative Medicine," the "Journal of School Nursing," "Preventative Science" as well as other reputable publications (YRBBS, 2019).

Of the 13,677 survey participants in 2019, 6,790 (approximately 50%**)** satisfied the sample requirements for this study: students in grades 9 through 12 attending public, Catholic, and other private school in the United States (not including the states mentioned above) and had complete data for the variables utilized in this study.

Methods: Model

[1] The states mentioned as "excluded" did not participate in the 2019 High School YRBBS and cannot be included as part of the population of interest.

The research objective of this study is to investigate the association between one or more suicide attempts within the last 12 months and gender. The model is summarized as follows:

SUICIDE = f(GENDER, DRUGUSE, ALCOHOLUSE, EXERCISE, CONCENTRATE)

SUICIDE (outcome variable) represents whether a YRBBS survey participant reported they attempted suicide 1 or more times within the last 12 months (1 = yes; 0 = no); the primary variable of interest (i.e., exposure variable) GENDER is coded as 0, or 1 to indicate female or male, respectively, and reports biological gender of the participant. Control variables include DRUGUSE, which represents whether a survey participant has ever used an illicit drug (cocaine, inhalants, heroin, methamphetamines, ecstasy, or hallucinogens) one or more times during their life (1 = yes; 0 = no), ALCOHOLUSE which is coded as 0, 1 to indicate whether the survey participant reported not having a drink of alcohol within the last 30 days or having one or more drinks of alcohol within the last 30 days, respectively. EXERCISE represents whether a survey participant indicated that they exercised at least once within the last 7 days to tone or strengthen their muscles (1=yes, 0 = no), while CONCENTRATE represents whether a survey participant indicated that they have had serious difficulty concentrating, remembering, or making decisions because of physical, mental, or emotional problems (1=yes, 0=no)[2].

Methods: Statistical Analysis

This analysis will consist of both test of association and logistic regression. Table 1 will provide results of Pearson Chi-Squared test of association performed on control variable and exposure variable, as well as provide univariate statistics. Similar test will be performed

[2] Correlation analysis was conducted between variable GRADE (indicating grade level for participant, 9th through 12th grade) and SUICIDE indicating -0.02952 correlation, and therefore ignored.

between control, exposure, and outcome variables and presented in Table 2, along with univariate statistics. Logistic regression will be conducted to estimate adjusted odds ratios (at the 95% confidence interval), for the outcome variable (SUICIDE) with respect to the exposure variable (GENDER) and control variables (DRUGUSE, ALCOHOLUSE, EXERCISE, CONCENTRATE). These are presented in Table 3.

With respect to regression analysis, tests for confounding between the exposure and control variables were conducted, as well as conducting and reporting goodness of fit test, as well as investigating for interactions between exposure and control variables. All statistical analysis was conducted with SAS.

Results

Of the 13,677 participants of the YRBBS 2019 survey, 6,790 (49.6%) had complete data for this analysis. The demographic characteristics of this population are compared in Table 1 with respect to exposure variable GENDER.

Table 1. Characteristics of 6,790 YRBBS 2019 participants by gender category.

	Population		Female		Male		
Variable	N	%	n	%	n	%	p value *
	6,790	100.00%	3,568	52.55%	3,222	47.45%	
Drug Use							
No	5,988	88.19%	3,172	88.90%	2,816	87.40%	
Yes	802	11.81%	396	11.10%	406	12.60%	0.0555
Alcohol Use							
No	4,754	70.01%	2,412	67.60%	2,342	72.69%	
Yes	2,036	29.99%	1,156	32.40%	880	27.31%	<0.0001
Exercise							
No	2,067	30.44%	1,301	36.46%	766	23.77%	
Yes	4,723	69.56%	2,267	63.54%	2,456	76.23%	<0.0001
Concentration							
No	4,223	62.19%	1,958	54.88%	2,265	70.30%	
Yes	2,567	37.81%	1,610	45.12%	957	29.70%	<0.0001

* p values based on Pearson chi-square test of association

Of the entire population 11.81% used illicit drugs, 29.99% used alcohol within the last 30 days, 69.56% exercised to tone muscles within the last 7 days, 37.81% had difficulty concentrating, remembering, or making decisions because of physical, mental, or emotional problems, and 47.45% were male. There were proportionally more male drug users than expected (12.60% vs 11.81%; p=0.0555 - although this association is not statistically significant at the 95% level of confidence). With respect to current alcohol use there were proportionally fewer males than expected (27.31% vs 29.99%; p<0.0001). With respect to exercise there were proportionally more males than expected (76.23% vs 69.56%; p<0.0001). With respect to difficulty concentrating, remembering, or making decisions because of physical, mental, or emotional problems there were proportionally fewer males than expected (29.70% vs 37.81%; p<0.0001).

Table 2. Characteristics of 6,790 YRBBS 2019 participants by suicide attempts.

