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ORIGINAL PAPER

The Influence of Risk and Protective Factors on Adolescent Alcohol, Cannabis, and Electronic Cigarette Use

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Abstract

The misuse of substances by adolescents is a serious public health concern in the United States, and the three most used substances by adolescents are alcohol, cannabis, and electronic cigarettes. In accordance with the Social Development Model, a better understanding of the risk and protective factors across these three substances can assist in predicting potential substance use as well as strategies for prevention. The purpose of the current study is to examine the similar or differential influence that a specific set of risk and protective factors (i.e., favorable attitudes toward substance use, perceived risk of harm, peer substance use, interaction with prosocial peers, parental favorable attitudes toward substance use, family management, perceived availability substances, and rewards for prosocial involvement) have on past 30-day alcohol, cannabis, and e-cigarette use by adolescents. The present study is based on a secondary data analysis of the 2019 Prevention Needs Assessment Survey, which is administered every two years in the State of Utah to a large sample of students in grades 6, 8, 10, and 12 grades. A subsample of students (n = 44,728) was included in the present analysis. Logistic regression was used to examine the predictive relation for the set of four risk and four protective factors on past 30-day use of alcohol, cannabis, and e-cigarette use. In general, the results indicated that endorsement of the four risk factors predicted *increases* in the use of each substance whereas endorsement of the four protective factors predicted *decreases* in use. Implications of these findings suggest that there may be more similarities in risk and protective factors across alcohol, cannabis, and electronic cigarettes than between them. In addition, this study adds to the budding literature on the risk and protective factors associated with adolescent e-cigarette use.

Keywords Shared risk and protective factors · Adolescent substance use · School-based sample · Alcohol · cannabis · Electronic cigarettes

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Introduction

The misuse of substances by adolescents is a serious public health concern in the United States as indicated by the 2016 Surgeon General's Report (HHS, 2016). Currently, the three most commonly used substances by adolescents are alcohol, cannabis, and electronic cigarettes (e-cigarettes; Miech et al., 2019; SAMHSA, 2020). The *Monitoring the Future* (MTF) survey estimates the past 30-day use rates for alcohol as 7.9% for 8th graders, 18.4% for 10th graders, and 29.3% for 12th graders (Miech et al., 2020). For cannabis, past 30-day use rates are estimated at 6.6% of 8th graders, 18.4% of 10th graders, and 22.3% of 12th graders. Finally, past 30-day e-cigarette use rates are estimated at 12.2% for 8th graders, 25% for 10th graders, and 30.9% for 12th graders; highest across all grade levels compared to alcohol or cannabis. Although e-cigarettes may be considered a cessation intervention for adult cigarette smokers, this not the case for adolescents (Brandon et al., 2015; Lippert, 2015). In fact, the opposite appears to be true; adolescent e-cigarette use significantly increases the likelihood of future combustible cigarette use (Barrington-Trimis et al., 2016). Whereas 31% of 12th graders are estimated to have used e-cigarettes in the past month, the inverse of this finding indicates that close to 70% of 12th graders are not using e-cigarettes. More broadly, what places some adolescents at-risk for using alcohol, cannabis, or e-cigarettes whereas other adolescents are less likely to use them. As such, it can be helpful to address the issue of adolescent substance use from the perspective of risk and protective factors.

The Social Development Model (SDM; Catalano & Hawkins 1996; Hawkins & Weis, 1985) is based on understanding how risk and protective factors influence antisocial and prosocial pathways for the development of substance use in youth. In particular, the SDM posits that exposure to certain risk and protective factors influences youth behavior in predictable ways. These risk and protective factors are thought to exist within the five socializing domains of *individual*, *peers*, *family*, *school*, and *community* (Hawkins et al., 1986, 1992a). A risk factor is considered a characteristic of the individual or their environment that *increases* the probability of using a substance whereas a protective factor *decreases* that probability (Hawkins et al., 1992b). These factors are not necessarily restricted to specific substances; rather, risk and protective factors may have unique or shared applicability across substances. In other words, certain risk and protective factors may exert similar or differential influences across the three most frequently used substances by adolescents (i.e., alcohol, cannabis, and e-cigarettes).

There is a substantial body of literature exploring the risk and protective factors for adolescent substance use. However, most studies focus on the use of a single substance (e.g., Burrow-Sánchez & Ratcliff 2021; Meier et al., 2019; Terry-McElrath et al., 2017). Several reviews exist comparing risk/protective factors across studies for alcohol, combustible cigarettes, and cannabis (e.g., Hawkins et al., 1992a; Stone et al., 2012), yet these reviews are limited in their ability to investigate the similar or differential influence that risk and protective factors have on the use of different substances by adolescents. A handful of studies have explored the similar or differential influence of risk and protective factors. A study by Beyers and colleagues (2004) compared 33 risk and protective factors on past 30-day use of alcohol, combustible

