

CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

Understanding the Role of Traditional Bullying and Cyberbullying in Adolescent Substance  
Abuse

A graduate project submitted in partial fulfillment of the requirements  
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## Abstract

# Understanding the Role of Traditional Bullying and Cyberbullying in Adolescent Substance Abuse

By

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Master of Public Health in Applied Epidemiology

**Objective:** Previous studies suggest that experiencing traditional bullying at school and/or electronic bullying, also known as cyberbullying, in adolescence can have negative long-term health effects. This study aims to determine the risk factors associated with traditional bullying and cyberbullying in relation to adolescent substance abuse (past 30-day alcohol, marijuana, and tobacco use).

**Methods:** Cross-sectional study; Student responses (N=14,765) from the 2017 National Sample Youth Risk Behavior Surveillance System (YRBSS), which was conducted by the Centers for Disease Control and Prevention. The sample included Females 51.4%. Mean age of 15.96 (SD=21.26). Non-Hispanic Whites (43.4%); African Americans (19.4%); Multiple Race –

Hispanics (14.6%); Hispanic/Latinos (10.7%); Asians (4.5%); American Indian/Alaskan Natives (0.9%); and Native Hawaiian/Pacific Islanders (0.8%).

Results: From the survey data, 18.2% of students responded that they have experienced traditional bullying and 14.5% of students responded that they have experienced cyberbullying. Regarding substance use in this population, 29.0% of students consumed alcohol in the past 30 days, followed by 19.8% and 19.3% of students who reported using marijuana and tobacco in the past 30 days, respectively. Logistic regression analysis was performed to assess the association between traditional bullying and cyberbullying exposure and the odds of substance use. After adjusting for covariates (age, gender, ethnicity, and sexual orientation), exposure to bullying and cyberbullying predicted increased odds of past 30-day alcohol ([AOR: 1.361, 95% CI: 1.227-1.510]; [AOR: 1.361, 95% CI: 1.227-1.510]), marijuana [AOR: 1.271, 95% CI: 1.139-1.419]; [AOR: 1.771, 95% CI: 1.579-1.987]), and tobacco ([AOR: 1.592, 95% CI: 1.418-1.789]; [AOR: 2.079, 95% CI: 1.837-2.353]) use in result findings.

Conclusion: There is evidence that traditional and cyberbullying play an important role in adolescent substance use. Since this study was performed with cross-sectional national data, there could be additional benefit replicating this study with longitudinal data. This study could serve as a reference or a baseline for future studies that wish to examine adolescent substance use and related risks.

Keywords: Adolescents, Traditional Bullying, Cyberbullying, Alcohol, Marijuana, Tobacco, Risks

## Introduction

With the increasing prevalence of violent and aggressive acts in schools in modern day society, school and government officials have had to develop certain policies to address these acts. Over time, bullying has received increased state and national attention and scrutiny, with several states mandating schools to implement anti-bullying policies. Traditional, or physical, bullying is defined as verbal or written name-calling, teasing, and threats, social exclusion, and hitting, kicking or other bodily contact (Espelage et al., 2001). In the United States, bullying starts as early as elementary school years (grades K-5) (Radliff, Wheaton, Robinson & Morris, 2012; Tharp-Taylor, Haviland & D'Amico, 2009). Recent data from the National Center for Education Statistics (NCES) has shown that 20.2% of youth aged 12-18 have reported being bullied at school (Seldin & Ynez, 2019).

Traditional bullying also has a variety of negative outcomes, including the onset of substance use during adolescence. Numerous studies have determined that substance use is common among individuals who are victims and/or perpetrators of bullying (Tharp-Taylor, Haviland & D'Amico, 2009; Peleg-Oren et al., 2012; Martino, Collins, & Ellickson, 2004) while some have conflicting arguments that there is no association with bullying and substance use (Copeland et al., 2013; Hemphill et al., 2011; Morris, Zhang, & Bondy, 2006). However, the differences in the studies may be due to a variety of factors such as an individual's ability to access substances, age, self-control, and/or gender (Cullen et al., 2008). Due to conflicting evidence from research on the substance use habits of individuals who have experienced bullying, it is important to continue investigating how the two factors influence each other.

In addition to traditional bullying at school, a newer type of bullying has developed online called cyberbullying (electronic bullying). Cyberbullying is commonly defined as the use

of the Internet or other digital communication devices with the intention of harming or threaten someone (Juvonen & Gross, 2008). Such devices used to perpetrate cyberbullying include instant messaging (IM), social media websites, text messaging (SMS), and e-mail. In the United States, studies have shown that about 21% of students aged 12-18 experienced cyberbullying, with 14.9% of all high school students reporting being cyberbullied in the last 12 months of 2017 (Bauer et al., 2008; Kann et al., 2018). However, multiple studies have inconsistent results of the risks of cyberbullying. Some researchers state that adolescence and gender are a factor, while some others state there were no significant gender differences in cyberbullying (e.g. Erdur-Baker, 2010; Smith et al., 2008). Internationally, rates of exposure to cyberbullying are higher for boys (8.6 % to 45.2 %) compared to girls (4.8 % to 35.8 %) but victimization is reported more by girls than boys (Craig et al., 2009). Gender differences are also apparent with females (23.8%) reporting higher rates of bullying at school than males (16.7%) (Seldin & Yanez, 2019).

Studies have shown that cyberbullying in adolescence correlates with an increased risk of depression, substance abuse, perpetuated violence, and in extreme circumstances, suicide ideation (Hinduja & Patchin, 2010). This issue has led to increasing concern within the public health sector as it has led to lasting effects well into adulthood affecting an individual's physical and mental wellbeing (Wölfer et al., 2014). Substance abuse and bullying have long been issues of concern especially during adolescence. One study reported that there was a significant association between bullies, bully-victims, and substance use (alcohol, tobacco, and marijuana) (Gaete et al., 2017). Studies also show that youth who are involved in bullying have higher odds of using substances well into their adult years than youth not involved in bullying (Ttofi et al., 2016).

Agnew's general strain theory (GST) hypothesizes that stressful events (i.e. bullying) and relationships are positively related to involvement in delinquency (Agnew 1992, 2001). Researchers previously studied this topic involving substance abuse and bullying (Glassner & Cho, 2018). Their results concluded that bullying victimization directly increases diminished moods for males and females in adolescence. In addition, findings further concluded that childhood bullying victimization directly increases substance use in adolescence and young adulthood for males but not females. Therefore, this creates the need for intervention programs in early adolescence to help decrease the risk of substance abuse in later life. This study has been informed by Agnew's general strain theory to investigate how does bullying/cyberbullying increase the risk adolescent substance use with the use of national data.