	Population		Suicide -NO		Suicide-YES		
Variable	N	%	n	%	n	%	p value *
	6,790	100.00%	6,202	91.34%	588	8.66%	
Gender							
Female	3,568	52.55%	3,162	50.98%	406	69.05%	
Male	3,222	47.45%	3,040	49.02%	182	30.95%	<0.0001
Drug Use							
No	5,988	88.19%	5,584	90.04%	404	68.71%	
Yes	802	11.81%	618	9.96%	184	31.29%	<0.0001
Alcohol Use							
No	4,754	70.01%	4,437	71.54%	317	53.91%	
Yes	2,036	29.99%	1,765	28.46%	271	46.09%	<0.0001
Exercise							
No	2067	30.44%	1864	30.05%	203	34.52%	
Yes	4723	69.56%	4,338	69.95%	385	65.48%	0.0244
Concentration							

No	4223	62.19%	4,088	65.91%	135	22.96%	
Yes	2567	37.81%	2,114	34.09%	453	77.04%	<0.0001

* p values based on Pearson chi-square test of association

Table 2 above allows a comparison of participant demographics with respect to the outcome variable SUICIDE - attempted suicide within the last 12 months. Overall, 8.66% of the population attempted suicide within the last 12 months. There were proportionally more drug users than expected who attempted suicide within the last 12 months (31.29% vs 11.81%; $p<0.0001$), and proportionally more current alcohol users than expected who attempted suicide within the last 12 months (46.09% vs 29.99%; $p<0.0001$). There were proportionally fewer exercisers than expected who attempted suicide within the last 12 months (65.48% vs 69.56%; $p=0.0244$), and proportionally more who reported difficulty concentrating, remembering, or making decisions because of physical, mental, or emotional problems than expected who attempted suicide within the last 12 months (77.04% vs 37.81%; $p<0.0001$). With respect to exposure variable GENDER, there were proportionally fewer males than expected who attempted suicide within the last 12 months (30.95% vs 47.45%; $p<0.0001$).

Table 3. Logistic regression analysis comparing the adjusted odds ratio of suicide attempts in 6,790 YRBBS 2019 participants.

	Suicide -NO		Suicide-YES		OR*	95% CI
Variable	n	%	n	%		
	6,202	91.34%	588	8.66%	-----	-----
Gender						
Female	3,162	50.98%	406	69.05%	-----	-----
Male	3,040	49.02%	182	30.95%	0.57	0.47 - 0.70
Drug Use						
No	5584	90.04%	404	68.71%	-----	-----
Yes	618	9.96%	184	31.29%	2.89	2.33- 3.59
Alcohol Use						
No	4437	71.54%	317	53.91%	-----	-----

	Yes	1,765	28.46%	271	46.09%	1.43	1.18 - 1.73
Exercise							
	No	1,864	30.05%	203	34.52%	-----	-----
	Yes	4338	69.95%	385	65.48%	1.03	0.85 - 1.25
Concentration							
	No	4,088	65.91%	135	22.96%	-----	-----
	Yes	2,114	34.09%	453	77.04%	5.27	4.30 - 6.47

* 95% confidence intervals are for reported odds ratios.

Adjusted odds ratio from logistic regression are presented in Table 3, above. Those who reported difficulty concentrating, remembering, or making decisions because of physical, mental, or emotional problems had 427% higher odds of attempting suicide within the least 12 months when compared to those who reported not having difficulty concentrating, remembering, or making decisions because of physical, mental, or emotional problems after controlling for exercise, current alcohol use, drug use and gender (OR = 5.27; 95% CI = 4.30 – 6.47). With respect to exercise, those who reported exercising to tone muscle within the last 7 days had roughly the same odds of attempting suicide within the last 12 months as those who reported not exercising to tone muscle within the last 7 days after controlling for difficulty concentrating, current alcohol use, drug use, and gender (OR = 1.03; 95% CI = 0.85 – 1.25)[3]. With respect to current alcohol use, those who reported using alcohol within the last 30 days had slightly higher odds (43%) of attempting suicide within the last 12 months compared to those who reported not using alcohol within the last 30 days after controlling for difficulty concentrating, exercise, drug use, and gender (OR = 1.43; 95% CI = 1.18 – 1.73). With respect to drug use, those who reported using drugs had 189% higher odds of attempting suicide within the last 12 months compared to those who reported not using drugs after controlling for difficulty concentrating,

[3] The offs ratio is not statistically significant as the 95% CI includes a value of 1.0.

exercise, current alcohol use, and gender (OR = 2.89; 95% CI = 2.33 – 3.59). With respect to exposure variable GENDER, males had 43% lower odds of attempting suicide within the last 12 months compared to females after controlling for difficulty concentrating, exercise, current alcohol use, and drug use (OR = 0.57; 95% CI = 0.47 – 0.70).