cigarettes, and cannabis for a sample of adolescents in the United States (i.e., the states of Oregon & Maine; N = 32, 403; ages 12–17; 51.9% female; 85% White) and Australia (N = 8,442; ages 12–17; 54% female; 89% White). Using the Communities that Care (CTC; Arthur et al., 2002) Youth Survey to measure the variables in the study, they found that risk and protective factors generally predict adolescent substance use in the anticipated direction. Additionally, the risk factors most strongly associated with an increased use of alcohol, combustible cigarettes, or cannabis was favorable attitudes toward substances (i.e., individual and parental), peer substance use, perceived availability of substances, and family history of substance use. In contrast, the protective factors most strongly related to decreases in substance use were recognition/opportunities for prosocial involvement (i.e., family and community), belief in the moral order, social skills, and religiosity. A second study by Graves and colleagues (2005) examined the predictive influences for a novel set of three risk factors and five protective factors on alcohol, combustible cigarettes, and cannabis use for a sample of 271 adolescents (mean age = 14.50; 69% male; 54% White, 40% Black/African-American) in North Carolina. They found that one risk factor (i.e., parental history of a felony) predicted decreases in alcohol and cannabis use and increases in cigarette use. A second risk factor (i.e., parental history of substance use) predicted increases in cannabis use only. Of the five protective factors they tested, only one (i.e., parental behavioral control) predicted decreases in cigarette and cannabis use. In sum, the researchers found that only a few of the risk and protective factors in their novel set of risk and protective factors were predictive of increases or decreases in the use of alcohol, cigarettes, or cannabis.

A third study (see Barnes et al., 2005) examined the shared predictors of gambling, substance use, and delinquency for two samples of older adolescents. They conducted secondary analysis of two longitudinal samples of adolescents originally sampled via population household surveys conducted in Buffalo, New York. The first sample contained data from 552 adolescents (mean age = 19.0; 54% female; 71% White, 29% Black/African American) and the second sample of 597 male adolescents (mean age = 19.0 years; 51% White, 49% Black/African American). The researchers utilized separate structural equation models for each sample to simultaneously test the predictive relation between sociodemographic factors (e.g., age, gender), individual risk factors (i.e., impulsivity and moral disengagement) as well as protective (i.e., parental monitoring) and risk (i.e., peer delinquency) socialization factors on the outcomes of gambling, alcohol misuse, other substance use (i.e., composite score that included combustible cigarettes, cannabis, and other illicit substances), and delinquency; most relevant to the present study are the alcohol and other substance use outcomes. For the first sample, peer delinquency predicted increases in alcohol and other substance use for males and females whereas impulsivity was only predictive of increased alcohol use for females. Parental monitoring predicted decreases in alcohol and other substance use for males only. For the second sample of male adolescents, peer delinquency predicted increases in alcohol and other substance use whereas moral disengagement predicted increases in other substance use only. Parental monitoring predicted decreases in alcohol and other substance use. Overall, the researchers found that peer delinquency and parental monitoring were most consistently predictive of increases or decreases, respectively, in alcohol and other substance use

across the two samples of adolescents. A fourth study (see Cleveland et al., 2008) examined three domains of risk factors (i.e., individual, peer, and family) and protective factors (i.e., family, school, and community) for lifetime and past 30-day use of alcohol, combustible cigarettes, and cannabis. This study included a large sample of students (N = 91,777; 90% White; ages and gender not reported) in grades 6, 8, 10, and 12 in the state of Pennsylvania. The researchers used an instrument based on the CTC survey (see Arthur et al., 2002) and then combined individual risk and protective factor measures into composite indices that represented three domains of risk and protection, respectively. When risk and protective factor indices were included in the same regression model, they found that most of the risk factor domains (i.e., individual, peer, and family) were predictive of increases in past 30-day alcohol, cigarette, and cannabis use whereas most protective factor domains (i.e., family, school, and community) were not predictive of decreases in substance use. In general, they concluded that risk factor domains were stronger predictors of substance use compared to protective factor domains when both were tested in the same model. A final study (see Barnes et al., 2009) examined seven risk and six protective factors for adolescent substance use and mental health symptomatology with a sample of 663 adolescents (mean age = 15.5; 51.5% female; 84.6% White) obtained via a study using a random sampling strategy of household telephone numbers in Victoria, British Columbia. Of relevance to the present study are one risk factor (i.e., risky peer affiliation) and two protective factors (i.e., protective peer affiliations and protective parenting). The risk and protective factors were tested in a series of hierarchical linear regressions using the outcomes of alcohol, combustible cigarette, and drug (i.e., composite variable that includes cannabis and other substances) use. The researchers found that risky peer affiliations predicted increased use of alcohol, cigarettes, and drugs. In contrast, protective peer affiliations and protective parenting predicted decreased use of alcohol, cigarettes, and drugs.

Based on the review above, a handful of studies have examined the similar or differential influence that risk and protective factors have on the three most frequently used substances by adolescents at the time the papers were published. The number of risk and protective factors included in these studies varied widely, and the inclusion criteria for a risk or protective factor were not always clear across the studies reviewed above. In addition, none of the studies included the use of e-cigarettes as an outcome, which is currently the most frequently used substances by adolescents (Miech et al., 2020).