The aim of the present study is to address the following research question: Does traditional bullying and cyberbullying increase the risk of past 30-day adolescent alcohol, marijuana, and tobacco use? If so, is there a difference in the relationship between traditional bullying and cyberbullying with substance use? From the main research question, this study will also ask: does gender moderate the bullying-substance use relationship? After adjusting for demographic covariates (e.g. age, race/ethnicity, and sexual orientation) the following hypotheses will be tested in this study:

1. Adolescent past 30-day alcohol use:

*H<sub>1</sub>: Adolescents who have been exposed to traditional bullying at school and/or cyberbullying will have higher odds for using alcohol in the past 30 days.*

Effect modification (gender):

*Adolescent males who have been exposed to traditional bullying at school and/or cyberbullying will have higher odds of using alcohol in the past 30 days than adolescent females who have been exposed to traditional bullying at school and/or cyberbullying.*

2. Adolescent past 30-day tobacco use:

*H<sub>1</sub>: Adolescents who have been exposed to traditional bullying at school and/or cyberbullying will have higher odds for using tobacco in the past 30 days.*

Effect modification (gender):

*Adolescent males who have been exposed to traditional bullying at school and/or cyberbullying will have higher odds of using tobacco in the past 30 days than adolescent females who have been exposed to traditional bullying at school and/or cyberbullying.*

3. Adolescent past 30-day marijuana use:

*H<sub>1</sub>: Adolescents who have been exposed to traditional bullying at school and/or cyberbullying will have higher odds for using marijuana in the past 30 days.*

Effect modification (gender):

*Adolescent males who have been exposed to traditional bullying at school and/or cyberbullying will have higher odds of using marijuana in the past 30 days than adolescent females who have been exposed to traditional bullying at school and/or cyberbullying.*

## **Methods**

### **a. Data Collection & Participants**

The data used for this study was retrieved from the 2017 Youth Risk and Behavior Surveillance System (YRBSS) survey administered by the Centers of Disease Control and Prevention (CDC). The YRBSS is a national school-based survey that was originally developed in 1990 to monitor health outcomes of youth in the United States. This survey, which is conducted biannually, seeks to collect data on risk behaviors for youth in grades 9-12 in the United States. Respondents of this National Survey include students from all public and private schools in the United States, excluding US territories, who were selected based on three-stage cluster sample design to create a nationally representative sample of grade 9-12 students. Using this sample design yielded a total of 14,765 student participants. Risk behaviors that the questionnaire assesses are behaviors that contribute to unintentional injuries and violence, unhealthy dietary behaviors, and sexual behaviors related to unintended pregnancy and sexually transmitted diseases (Centers for Disease Control and Prevention [CDC], 2018).

Software used to conduct statistical analysis for this study was IBM® SPSS® Statistics Version 25. This software was used to perform the bulk of this study's analysis with supplemental information provided from the original 2017 YRBSS survey. The main variables that were selected for this study included a student's experience of traditional bullying at school and cyberbullying (independent variables – IV) and past 30-day alcohol, marijuana, and tobacco use (dependent variables – DV).

## b. Measures

### *Age & Gender*

In the YRBSS dataset, age was originally labelled as “How old are you?” and coded as follows: 1 = “12 years old or younger”, 2 = “13 years old”, 3 = “14 years old”, and continued up

until 7 = “18 years old or older”. “Age” was recoded as: 12 = “12 years old or younger”, 13 = “13 years old”, 14 = “14 years old”, and continued until 18 = “18 years old or older”. Missing values or responses from the survey were coded as “Missing”.

Sex was originally coded as “What is your sex?” whereas 1 = *female* and 2 = *male*. This was subsequently recoded as a “Gender” variable with 0 = *female*, 1 = *male*, and 99 for missing responses. For future reference with binary variables, values recoded as “0” in this study are referred to the reference group if they have the highest frequency and “1” and subsequent numbers were used as the group of interest. For sex, females were the reference group.

### *Ethnicity*

In the YRBSS dataset, race/ethnicity contained 8 different responses which were: 1 = *American Indian/Alaskan Native*, 2 = *Asian*, 3 = *African-American/Black*, 4 = *Native Hawaiian or Other Pacific Islander*, 5 = *White*, 6 = *Hispanic/Latino*, 7 = *Multiple – Hispanic*, 8 = *Multiple – Non-Hispanic*. These race/ethnicity groups were then recoded as the “Ethnic” variable and coded 0 = *Non-Hispanic White*, 1 = *Black or African American*, 2 = *Multiple Race – Hispanic*, 3 = *Hispanic/Latino*, 4 = *Multiple Race – Non-Hispanic*, 5 = *Asian*, 6 = *American Indian/Alaskan Native*, 7 = *Native Hawaiian/Other Pacific Islander*.

### *Sexual Orientation*

Sexual orientation was originally coded in the dataset as variable “Described themselves as gay or lesbian or bisexual”. The responses were coded as follows: 1 = *Heterosexual*, 2 = *Gay or lesbian*, 3 = *Bisexual*, 4 = *Not sure*. This was then recoded from highest to lowest frequency whereas: 0 = *Heterosexual*, 1 = *Bisexual*, 2 = *Not sure*, and 3 = *Gay or lesbian*.

### *Independent Variable Recoding:*

### *Bullying at School (Traditional Bullying) and Electronic Bullying (Cyberbullying)*

The YRBSS assesses bullying at school with one question “Were you bullied on school property?”. The responses for this question were coded as: 1 = *Yes* and 2 = *No*. For the recoding, a new variable was created, and the responses were recoded as: 0 = *Has not experienced bullying at school* and 1 = *Has experienced bullying at school*.

Similar recoding was done for the cyberbullying variable which was originally labelled as “Were electronically bullied?”. The responses were also coded the same with 1 = *Yes* and 2 = *No*. This variable was then renamed, and the responses were recoded as: 0 = *Has not experienced cyberbullying* and 1 = *Has experienced cyberbullying*.

#### *Dependent Variable Recoding:*

##### *Past 30-Day Adolescent Alcohol, Marijuana, and Tobacco Use*

Past 30-day alcohol and marijuana use were assessed with two questions, respectively: “During the past 30 days, on how many days did you have at least one drink of alcohol?” and “During the past 30 days, how many times did you use marijuana?” The responses for both variables were coded the same as follows: 1 = “0 days”, 2 = “1 or 2 days”, 3 = “3 to 5 days”, 4 = “6 to 9 days”, 5 = “10 to 19 days”, 6 = “20 to 29 days”, 7 = “All 30 days”. These were both recoded and a new past 30-day alcohol use variable was created with responses: 0 = *Has consumed alcohol in the past 30 days* and 1 = *Has not consumed alcohol in the past 30 days*. The past 30-day marijuana use variable was recoded as: 0 = *Has smoked marijuana in the past 30 days* and 1 = *Has not smoked marijuana in the past 30 days*.

The past 30-day tobacco use question “Currently smoked cigarettes or cigars or used smokeless tobacco or electronic vapor products?” was used and the responses were as follows: 1

= Yes, 2 = No. This was recoded into a binary variable with 0 = *Has not smoked or used tobacco products in the past 30 days*, 1 = *Has smoked or used tobacco products in the past 30 days*.

These variables were recoded to binary variables to satisfy one of the assumptions of logistic regression which is to have dichotomous dependent variable(s).

### c. Analysis

Logistic regression models assessed the relationship between traditional bullying and cyberbullying (independent variables) and odds of an adolescent using alcohol, marijuana, or tobacco in the past 30 days (dependent variables). Logistic regression analysis is used to examine the association of (categorical or continuous) independent variable(s) with one dichotomous (binary) dependent variable. Assumptions of this test include the outcome of the dependent variable following a binomial distribution, observation independence, absence of high correlation between independent variables, and a typically large sample size due to the events per variable rule.

The model fit tests used for this study were the Hosmer and Lemeshow Test (H & L) and the Receiver Operating Characteristics (ROC) curve model fit test. The H & L test is used to assess overall goodness of fit and whether the observed event rates match the expected event rates in population subgroups. However, this test has a large sample problem and large datasets can commonly prove significant when using this test. The ROC model helps show the comparison of the true negative (specificity) and true positive (sensitivity) which shows if the model fit test is doing a good job of predicting Y. A test with a sensitivity close to 70% shows that test is optimal.

## Results

### Sample Characteristics

As seen in Table 1, the sample included 14,765 student participants with 7,526 females (51.4%). The 2017 national YRBSS data included students ranging in age from 12 to 18 years old with a mean age of 15.96 (SD = 1.26). Most students identified as Non-Hispanic Whites (N=6,261), followed by African-Americans (19.4%), Multiple Race – Hispanics (14.6%), Hispanic/Latinos (10.7%), Multiple Race – Non-Hispanics (5.7%), Asians (4.5%), American Indian/Alaskan Natives (0.9%), and Native Hawaiians/Pacific Islanders (0.8%). When students were asked about their sexual orientation 12,012 students identified as heterosexual (straight) (85.1%), followed by bisexual (8.1%), not sure (4.3%), and gay or lesbian (2.5%).