The AUC statistic for the logistic regression was 0.780. As a reminder, Table 1 indicated that DRUGUSE was not statistically significant when compared to exposure variable GENDER, while Table 3 indicated that the odds ratio for variable EXERCISE is not statistically significant. A Deviance test generated a p-value of 0.0060, indicating that the current model does not fit the data well when compared to a model with variable interactions. The statistically significant interactions were added to the model, yielding the following[4]:

$$SUICIDE = \alpha + \beta_1 \text{GENDER} + \beta_2 \text{DRUGUSE} + \beta_3 \text{ALCOHOLUSE} + \beta_4 \text{EXERCISE} + \beta_5 \text{CONCENTRATE} + \beta_6 \text{DRUGUSE} * \text{CONCENTRATE}$$

Estimation of the model above indicated that interactions were statistically significant. Deviance test statistic for this interacted model is not statistically significant (p-value = 0.0750), while the AUC increased slightly to 0.785. Since the statistically significant interaction does not involve the exposure variable GENDER, no adjustments to OR are required. That is, no control variables modify the association between SUICIDE and GENDER. Interactions are ignored, as less complex model uses less degrees of freedom while still maintaining approximately that same AUC value.

Finally, we tested for confounding relationships between exposure variable GENDER and the control variables DRUGUSE, ALCOHOLUSE, EXERCISE, AND CONCENTRATE.

[4] 3-way interactions were not used due to complexity of interpretation.

Employing the 10% rule, that is whether the base GENDER adjusted OR's changed by more than 10% with the removal of either DRUGUSE, ALCOHOLUSE, EXERCISE, or CONCENTRATE, we found that all variables are confounding the relationship. Recommend maintain all variables within the model.

Strength and Limitations

Strengths

This study was based upon a strong and well-established survey system to analyze the association between suicide attempts and gender, while controlling for drug use, current alcohol use, exercise, and difficulty concentrating. The data used was taken from a recent survey conducted in 2019. By selecting control variables that correspond to observable behaviors, as opposed to behaviors or factors that must be reported, our model does not require self-reporting when it pertains to identifying an individual who is at risk of attempting suicide. This provides a strong foundation in terms of developing methodologies to identify teenage suicide attempts. In other words, this research can be used to begin to develop methodologies for suicide prevention by providing a means of identifying teenager at risk of attempting suicide. Essentially, this research represents a first step – that is a model used to identify individuals who are at risk of suicide, without having to rely on self-reporting.

Limitations

As with all survey's, the validity of the data is predicated on the ability and willingness of the participants to accurately answer the questions in the survey. Also, it is based on self-reporting. Our criteria reduced the number of participants from approximately 13,700 to approximately 6,800, about 50% of the entire data set. A few states did not participate in the

survey, meaning that this is not truly a model that can be generalized to the entire United States. It would be interesting to add to this research the data set from the study done in Korea, as it may provide stronger predictive capability. Given that the coefficient to variable EXERCISE was not statistically significant, this model will require adjustment by searching for and adding a different variable that corresponds to an observable behavior associated with suicide attempts. Finally, this research does not answer an important question, meaning it does not handle the question of what to do after an individual has been identified as someone who is at risk of attempting suicide. As mentioned before, there is very little evidence to the efficacy of current suicide prevention methodologies.

Conclusion

The objective of this study is to quantify the relationship between suicide attempts in high school teenagers and gender, while controlling for drug use, current alcohol use, exercise, and difficulty concentrating. This study was based on data collected from the 2019 YRBBS survey of approximately 13,700 participants. The survey asks health related questions to monitor behaviors that contribute to causes of death and disability among youth and adults. The population of interest for this study is all public, Catholic, and other private school students in grades 9 through 12 in the United States (excluding Washington, Oregon, Minnesota, and Wyoming) and Guam, Northern Mariana Islands and Puerto Rico.

The study finds that males had lower odds of attempting suicide within the last 12 months (OR = 0.57) compared to females after controlling for difficulty concentrating, exercise, current alcohol use, and drug use. It is important to point out that this is consistent with previous research conducted comparing suicidal ideation with gender. Teenagers who reported using

illicit drugs one or more times throughout their lifetime had 2.89 greater odds of attempting suicide within the last 12 months then those that have not used illicit drugs. Current usage of alcohol, that is at least one drink of alcohol within the last 30 days, increased the odds of attempting suicide by 1.43 times when compared to non-alcohol users. Those who exercised had about the same odds, 1.03, of attempting suicide when compared to non-exercisers, the confidence interval for EXERCISE has a probability of containing a value of 1.0. Difficulty concentrating accounted for the greatest increase in odds of attempting suicide, by 5.27 times.

This study increases our knowledge of the relationship between suicide and gender and can be used as a basis of identifying observable behaviors that predict for suicide attempts. This reduces the dependency upon self-reporting, when it is possible that someone who is at risk of attempting suicide may not report, or attempt to hide behaviors, ideation, and plans that will indicate attempting suicide.

Though a good first step, this model is not complete. Due to the criterion for this research, only 50% of the data set could be used. Combining research conducted in other countries may provide more insight to this research. Further research expanding the number of control variables that account for observable behaviors should be strongly considered. Though this research can be used as a basis to identify teenagers at risk of attempting suicide, it does not consider what to do once a teenager has been identified. Indeed, the current body of knowledge suggest that our methods of suicide prevention are not effective.

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