For the present study, we chose to include a balance of risk and protective factors across four domains that have a clear theoretical, empirical, and practical relation to either alcohol, cannabis, or cigarettes/e-cigarettes as evidenced in at least three prior studies. Using the criteria described above, we identified four risk factors and four protective factors for inclusion in the current study. From the individual domain, we selected *favorable attitudes toward substance use* as a risk factor (Beyers et al., 2004; Guo et al., 2001; Jackson et al., 2005) and *perceived risk of harm* as protective factor (Johnston, 1991, 2003; Keyes et al., 2016; Lipari et al., 2017; Miech et al., 2017, 2018; Terry-McElrath et al., 2017). From the peer domain, we choose *peer substance use* as a risk factor (Brook et al., 1999; Chassin et al., 2002; Sher & Rutledge, 2007; van den Bree & Pickworth, 2005; van den Bree et al., 2004) and *interaction*

with prosocial peers as a protective factor (Barber et al., 2001; Lam, 2012; Walters, 2020). From the family domain we choose *parental favorable attitudes toward substance use* as a risk factor (Beyers et al., 2004; Brook et al., 1986; McDermott, 1984) and *family management* as a protective factor (Engels et al., 2005; Guo et al., 2001; Roche et al., 2008). Finally, for the community domain, we selected *perceived availability substances* as a risk factor (Broman, 2016; Scribner et al., 2008; Weitzman et al., 2003) and *rewards for prosocial involvement* as a protective factor (Barber et al., 2001; Fagan et al., 2007; Lam, 2012).

The purpose of the current study is to examine the influence a specific set of risk and protective factors have on alcohol, cannabis, and e-cigarette use for adolescents in the past 30 days. Our first hypothesis is that endorsement of risk factors will predict past 30-day substance use. Our second hypothesis is that endorsement of protective factors will predict not using substances in the past 30-days. The risk and protective factors will be consistent across all three models for each type of substance examined. Results of this study may have implications for ways a specific set of risk and protective factors are utilized to prevent substance use by adolescents, including e-cigarettes.

Methods

Design

The present study is a secondary data analysis of the 2019 Prevention Needs Assessment (PNA) Survey, which is administered every two years by the Utah Department of Health and Human Services (UDHHS) to a large state sample of students in 6th, 8th, 10th, and 12th grades (Bach Harrison, 2019; UDHHS, 2019). The PNA is based on the Communities that Care (CTC) Youth Survey (see Arthur et al., 2002) and is designed to measure substance use, mental health symptoms, and antisocial behavior as well as their associated risk and protective factors. The psychometric properties of the CTC Youth Survey and item scales for risk and protective factors have been psychometrically validated across several studies (see Arthur et al., 2002; Beyers et al., 2004; Cleveland et al., 2008). The PNA was administered using a complex sampling framework. Strata were at the school district level, clustering at the school level, and weights were calculated for the entire survey as well as two versions (i.e., A and B) to approximate the population characteristics.

Participants

In Spring 2019, the PNA was administered to 92,594 students in over 600 public or charter schools across the State of Utah (Bach Harrison, 2019). Active parental consent was used to recruit students to participate in the survey. The survey did not ask students for identifying information, and their responses remained anonymous. A total of 2,591 (2.8%) of surveys were eliminated from the final sample due to self-reporting being *"Not Honest At All"* during survey completion ($n=336$), using a fake substance (i.e., phenoxydine; $n=1{,}005$), using an unrealistically high level of sub-

stances ($n=284$), a past-month substance use rate that was higher than their lifetime substance use rate ($n=281$), an age inconsistent with their grade or school ($n=351$), or a grade that was not possible for their school ($n=334$). Additionally, 3,202 students were excluded because they reported being in 7th, 9th, or 11th grade, and 455 were excluded because they did not mark or marked multiple grade levels, resulting in a total sample of 86,346 students. The survey was administered to students in paper (36.8%) or online (63.2%) formats. Two versions of the PNA, versions A (51.8%) and B (48.2%), were administered randomly during a standard class period. Most items were included on both versions of the survey whereas some items were only included on version A or B.

Measures

Past 30-Day substance use

The past 30-day use of alcohol, cannabis, and e-cigarettes was determined through participant responses to three questions that asked how many occasions/days they use any of the aforementioned substances. Anything marked as zero occassions/days was coded as "0" and anything marked as 1 or more was coded as "1" to create the three dichotomous variables. These variables are used as dependent variables in the present study.

Risk and protective factors

The subscales for the risk and protective factors on the PNA Survey were based on the CTC (see Arthur et al., 2002) youth survey. The items were developed and validated to measure risk and protective factors for substance use and related problem behaviors. Table 1 contains the item desciptions and estimates of reliablity for the risk and protective factor subscales used in the present study. The responses to the subscale items were averaged to create the risk and protective factor variables. The risk and protective factor variables were coded as continous (i.e., 4- or 5-point scale) pending the number of response options provided in the survey.