As shown in Table 1 and Figure 1, 29.0% of students in the national YRBSS survey reported using alcohol in the past 30 days which is slightly less than the national average of 29.8%. For marijuana use, 19.9% of students responded using marijuana in the past 30 days compared to the national average of 19.8% from the 2019 National Institute of Health's (NIH) Monitoring the Future (MTF) survey (Miech et. al, 2019). For any tobacco product use, 19.3% of students responded that they misused tobacco in the past 30 days compared to the current national average of 31.2% from the most recent National Youth Tobacco Survey (NYTS) results (Wang et. al, 2019). When students were asked if they had been exposed to traditional school bullying, 18.2% of students responded "yes". Compared to traditional bullying, 14.5% of students in the survey responded that they have experienced cyberbullying.

### Traditional Bullying/Cyberbullying and Adolescent Past 30-Day Alcohol Use

Results for bivariate analysis of traditional bullying/cyberbully and substance use are presented in Table 2 and Table 3. Students who have experienced traditional bullying had a higher frequency of past 30-day alcohol consumption (35.3%) than students who have not experienced traditional bullying (27.6%). A Chi square ( $\chi^2$ ) test of independence was performed to assess the association between traditional bullying and past 30-day substance use and results showed statistical significance between the two variables ( $\chi^2= 54.84, p < 0.001$ ). This trend was also seen within cyberbullying exposure as 41.6% of students who had experience with cyberbullying consumed alcohol in the past 30 days compared to the 26.8% of students who did not have experience with cyberbullying.

The odds of substance use were estimated by using logistic regression analysis after adjusting for covariates (e.g., age, gender, race/ethnicity, and sexual orientation). Results from the logistic regression direct effects models are presented in Table 4 and Table 5. Adolescents who experienced traditional bullying at school have 1.361 times the odds of consuming alcohol in the past 30 days compared to adolescents who have not experienced traditional bullying at school [AOR: 1.361, 95% CI: 1.227-1.510]. For cyberbullying, adolescents who have experienced cyberbullying have 1.787 times the odds of consuming alcohol in the past 30 days compared to adolescents who have not experienced cyberbullying [AOR:1.787 95% CI: 1.598-1.998].

When comparing both forms of bullying, adolescents who have experienced cyberbullying have higher odds of consuming alcohol in the past 30 days than adolescents who have experienced traditional bullying. However, both forms of bullying increase the odds of using alcohol in the past 30 days compared to individuals who have not experienced either form of bullying, supporting the original hypothesis. When testing for effect modification, gender and

traditional bullying/cyberbullying were not significant effect modifiers, as seen in previous studies (Li, 2007; Patchin and Hinduja, 2006).

#### Traditional Bullying/Cyberbullying and Adolescent Past 30-Day Marijuana Use

For direct effects between traditional bullying and past 30-day marijuana use, adolescents who have experienced traditional bullying have 1.271 times the odds of using marijuana in the past 30 days compared to adolescents who have not experienced traditional bullying [AOR: 1.271, 95% CI: 1.139-1.419]. For adolescents who have experienced cyberbullying, they had 1.771 times the odds of using marijuana in the past 30 days compared to adolescents who have not experienced cyberbullying [AOR: 1.771, 95% CI: 1.579-1.987]. Similar to past 30-day alcohol use, adolescents who have experienced cyber bullying had higher odds of using marijuana in the past 30 days than adolescents who have experienced traditional bullying.

#### Traditional Bullying/Cyberbullying and Adolescent Past 30-Day Tobacco Use

Lastly, there was a statistically significant relationship between bullying and past 30-day tobacco use. Adolescents who have experienced traditional bullying have 1.592 times the odds of using tobacco products in the past 30 days compared to adolescents who have not experienced traditional bullying [AOR: 1.592, 95% CI: 1.418-1.789]. Adolescents who have experienced cyberbullying have 2.079 times the odds of using tobacco products in the past 30 days compared to adolescents who have not experienced cyberbullying [AOR: 2.079, 95% CI: 1.837-2.353]. When comparing both forms of bullying, adolescents who have experienced cyberbullying have statistically significant higher odds of using tobacco products compared to adolescents who have experienced traditional bullying at school.

#### Bullying and Substance Use Stratified by Gender

Gender, bullying, and all three substance use variables were tested in a model to see if gender was an effect modifier in the relationship between bullying and adolescent substance use. After testing for an effect modifier, there were no statistically significant gender differences in the association between traditional bullying/cyberbullying and past 30-day alcohol, marijuana, and tobacco usage. Therefore, gender does not moderate the relationship between bullying exposure and past 30-day substance use.

### Model Fit Tests

#### *Hosmer and Lemeshow Test*

Results of H & L tests were not statistically significant with all three types of adolescent substance use, indicating a correct model fit. This test was performed across both types of bullying and proved insignificant for all substances, except with alcohol use and cyberbullying ( $X_2$ : 18.43,  $p < 0.05$ ). These results can also be found in Table 6.

#### *Receiver Operating Characteristics (ROC) Curve*

The ROC model fit test was first performed with the demographic covariates including age, gender, race/ethnicity, and sexual orientation assessing the relationship between X and Y yielding an area under curve close to random chance, 0.568. The curve was improved to 0.599 after adding the primary independent variables, either cyberbullying or bullying. The same result was observed with cyberbullying and past 30-day alcohol use where the area under the curve improved from 0.568 to 0.608 as seen in Figure 4 and Table 7. For past 30-day marijuana use in Figure 6 and 7, the first ROC model curve area was 0.528 which was improved to 0.562 after adjusting for demographic covariates for traditional bullying and the curve improved from 0.528 to 0.586 for cyberbullying. For past 30-day tobacco use also seen in Figure 8 and 9, the first

ROC model curve area for traditional bullying was 0.611 which was improved to 0.630 after adjusting for demographic covariates and for cyberbullying, it improved from 0.611 to 0.639. Overall, the ROC curves improved for all substance use dependent variables indicating appropriate model fit. In addition, the models are also shown in figures 4-8, which visually illustrates the model approaching the optimal level of 0.75.

## **Discussion**

This cross-sectional study explored the association between exposure to two forms of bullying (traditional bullying and cyberbullying) and past 30-day alcohol, marijuana, and tobacco use for US students who participated 2017 Youth Risk and Behavior Surveillance System (YRBSS) survey. Prevalence trends were consistent with national trends seen in NIH's Monitoring the Future survey and the National Youth Tobacco Survey with tobacco being the only substance used significantly less than the national average. Tobacco usage trends have decreased for this study's population along with marijuana, which can be reflective of the social norms set within this population. In addition, the prevalence of high school tobacco users has decreased significantly over the past two decades as indicated by past surveys by MTF which could explain the low prevalence compared to the national average (Johnston et al., 2019).

The prevalence of traditional bullying within this population were comparable to findings from previous literature with 18.2% of high school students reporting traditional bullying in the YRBSS survey compared to 21% in previous studies. The prevalence of cyberbullying was also consistent with literature findings showing that results are comparable with past studies (Bauer et al., 2008; Kann et al., 2018).

Logistic regression results were consistent with past literature, in that the odds of substance use were nearly 1-2 times higher for bullied youth than of their peers who did not experience either form of bullying (Gaete et al., 2017). However, for students who experienced traditional bullying or cyberbullying the highest odds were observed within the past 30-day tobacco use group. Meaning that regardless of the form of bullying, students have higher odds of using tobacco in the past 30 days than alcohol or marijuana. There was not a statistically significant difference between both forms of bullying in terms of the odds ratios for all substance use variables.

Students who experienced cyberbullying had higher odds of using alcohol, marijuana, and tobacco in the past 30-days than students who experienced traditional bullying. This study can contribute to existing knowledge by providing additional insight on how cyberbullying can be more harmful than traditional bullying regarding risks of adolescent substance abuse.

Another interesting finding from this study was testing the interaction terms between gender and both forms of bullying. Gender and traditional bullying/cyberbullying were tested across all forms of substance use and proved to be statistically insignificant which was somewhat surprising considering previous research where gender differences were observed (Johnston et al., 2017). However, other studies have had similar results as this study with no significant gender differences (Li, 2007; Ybarra et al., 2007). Regarding the original research question, gender does not moderate the relationship between bullying.

### Limitations

Study limitations include limited data provided by the original dataset. One of the main limitations in this research is assessing cyberbullying and traditional bullying. The survey did

specifically ask about the participant's bully experience whether they were the bullying victim, perpetrator, bystander, or a bully-victim. This information would be useful to determine which exact bullying experience increases the risk of adolescent substance use. Similar studies have investigated and provided detailed insight on the differences of substance use among high school students based on their experience with bullying (Radliff, Wheaton, Robinson, & Morris, 2012; Tharp-Taylor, Haviland, & D'Amico, 2009). In addition, more questions could have been added to the dataset that pertained to socioeconomic status (SES), family composition, and other variables. These covariates would provide more information on the relationship between bullying and substance use and could be used in the logistic regression models in future studies.

Bias that exist in this study include non-response and recall biases especially regarding past 30-day substance use questions. In the original questionnaire, substance use was assessed using past 30-day usage separated as seven responses ranging from 0-30 days. This could create an issue in which some respondents could have incorrectly reported information. Non-response bias exists because the original YRBSS questionnaire is national however, data is missing from four states who chose not to participate. In addition, some students elected not to answer some of the questions pertaining to substance use and bullying, so their responses were filtered out from analysis. External validity of this study is largely affected due to the demographics of this population.

This study is also based on cross sectional data which can prove to be one-dimensional and not provide as much insight as compared to a longitudinal study where years and trends can be observed, and additional data can be analyzed. This would provide a more comprehensive view of this subject matter for this population.

## **Conclusion**

Overall, there is empirical evidence that supports the original hypotheses and research question that traditional bullying and cyberbullying both play a role in past 30-day adolescent substance use. Substance use prevalence was comparable to other national data, however there is decreased prevalence of tobacco use for students in the 2017 YRBSS sample. Compared to alcohol and marijuana use for this study population, students exposed to either form of bullying are shown to have the highest odds of past 30-day tobacco use. This can be due to increasing popularity of new vaping and e-cigarette devices which appeal to adolescents due to advertising and the variety of flavors available. Logistic regression results were consistent with previous studies which indicated that exposure to bullying increases the odds of substance use in adolescence. However, when testing for effect modifiers and confounding, gender was non-significant and further research should be done on additional covariates such as family composition, socioeconomic status (SES), and other variables.

From the findings of this study, future studies should address the importance of bullying prevention strategies among adolescents. From the general strain theory, individuals in stressful situations will use illegitimate mechanisms to cope with negative stimuli, or strain. Future studies should address the importance of family structure and factors related to home imbalances that can contribute to increased rates of substance abuse for adolescents. In addition, future studies could also examine the effect of sexual and domestic violence on adolescent substance use. Lastly, with these risks and factors in mind we can hope to further develop/plan interventions that include both parents and adolescents to help decrease substance use and for families.

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## Appendix A:

### Descriptive Statistics Table

**Table 1.** Descriptive statistics for 2017 Youth Risk Behavior Surveillance System (YRBSS) based on past 30-day substance use and bullying victimization [N= 14,765]

<b>Variables</b>	
<b>Gender</b>	<b>Frequency (%)</b>
<i>Female**</i>	7,526 (51.4)
<i>Male</i>	7,112 (48.6)
<b>Age</b>	<b>Mean (SD)</b>
	15.96 (1.26)
<b>Ethnicity</b>	<b>Frequency (%)</b>
<i>Non-Hispanic White**</i>	6,261 (43.4)
<i>Black or African American</i>	2,796 (19.4)
<i>Multiple Race - Hispanic</i>	2,104 (14.6)
<i>Hispanic/Latino</i>	1,543 (10.7)
<i>Multiple Race – Non-Hispanic</i>	823 (5.7)
<i>Asian</i>	648 (4.5)
<i>American Indian/Alaskan Native</i>	137 (0.9)
<i>Native Hawaiian/Pacific Islander</i>	116 (0.8)
<b>Sexual Orientation</b>	<b>Frequency (%)</b>
<i>Heterosexual (straight)**</i>	12,012 (85.1)
<i>Bisexual</i>	1,137 (8.1)
<i>Not sure</i>	602 (4.3)
<i>Gay or lesbian</i>	357 (2.5)
<b>Bullying at School (Traditional Bullying)</b>	<b>Frequency (%)</b>
<i>Has experienced bullying at school</i>	2,665 (18.2)
<i>Has not experienced bullying at school**</i>	11,941 (81.8)
<b>Cyberbullying</b>	<b>Frequency (%)</b>
<i>Has experienced cyberbullying</i>	2,113 (14.5)
<i>Has not experienced cyberbullying**</i>	12,482 (85.5)
<b>Past 30-day Alcohol Use</b>	<b>Frequency (%)</b>
<i>None**</i>	9,224 (71.0)
<i>1-30 days</i>	3,760 (29.0)
<b>Past 30-day Marijuana Use</b>	<b>Frequency (%)</b>
<i>None**</i>	11,520 (80.1)
<i>1-30 days</i>	2,866 (19.9)
<b>Past 30-day Tobacco Use</b>	<b>Frequency (%)</b>
<i>None**</i>	10,397 (80.7)
<i>1-30 days</i>	2,487 (19.3)

Note: SD – standard deviation. \*\* - reference group.

## Appendix B:

### Bivariate Analysis Results for Traditional Bullying/Cyberbullying and Substance Use

<b>Table 2.</b> Bivariate analysis results for traditional bullying and past 30-day substance use.			
	Has Not Experienced Traditional Bullying (N = 11,941)	Has Experience with Traditional Bullying (N = 2,665)	X <sup>2</sup> Statistic
	<b>Frequency (%)</b>		<b>P-value</b>
<b>Alcohol Use</b>			54.84 (p=0.000)**
No	7,655 (72.4)	1,491 (64.7)	
Yes	2,913 (27.6)	813 (35.3)	
<b>Marijuana Use</b>			20.594 (p=0.000)**
No	9,433 (80.9)	1,992 (76.9)	
Yes	2,231 (19.1)	597 (23.1)	
<b>Tobacco Use</b>			91.04 (p=0.000)**
No	8,637 (82.5)	1,693 (73.8)	
Yes	1,835 (17.5)	600 (26.2)	

Note: \*\* - p<0.001

<b>Table 3.</b> Bivariate analysis results for cyberbullying and past 30-day substance use.			
	Has Not Experienced Cyberbullying (N = 12,482)	Has Experience with Cyberbullying (N = 2,113)	X <sup>2</sup> Statistic
	<b>Frequency (%)</b>		<b>P-value</b>
<b>Alcohol Use</b>			165.68 (0.000)**
No	8,093 (73.2)	1,056 (58.4)	
Yes	2,967 (26.8)	753 (41.6)	
<b>Marijuana Use</b>			101.16 (0.000)**
No	9,950 (81.5)	1,476 (72.0)	
Yes	2,253 (18.5)	575 (28.0)	
<b>Tobacco Use</b>			171.12 (0.000)**
No	9,071 (82.8)	1,256 (69.8)	
Yes	1,880 (17.2)	544 (30.2)	