Demographics and covariates

The demographic variables age, gender, and racial/ethnic identification were included on the survey and used in the analysis as covariates. Age was coded as a continuous variable (i.e., 10 or younger through 19 or older) whereas gender (i.e., male, female, transgender, other) and race/ethnicity (i.e., White, Hispanic/Latino, Black/African-American, American Indian/Alaskian Native, Asian, Native Hawaiian/Other Pacific Islander, and Multiracial) were coded as categorical variables. The dichotomous substance use variables (i.e., past 30-day use of alcohol, cannabis, and e-cigarettes) were included as covariates in the models as described in the analytical plan section below.

Analytical Plan

Dependent and independent variables: logistic regression

The dichotmous variables (No = 0 or Yes = 1) of past 30-day use for alcohol, cannabis, or e-cigarettes were treated as dependent variables in three separate logistic regression models. Each model included the covariates of age, gender, and race/ethnicity. The fourth and fifth covariates were dichotomous (No = 0 or Yes = 1) and indicated the past 30-day use of either alcohol, cannabis or e-cigarettes and were rotated based on the dependent variable in the model to avoid overlap. For example, when alcohol was the dependent variable the substance use covariates were cannabis and e-cigarettes; we included these covariates to control for the influence of using a substance other than the dependent variable in each model. The eight independent variables of interest were the four risk and four protective factors indentified in Table 1. The same four risk factors and three of the protective factors were used in all three models. The exception was the protective factor for perceived risk of a substance; this factor was changed in each model for congruence with the dependent variable. For example, when alcohol was the dependent variable, the protective factor was perceived risk of alcohol (instead of cannabis or e-cigarettes) and was then changed for the other two models to match the substance of the dependent variable. Logistic regression produces odds ratios, a type of effect size, that can be used to compare the *similar or differential* outcomes of the risk and protective factors across substances within the same model.

Complex Survey Design and Analysis

The data collected for the PNA was via a complex survey design and the design elements (i.e., strata, cluster, survey weight) were included in the analysis. Sample weights for the total survey as well as forms A and B were provided by the survey administrators. Analyses were conducted using SAS v.9.4 survey procedures that can account for the strata, cluster, and weight elements that are part of the design elements for complex surveys. Five of the eight (62.5%) risk and protective factors used in the logistic regression models were administered only on Form A of the survey. Thus, a decision was made to include the sample data and weights from Form A (instead of Form B) of the survey for all analyses in the present study.

Missing Data

The proportion of missing data on Form A for the variables included in the anlaysis ranged from 0.47 to 18.13% (mean = 7.92, SD = 4.77; see Appendix A for additional detail of missing data for specific variables) with exception of the district, school, and weight variables, which had no missing data. To account for the missing data on the study variables, mutiple imputation was conducted for each of the three analytic models prior to conducting the logistic regressions using the SAS multiple imputation procedure (PROC MI). Ten data sets were imputed for each model and included the complex survey design elements (i.e., strata, cluster, weight) using analytic rec-

Table 1 Risk and protective factor subscales, reliability, and item descriptions

Risk or Protective Factor	Reliability (α)	# of Items	Item Description(s)	Response Options
Risk Factors				
Favorable attitudes toward substance use	0.839	4	♣ How wrong do you think it is for someone your age to: ♣ drink beer, wine, or hard liquor(for example, vodka, whiskey, or tequila) regularly? ♣ smoke cigarettes? ♣ smoke marijuana? ♣ use LSD, cocaine, amphetamines or another illegal drug?	Very Wrong, Wrong, A Little Bit Wrong, Not Wrong at All
Peer substance use	0.784	4	♣ Think of you four best friends (the friends you feel closest to). In the past year (12 months), how many of your best friends have: ♣ smoked cigarettes? ♣ tried beer, wine, or hard liquor(for example, vodka, whiskey, or tequila) when their parents didn't know about it? ♣ used marijuana? ♣ used LSD, cocaine, amphetamines or another illegal drugs?	0, 1, 2, 3, 4
Parental favorable attitudes towards drug use	0.740	3	♣ How wrong do your parents feel it would be for YOU to: ♣ drink beer, wine, or hard liquor(for example, vodka, whiskey, or tequila) regularly? ♣ smoked marijuana? ♣ smoked cigarettes?	Very wrong, Wrong, A little bit wrong, Not wrong at all
Perceived availability of drugs	0.887	4	♣ If you wanted to get some cigarettes, how easy would it be for you to get some? ♣ If you wanted to get some beer, wine, or hard liquor (for example, vodka, whiskey, or gin), how easy would it be for you to get some? ♣ If you wanted to get a drug like cocaine, LSD, or amphetamines, how easy would it be for you to get some? ♣ If you wanted to get some marijuana, how easy would it be for you to get some?	Very hard, Sort of Hard, Sort of easy, Very easy
Protective Factors				
Perceived risk of harm from alcohol	NA	1	♣ How much do you think people risk harming themselves (physically or in other ways) if they take one or two drinks of an alcoholic beverage (beer, wine, liquor) nearly every day.	No Risk, Slight Risk, Moderate Risk, Great Risk