Note: \*\* - p<0.001

## Appendix C:

### Direct Effect Results for Traditional Bullying and Substance Use

**Table 4.** Logistic regression results for past 30-day substance use and traditional bullying.

	Past 30-Day Alcohol Use			Past 30-Day Marijuana Use			Past 30-Day Tobacco Use		
	AOR	95% CI		AOR	95% CI		AOR	95% CI	
<b>Demographics</b>									
Age	1.38	1.33,	1.43***	1.29	1.25,	1.34***	1.27	1.22,	1.32***
Gender (Males)	0.76	0.70,	0.83***	1.02	0.93,	1.11	1.69	1.54,	1.87***
<b>Ethnicity</b>									
Non-Hispanic White	--	--	--	--	--	--	--	--	--
Black/African American	0.45	0.39,	0.50***	1.29	1.15,	1.45***	0.45	0.39,	0.52***
Multiple - Hispanic	0.83	0.74,	0.94**	1.31	1.15,	1.48***	0.65	0.57,	0.75***
Hispanic/Latino	0.74	0.64,	0.84***	1.11	0.96,	1.29	0.48	0.40,	0.57***
Multiple – Non-Hispanic	0.81	0.68,	0.96*	1.05	0.87,	1.27	0.64	0.52,	0.79***
Asian	0.24	0.19,	0.32***	0.31	0.22,	0.43***	0.19	0.14,	0.28***
American Indian/Alaskan Native	0.85	0.55,	1.32	1.41	0.91,	2.18	1.34	0.87,	2.06
Native Hawaiian/Pacific Islander	0.48	0.27,	0.84***	1.09	0.65,	1.81	0.78	0.45,	1.35
<b>Sexual Orientation</b>									
Heterosexual (straight)	--	--	--	--	--	--	--	--	--
Bisexual	1.40	1.21,	1.62***	1.85	1.60,	2.14***	1.86	1.58,	2.19***
Not sure	0.74	0.60,	0.93***	0.95	0.76,	1.19	1.05	0.82,	1.34
Gay or lesbian	1.57	1.22,	2.02***	1.69	1.32,	2.16***	1.98	1.52,	2.57***
<b>Traditional Bullying at School</b>									
Has experience	1.36	1.23,	1.51***	1.27	1.14,	1.41***	1.59	1.41,	1.79***

Note: All models adjust for age, gender, race/ethnicity, and sexual orientation. AOR = Adjusted Odds Ratio. 95% CI = 95% Confidence Interval. -- reference group.

\*\*\* - p < 0.001, \*\* - p < 0.01, \* - p < 0.05.

## Appendix D:

### Direct Effect Results for Cyberbullying and Substance Use

**Table 5.** Logistic regression direct effects results for past 30-day substance use and cyberbullying.

	Past 30-Day Alcohol Use			Past 30-Day Marijuana Use			Past 30-Day Tobacco Use		
	AOR	95% CI		AOR	95% CI		AOR	95% CI	
<b>Demographics</b>									
Age	1.38	1.34,	1.43***	1.30	1.25,	1.34***	1.28	1.23,	1.33***
Gender	0.79	0.72,	0.86	1.07	0.97,	1.16	1.78	1.61,	1.97***
<b>Ethnicity</b>									
Non-Hispanic White	--	--	--	--	--	--	--	--	--
Black/African American	0.45	0.40,	0.51***	1.34	1.19,	1.51***	0.46	0.40,	0.52***
Multiple - Hispanic	0.84	0.74,	0.94**	1.33	1.17,	1.50***	0.65	0.56,	0.75***
Hispanic/Latino	0.75	0.65,	0.86***	1.14	0.99,	1.32	0.49	0.41,	0.58***
Multiple – Non-Hispanic	0.81	0.68,	0.97*	1.06	0.87,	1.28	0.65	0.52,	0.80***
Asian	0.24	0.19,	0.32***	0.31	0.23,	0.44***	0.20	0.14,	0.28***
American Indian/Alaskan Native	0.86	0.56,	1.37	1.46	0.94,	2.26	1.30	0.84,	2.03
Native Hawaiian/Pacific Islander	0.47	0.26,	0.83**	1.08	0.64,	1.79	0.72	0.41,	1.27
<b>Sexual Orientation</b>									
Heterosexual (straight)	--	--	--	--	--	--	--	--	--
Bisexual	1.37	1.18,	1.58***	1.82	1.58,	2.11***	1.80	1.53,	2.12***
Not sure	0.72	0.58,	0.90**	0.92	0.73,	1.16	1.01	0.78,	1.29
Gay or lesbian	1.51	1.18,	1.95**	1.67	1.30,	2.15***	1.89	1.45,	2.47***
<b>Cyberbullying</b>									
Has experience	1.79	1.60,	2.00**	1.77	1.58,	1.99***	2.08	1.84,	2.35

Note: All models adjust for age, gender, race/ethnicity, and sexual orientation. AOR = Adjusted Odds Ratio. 95% CI = 95% Confidence Interval. -- reference group.  
 \*\*\* - p < 0.001, \*\* - p < 0.01, \* - p < 0.05.

## Appendix E:

### Hosmer & Lemeshow Model Fit Test Results

**Table 6.** Hosmer & Lemeshow model fit test results for exposure to bullying and substance use.

<b>Traditional Bullying</b>			
<b>Variable</b>	<b>Chi-Square</b>	<b>df</b>	<b>P-value</b>
<i>Past 30-Day Alcohol Use</i>	14.54	8	0.069
<i>Past 30-Day Marijuana Use</i>	6.55	8	0.59
<i>Past 30-Day Tobacco Use</i>	13.08	8	0.11

<b>Cyberbullying</b>			
<b>Variable</b>	<b>Chi-Square</b>	<b>df</b>	<b>P-value</b>
<i>Past 30-Day Alcohol Use</i>	18.43	8	0.018
<i>Past 30-Day Marijuana Use</i>	8.36	8	0.40
<i>Past 30-Day Tobacco Use</i>	13.92	8	0.084

**Appendix F:**

ROC Curve Model Fit Test Results Table

**Table 7.** ROC Curve model fit test results for exposure to bullying and substance use.

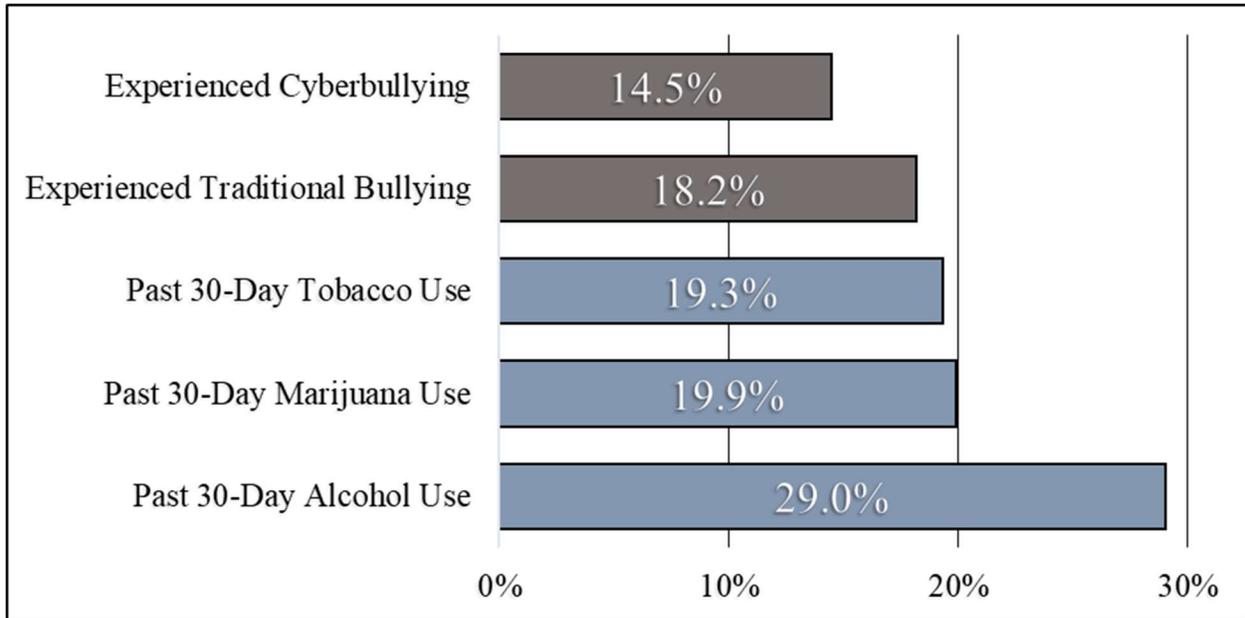
<b>Traditional Bullying</b>			
<b><i>ROC Curve</i></b>	<b>Past 30-Day Alcohol Use</b>	<b>Past 30-Day Marijuana Use</b>	<b>Past 30-Day Tobacco Use</b>
Area Before	.568	.528	.611
Area After	.599	.562	.630

<b>Cyberbullying</b>			
<b><i>ROC Curve</i></b>	<b>Past 30-Day Alcohol Use</b>	<b>Past 30-Day Marijuana Use</b>	<b>Past 30-Day Tobacco Use</b>
Area Before	.568	.528	.611
Area After	.608	.586	.639

## Appendix G:

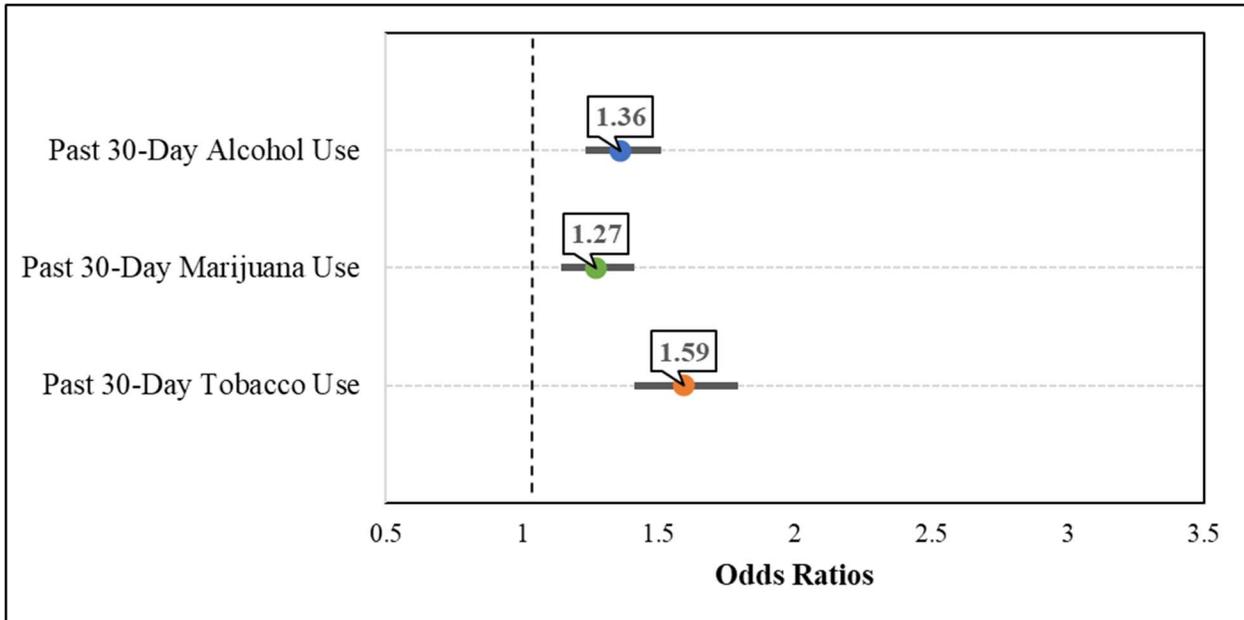
### Prevalence of Bullying and Substance Use



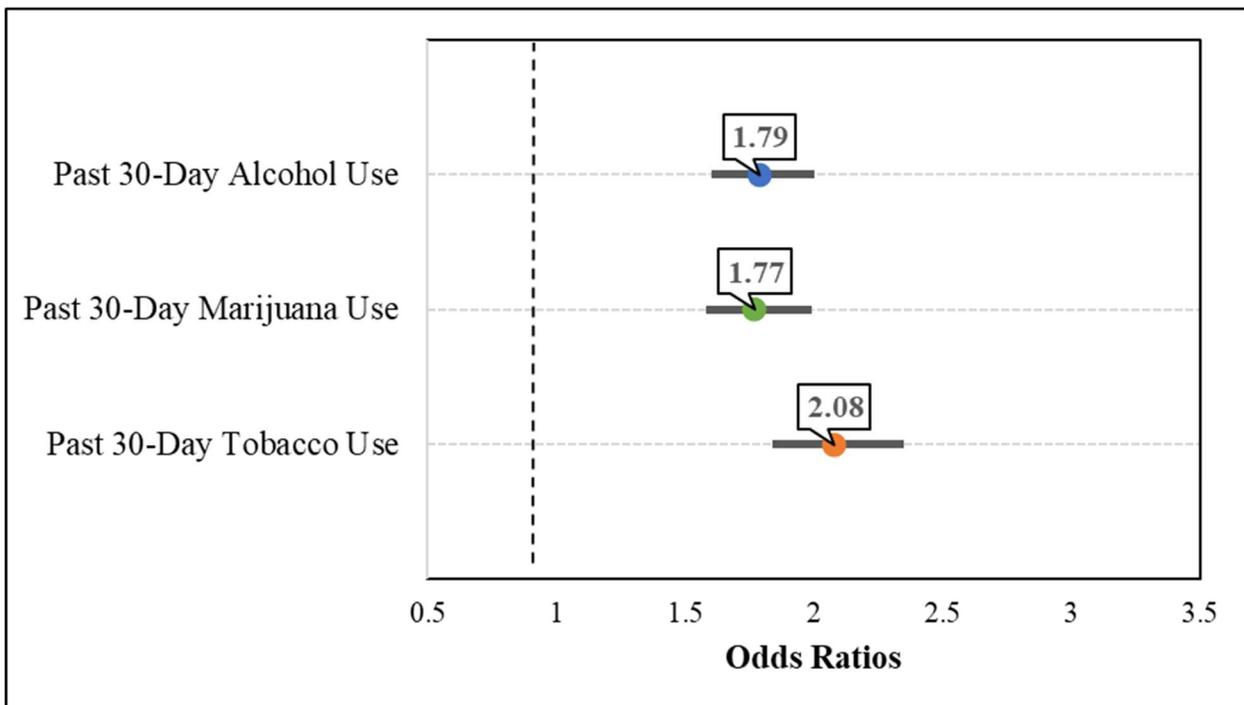
**Figure 1.** Prevalence of cyberbullying, traditional bullying with past 30-day alcohol, marijuana, and tobacco use among students (grades 9-12) from the 2017 YRBSS survey.