Table 1 (continued)

Risk or Protective Factor	Reliability (α)	# of Items	Item Description(s)	Response Options
Perceived risk of harm from cannabis	0.867	2	♣ How much do you think people risk harming themselves (physically or in other ways) if they: ♣ try marijuana once or twice? ♣ smoke marijuana regularly?	No Risk, Slight Risk, Moderate Risk, Great Risk
Perceived risk of harm from vaping	NA	1	♣ How much do you think people risk harming themselves (physically or in other ways) if they use vape products such as e-cigarettes, vape pens, or mods?	No Risk, Slight Risk, Moderate Risk, Great Risk
Prosocial peers	0.747	4	♣ Think of you four best friends (the friends you feel closest to). In the past year (12 months), how many of your best friends have: ♣ smoked cigarettes? ♣ tried beer, wine, or hard liquor(for example, vodka, whiskey, or tequila) when their parents didn't know about it? ♣ used marijuana? ♣ used LSD, cocaine, amphetamines or another illegal drugs?	0, 1, 2, 3, 4

Table 1 (continued)

Risk or Protective Factor	Reliability (α)	# of Items	Item Description(s)	Response Options
Family management	0.866	8	♣ My parents ask if I've gotten my homework done. ♣ Would your parents know if you did not come home on time? ♣ The rules in my family are clear. ♣ When I am not at home, one of my parents knows where I am and who I am with. ♣ If you drank some beer or wine or liquor (for example, vodka, whiskey, or gin) without your parents' permission, would you be caught by your parents? ♣ My family has clear rules about alcohol and drug use. ♣ If you carried a handgun without your parents' permission, would you be caught by your parents? ♣ If you skipped school would you be caught by your parents?	Definitely No, Somewhat No, Somewhat Yes, Definitely Yes
Rewards for prosocial involvement	0.905	3	♣ My neighbors notice when I am doing a good job and let me know about it. ♣ There are people in my neighborhood who are proud of me when I do something well. ♣ There are people in my neighborhood who encourage me to do my best.	Definitely No, Somewhat No, Somewhat Yes, Definitely Yes

Note. Reliability (α) = Cronbach's alpha. Coding for response options are as follows: Very Wrong = 1, Wrong = 2, A Little Bit Wrong = 3, Not Wrong at All = 4; Very hard = 1, Sort of Hard = 2, Sort of easy = 3, Very easy = 4; No Risk = 1, Slight Risk = 2, Moderate Risk = 3, Great Risk = 4; Definitely No = 1, Somewhat No = 2, Somewhat Yes = 3, Definitely Yes = 4. Scales were created by averaging item responses

ommendations from the literature (see Berglund & Heeringa 2014; Heeringa et al., 2017). The logistic regression models were then run using PROC SURVEY LOGISTIC with the 10 imputed data sets. Finally, the point and variance estimates for each logistic regression model was combined across the 10 imputed data sets using PROC MIANALYZE, producing final results for each model. The results from each of the imputed models was compared against the results of each complete case anlaysis model; this comparison indicated that differences between the two approaches were neligible. Thus, a decision was made to include the logistic regression results from the complete case anlysis in the main paper whereas results from multiply imputed logistic regressions are included in the Appendix B for reader comparison purposes.

Results

Demographics for the Sample and Population

Table 2 contains the unweighted (sample) and weighted (population) estimates for the demographic variables. The mean age of the sample was 14.00 (SD = 2.15) with slightly more females (51.4%) than males (47.7%) and smaller numbers identifying as transgender (0.4%) or other (0.6%). The majority of students in the sample identified as White (72.9%) with smaller subgroups of Latinx (12.2%) and multiracial (8.8%), which reflects the racial/ethnic demographics of the state in which the sample was drawn. Approxmimately 5% of the sample indicated using alcohol (4.6%) and cannabis (5.1%) in the past 30 days whereas the rates were highest for e-cigarrettes (8.7%).

Risk factors for Alcohol, Cannabis, and E-Cigarrettes

Results of the logistic regressions for risk factors, including odds ratios (ORs), for alcohol, cannabis, and e-cigarrette use can be found on Tables 3 and 4, and 5, respectively. The results indicated higher levels of *favorable attitudes toward substances* significantly predicted higher odds of using either alcohol, cannabis, or e-cigarrettes in the past 30-days with the highest odds for alcohol use (OR = 1.87, $p < .0001$). Similar findings were observed for *peer use of substances* with the highest odds for cannabis use (OR = 2.36, $p < .0001$). The only significant finding for *parental favorable attitudes toward substances* was observed for alcohol use (OR = 1.63, $p < .0001$). Finally, higher scores on *perceived availability of substances* predicted significantly higher odds of using all three substances in the past 30-days with the highest odds for e-cigarrette use (OR = 1.64, $p < .0001$). Overall, higher endorsement of all four risk factors, with the exception of parental favorable attitudes, predicted significantly higher odds of adolecent use of alcohol, cannabis, or e-cigarrettes in the past 30-days.