## Appendix H:

### Forest Plots for Adjusted Odds Ratio of Bullying Exposure by Substance Use



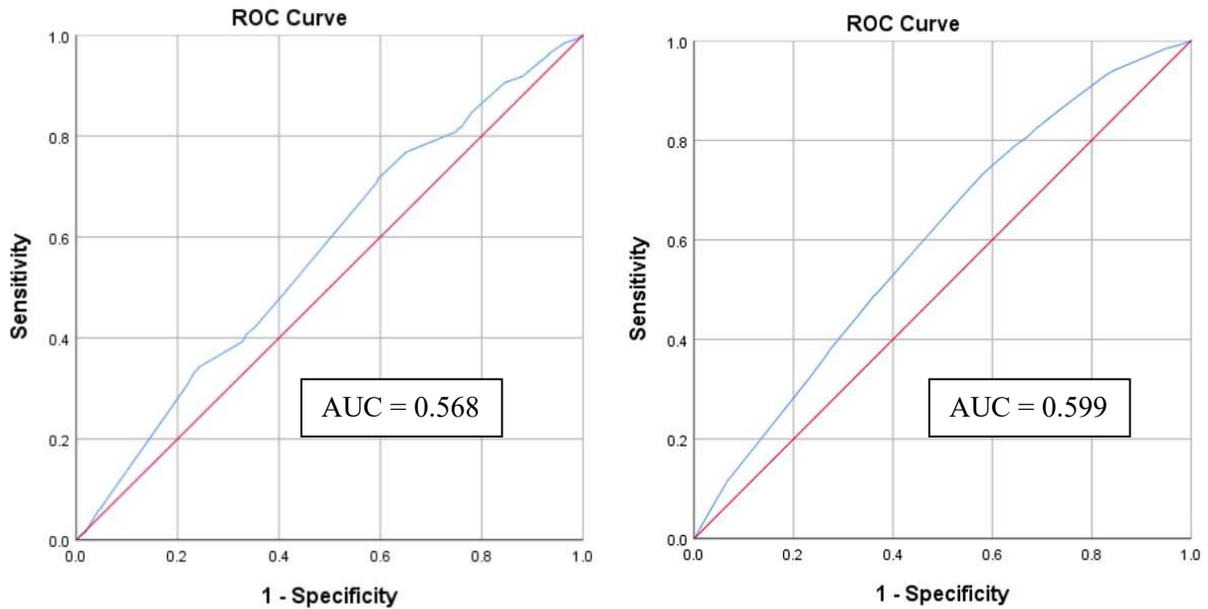
**Figure 2.** Odds of past 30-day alcohol, marijuana, and tobacco use based on exposure to traditional bullying at school. *Note:* Model adjusted for age, gender, race/ethnicity, and sexual orientation.



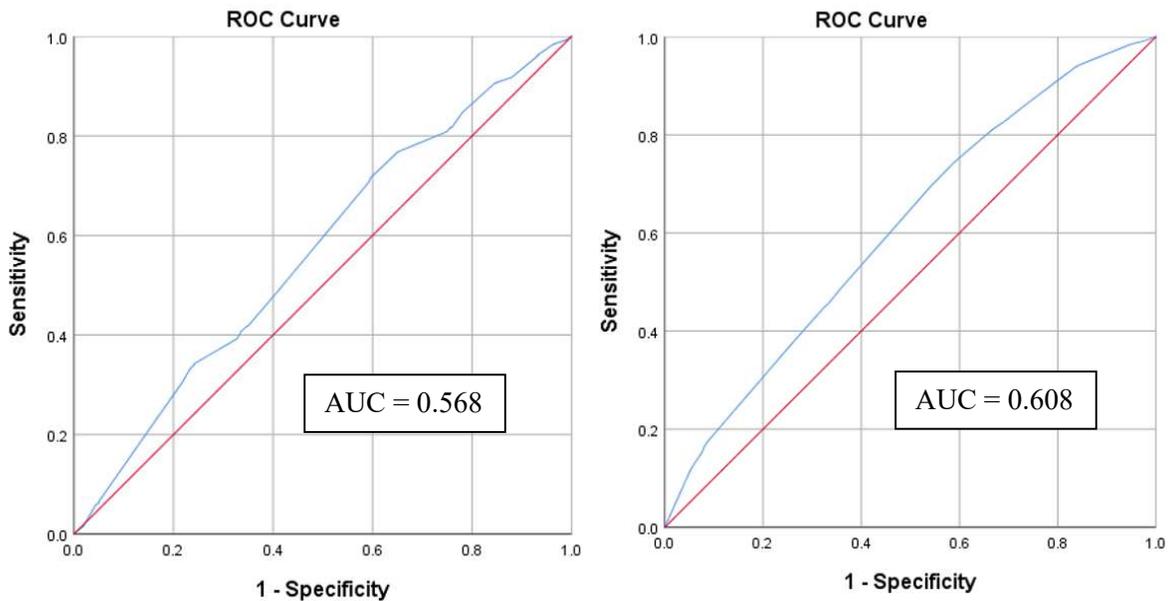
**Figure 3.** Odds of past 30-day alcohol, marijuana, and tobacco use based on exposure to cyberbullying. *Note:* Model adjusted for age, gender, race/ethnicity, and sexual orientation.

## Appendix I:

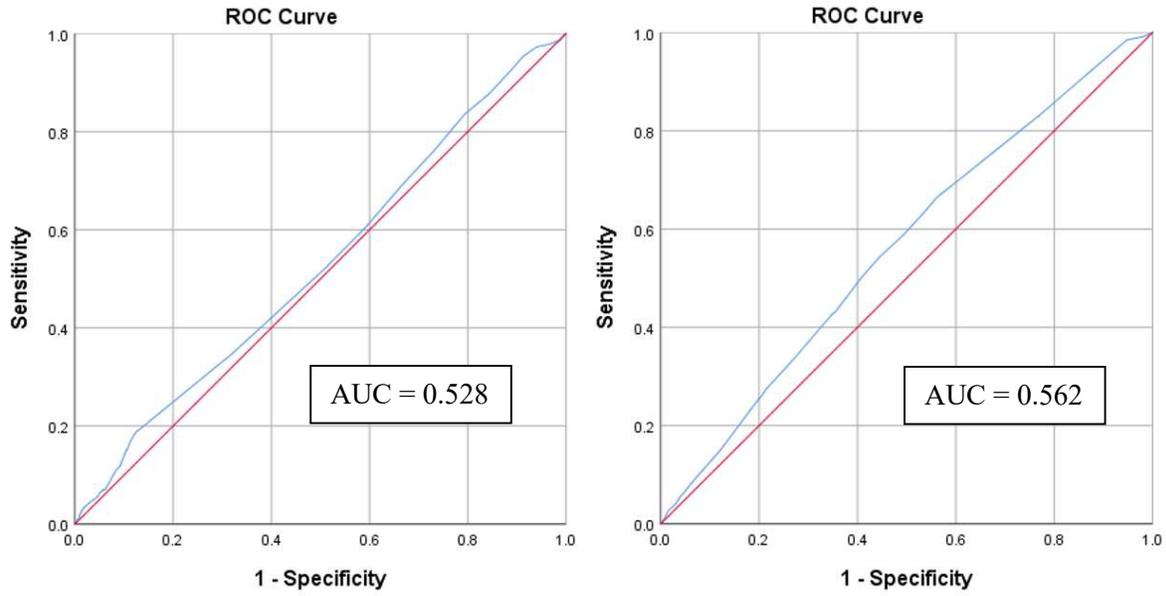
### ROC Curve Models of Bullying Exposure by Substance Use