Protective factors for Alcohol, Cannabis, and E-Cigarettes

Results of the logistic regressions for protective factors, including odds ratios (ORs), for alcohol, cannabis, and e-cigarrettes can be found on Tables 3 and 4, and 5, respec-

Table 2 Sample demographics and population estimates

	Sample		Population Estimates	
Sociodemographic Factor	Mean (SE), %	n	Mean (SD), %	N
Age	14.01 (2.151)	44,242	14.49 (0.134)	183,802
Grade		44,728		201,394
6th	32.2%		26.7%	
8th	29.7%		25.4%	
10th	23.5%		24.8%	
12th	14.6%		23.1%	
Gender		44,520		200,953
Male	51.4%		51.0%	
Female	47.7%		48.5%	
Transgender	0.4%		0.2%	
Other	0.6%		0.3%	
Race/Ethnicity		44,218		199,399
White	72.9%		73.8%	
Latino/a	12.2%		17.6%	
Black/African American	1.5%		1.4%	
Asian/Asian American	1.7%		1.7%	
Native American	1.6%		1.1%	
Native Hawaiian/Pacific Islander	1.3%		1.6%	
Multiracial	8.8%		2.7%	
Past 30 Day Substance Use				
Alcohol Use	4.6%	41,744	5.5%	189,543
Cannabis Use	5.1%	41,744	6.2%	189,541
E-Cigarette Use	8.7%	41,261	9.8%	187,497
Co-Use of Substances[a]				
No Use	81.3%	36,350	87.3%	161,988
1 Substance	5.4%	2,403	6.7%	12,396
2 Substances	2.9%	1,310	3.7%	6,911
3 Substances	1.7%	775	2.3%	4,280

Note: Percentages for the sample are valid response percentage within sociodemographic factor. Population estimates were calculated using a complex samples analysis to approximate the finite population (i.e., Utah school-aged youth). [a]Percent of participants reporting the co-use of substances from none ("0") to all three ("3")

tively. The results indicated that higher levels of the *perceived risk of a substance* (i.e., alcohol, cannabis, or e-cigarettes) predicted significantly lower odds of using cannabis (OR = 0.57, $p < .0001$) or e-cigarettes (OR = 0.51, $p < .0001$), but not alcohol (OR = 0.98, $p = .72$). A similar trend was found for *interaction with prosocial peers* albiet the magnitude of the ORs were smaller for cannabis (OR = 0.83, $p < .0001$) and e-cigarettes (OR = 0.80, $p < .0001$). Higher higher levels of *family management* significantly predicted lower odds of using any of the three substances with alcohol having the lowest odds (OR = 0.71, $p < .0001$). Finally, higher levels of *prosocial rewards* significantly predicted lower odds of using alcohol (OR = 0.84, $p < .0014$) or e-cigarettes (OR = 0.89, $p < .0003$), but not cannabis (OR = 0.92, $p < .13$). In most instances, the endorsement of a protective factor was related to significantly lower odds of adolescent use of alcohol, cannabis, or e-cigarettes in the past 30-days.

Table 3 Logistic regression for past 30-day alcohol use (n = 31,591)

	B	*SE*	*95% CI*		*Exp(B)/OR*	*p*
			LL	*UL*		
Intercept	-7.274	0.475	-8.207	-6.341	0.001	< 0.001
Age	0.146	0.026	0.094	0.198	1.157	< 0.001
Gender						
Male	reference	-----	-----	-----	-----	-----
Female	-0.390	0.128	-0.641	-0.140	0.677	0.002
Transgender	0.206	0.355	-0.492	0.904	1.229	0.562
Other	-0.301	0.388	-1.063	0.461	0.740	0.438
Race/Ethnicity						
White	reference	-----	-----	-----	-----	-----
Hispanic/Latino	0.598	0.117	0.368	0.828	1.818	< 0.001
Black/Africana American	-0.209	0.359	-0.915	0.496	0.811	0.560
Asian	0.409	0.254	-0.089	0.907	1.506	0.107
American Indian/Alaskan Native	-0.996	0.383	-1.748	-0.243	0.369	0.010
Native Hawaiian/Other Pacific Islander	-0.217	0.349	-0.902	0.469	0.805	0.535
Multiracial	0.202	0.302	-0.391	0.795	1.224	0.504
Past 30-Day Substance Use						
Cannabis	0.781	0.124	0.537	1.026	2.185	< 0.001
E-Cigarette	1.223	0.125	0.976	1.469	3.396	< 0.001
Risk Factors (4)						
Favorable Attitudes	0.627	0.069	0.491	0.762	1.872	< 0.001
Peer Use	0.560	0.069	0.425	0.694	1.750	< 0.001
Parental Favorable Attitudes	0.490	0.099	0.296	0.685	1.633	< 0.001
Perceived Availability of Substances	0.311	0.066	0.181	0.440	1.364	< 0.001
Protective Factors (4)						
Perceived Risk of Alcohol Use	-0.021	0.057	-0.132	0.090	0.980	0.715
Prosocial Peers	-0.045	0.045	-0.133	0.044	0.956	0.325
Family Management	-0.347	0.069	-0.482	-0.211	0.707	< 0.001
Prosocial Rewards	-0.172	0.054	-0.278	-0.067	0.842	0.001

Note. *B* = beta value; *Exp(B)* = exponentiated beta value; *OR* = odds ratio; *SE* = standard error; 95% *CL* = 95% confidence interval; *LL* = lower limit; *UL* = upper limit; reference = reference category

Discussion

We conducted an examination of the predictive influence a specific set of risk and protective factors have on past 30-day use of alcohol, cannabis, and e-cigarettes for a school-based sample of adolescents. In general, we found that endorsment of four specific risk factors increased the odds of past 30-day use of the three substances tested whereas endorsment of the four specific protective factors decreased the odds of substance use. Findings from the present study add to the literaure by examining the predictive influence that a specific set of risk and protective factors had on the three most frequently used substances by adolescents, including e-cigarettes. In

Table 4 Logistic regression for past 30-day cannabis use (n = 31,258)

	B	*SE*	*95% CI*		*Exp(B)/OR*	*p*
			LL	*UL*		
Intercept	-5.558	0.490	-6.519	-4.596	0.004	< 0.001
Age	0.080	0.023	0.034	0.125	1.083	< 0.001
Gender						
Cisgender Male	reference	-----	-----	-----	-----	-----
Cisgender Female	-0.168	0.091	-0.348	0.011	0.845	0.066
Transgender	0.010	0.433	-0.842	0.861	1.010	0.982
Other	-0.075	0.326	-0.714	0.564	0.928	0.818
Race/Ethnicity						
White	reference	-----	-----	-----	-----	-----
Latino	0.608	0.113	0.387	0.829	1.836	< 0.001
Black	0.129	0.329	-0.517	0.775	1.138	0.695
Asian	-0.973	0.402	-1.761	-0.184	0.378	0.016
Native American	0.8502	0.648	-0.423	2.123	2.340	0.190
Native Hawaiian/Other Pacific Islander	1.116	0.329	0.471	1.762	3.054	< 0.001
Multiracial	0.542	0.243	0.064	1.020	1.719	0.026
Past 30-Day Substance Use						
Alcohol Use	0.815	0.119	0.582	1.048	2.258	< 0.001
E-Cigarette Use	1.991	0.107	1.780	2.201	7.319	< 0.001
Risk Factors (4)						
Favorable Attitudes	0.510	0.092	0.328	0.691	1.665	< 0.001
Peer Use	0.857	0.055	0.748	0.966	2.355	< 0.001
Parental Favorable Attitudes	-0.002	0.120	-0.239	0.234	0.998	0.984
Perceived Availability of Substances	0.352	0.054	0.246	0.457	1.421	< 0.001
Protective Factors (4)						
Perceived Risk of Cannabis Use	-0.567	0.049	-0.663	-0.470	0.567	< 0.001
Prosocial Peers	-0.191	0.046	-0.281	-0.102	0.826	< 0.001
Family Management	-0.142	0.069	-0.278	-0.006	0.868	0.041
Prosocial Rewards	-0.081	0.053	-0.185	0.024	0.922	0.130

Note. *B* = beta value; *Exp(B)*=exponentiated beta value; *OR*=odds ratio; *SE*=standard error; 95% *CL*=95% confidence interval; *LL*=lower limit; *UL*=upper limit; reference=reference category

addition, the findings have important implications for ways of approaching preventive interventions for alcohol, cannabis, and e-cigarette use.

The findings indicated that endorsement of all four risk factors in this study, except for parental favorable attitudes, predicted higher odds of using alcohol, cannabis, and e-cigarettes in the past 30-days, albeit the magnitude of odds ratios varied among risk factors. For example, higher odds ratios were found for peer substance use predicting alcohol, cannabis, and e-cigarette use. The findings for alcohol and cannabis use are consistent with prior research (Beyers et al., 2004), and the findings for e-cigarette use add to the emerging risk factor literature in this area (Burrow-Sánchez & Ratcliff, 2021; Kwon et al., 2018). Favorable attitudes toward substance use also predicted increased use of all three substances with the largest effect for alcohol use and small-

Table 5 Logistic regression for past 30-day E-cigarette use (n=31,518)