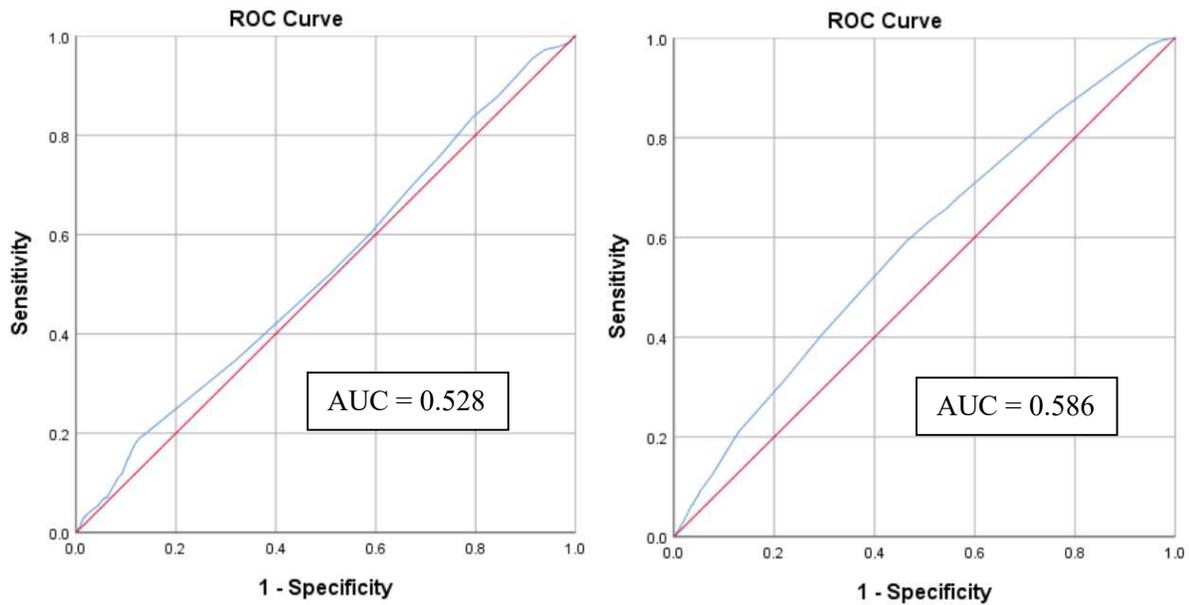
**Figure 4.** ROC (Receiver Operating Characteristics) Models for the probability of consuming alcohol in the past 30 days based on gender, ethnicity, and sexual orientation covariates with traditional bullying. Note: AUC = Area Under the Curve.



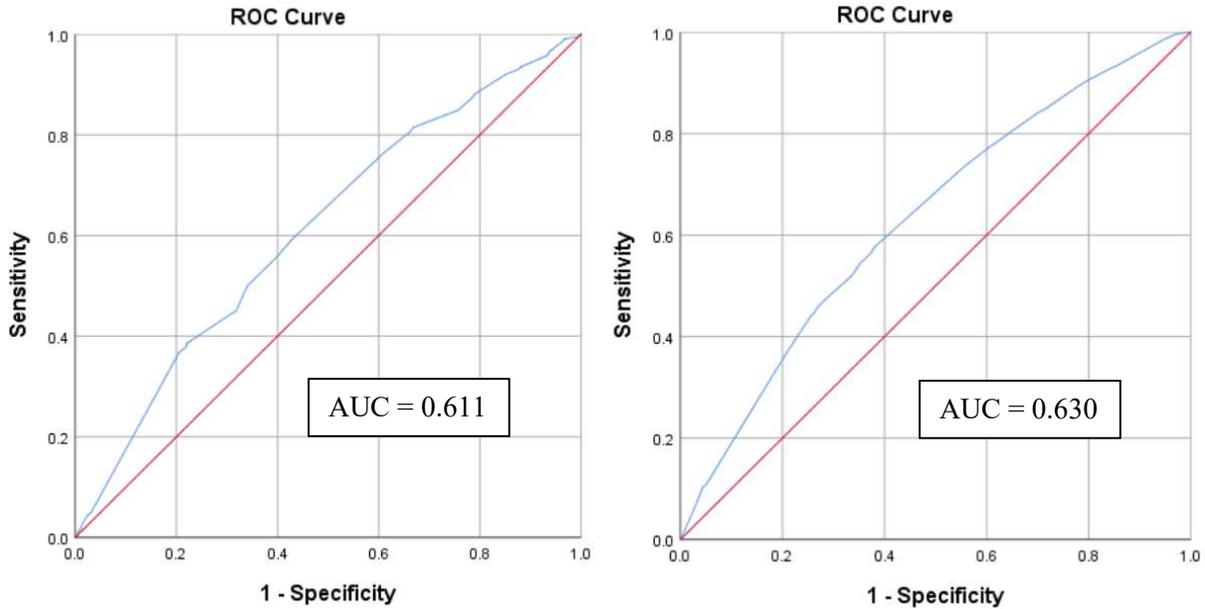
**Figure 5.** ROC (Receiver Operating Characteristics) Models for the probability of consuming alcohol in the past 30 days based on gender, ethnicity, and sexual orientation covariates with cyberbullying. Note: AUC = Area Under the Curve.



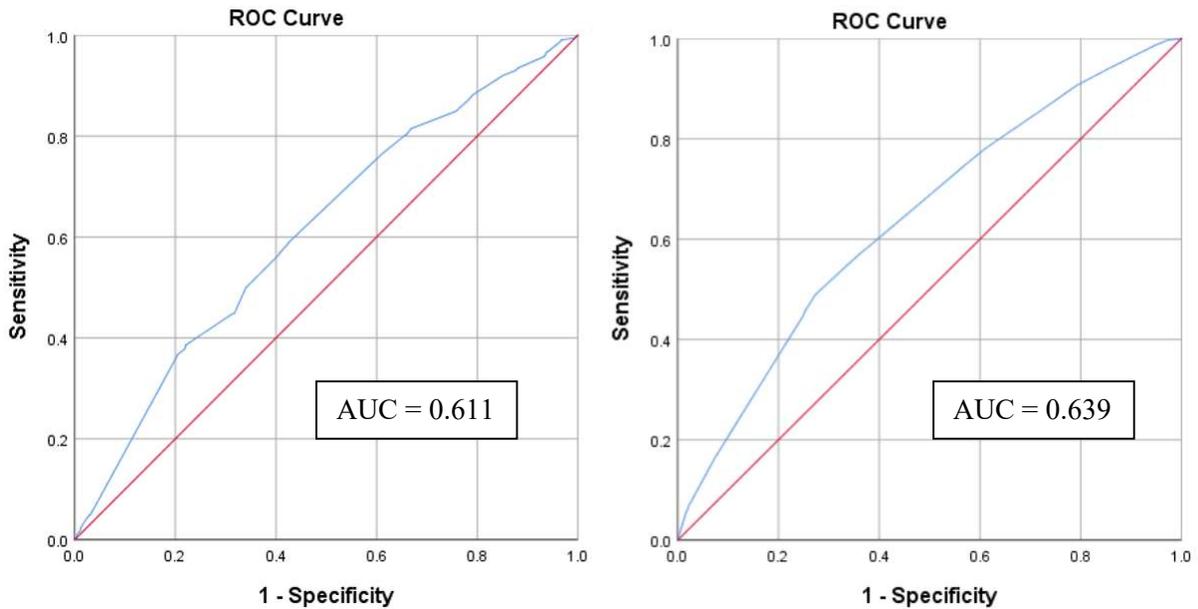
**Figure 6.** ROC (Receiver Operating Characteristics) Models for the probability of consuming marijuana in the past 30 days based on gender, ethnicity, and sexual orientation covariates with traditional bullying. Note: AUC = Area Under the Curve.



**Figure 7.** ROC (Receiver Operating Characteristics) Models for the probability of consuming marijuana in the past 30 days based on gender, ethnicity, and sexual orientation covariates with cyberbullying. Note: AUC = Area Under the Curve.



**Figure 8.** ROC (Receiver Operating Characteristics) Models for the probability of consuming tobacco in the past 30 days based on gender, ethnicity, and sexual orientation covariates with traditional bullying. Note: AUC = Area Under the Curve.



**Figure 9.** ROC (Receiver Operating Characteristics) Models for the probability of consuming tobacco in the past 30 days based on gender, ethnicity, and sexual orientation covariates with cyberbullying. Note: AUC = Area Under the Curve.