	B	*SE*	*95% CI*		*Exp(B)/OR*	*p*
			LL	*UL*		
Intercept	-1.925	0.364	-2.640	-1.211	0.146	<0.001
Age	0.014	0.020	-0.025	0.053	1.014	0.494
Gender						
Cisgender Male	reference	-----	-----	-----	-----	-----
Cisgender Female	-0.310	0.076	-0.459	-0.160	0.734	<0.001
Transgender	-0.403	0.386	-1.162	0.356	0.668	0.297
Other	0.109	0.258	-0.398	0.616	1.115	0.672
Race/Ethnicity						
White	reference	-----	-----	-----	-----	-----
Latino	-0.249	0.116	-0.476	-0.021	0.780	0.033
Black	0.210	0.233	-0.247	0.666	1.233	0.368
Asian	-0.944	0.280	-1.493	-0.395	0.389	<0.001
Native American	-0.513	0.367	-1.234	0.207	0.598	0.162
Native Hawaiian/Pacific Islander	-0.123	0.255	-0.623	0.377	0.884	0.628
Multiracial	0.119	0.169	-0.213	0.451	1.126	0.483
Past 30-Day Substance Use						
Alcohol Use	1.021	0.143	0.740	1.302	2.776	<0.001
Cannabis Use	1.784	0.104	1.581	1.988	5.956	<0.001
Risk Factors (4)						
Favorable Attitudes	0.198	0.069	0.063	0.333	1.219	0.004
Peer Use	0.711	0.047	0.618	0.803	2.035	<0.001
Parental Favorable Attitudes	0.090	0.091	-0.088	0.268	1.094	0.323
Perceived Availability of Substances	0.495	0.045	0.407	0.584	1.641	<0.001
Protective Factors (4)						
Perceived Risk of E-Cigarette Use	-0.676	0.058	-0.789	-0.563	0.509	<0.001
Prosocial Peers	-0.224	0.036	-0.295	-0.154	0.799	<0.001
Family Management	-0.141	0.059	-0.257	-0.025	0.869	0.018
Prosocial Rewards	-0.115	0.032	-0.177	-0.053	0.891	<0.001

Note. *B* = beta value; *Exp(B)*=exponentiated beta value; *OR*=odds ratio; *SE*=standard error; 95% *CL*=95% confidence interval; *LL*=lower limit; *UL*=upper limit; reference=reference category

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est for e-cigarette use. Interestingly, the reverse pattern was found for the perceived availability of substances (i.e., the largest effect for e-cigarette use and the smallest effect for alcohol use). Taken together, these results suggest that favorable attitudes toward substance is a stronger predictor for alcohol use whereas the perceived availability of substances is a stronger predictor for e-cigarette use. In other words, the high perceived availability of e-cigarettes (e.g., physical storefronts, internet/mail order, social media marketing) by adolescents likely contributes to their higher rates of use (Loukas et al., 2019; Miech et al., 2020). The exception to the general pattern of findings described above involved parental favorable attitudes toward substances. Endorsement of this risk factor only predicted alcohol use. In general, parental favor-

able attitudes are predictive of substance use by adolescents (Beyers et al., 2004), yet adolescent individual attitudes and peer use clearly had higher predictive effect across all three substances in this study. While parental influence is important, the influence the individual's attitudes and beliefs, their peers, and the availability of substances in the community clearly contribute more to predicting past 30-day use of alcohol, cannabis, and e-cigarettes among adolescents.

The endorsement of the four protective factors in this study predicted decreases in past 30-day use of all three substances with three exceptions. The largest odds ratios were found for the perceived risk of a substance predicting decreases in past month use of e-cigarettes and cannabis. These findings are consistent for cannabis use (Miech et al., 2017; Terry-McElrath et al., 2017) and add to the emerging literature on e-cigarettes (see Kreslake et al., 2021). Interestingly, no effect was found for perceived risk of alcohol. The differential findings for perceived risk across substances may be explained by the fact that many prior studies use an aggregate perceived risk of substances item, rather than including separate items measuring each substance. Thus, when measured separately, the perceived risk for predicting substance use may indeed vary depending on the substance (i.e., alcohol, cannabis, or e-cigarettes). Family management was the only protective factor that predicted decreases in use across all three substances with the largest effect for alcohol use. In other words, protective family management practices may buffer the use for all three substances and underscores the positive influence that families can have for their adolescents.

Implications

Findings from the current study have important implications for the prevention of the three most frequently used substances by adolescents, that is, alcohol, cannabis, and e-cigarettes. First, our study is one of the few to compare a specific set of risk and protective factors across substances, allowing for the examination of effects for each substance. The findings suggest that endorsement of all four risk factors predicted increases in all three substances with only two exceptions. In addition, endorsement of all four protective factors predicted decreases in all three substances with only three exceptions. In general, these findings suggest preventive interventions that focus on reducing risk factors and enhancing protective factors can take a broader perspective on addressing multiple substances as opposed to interventions that focus on a single substance (e.g., Kelder et al., 2020; Wyman et al., 2021).

Second, the risk factor with the highest odds of predicting use across each substance was associating with peers who also use substances. However, this risk factor may not be the most amenable to direct intervention (e.g., "Let's change your peer group."). Rather, favorable attitudes toward substances was the risk factor with the second highest odds of predicting substance use and could be a key area for prevention efforts. Specifically, prevention efforts could focus on deconstructing the positive attitude held by adolescents towards substance use. For example, preventive interventions could challenge the common reasons adolescents choose to use alcohol, cannabis, and e-cigarettes. In addition, enhancing attitudes that support non-use may help in buffering this salient risk factor. Such attitude-changing interventions have

been shown to be effective independently (see Giannotta et al., 2014; Giovazolias & Themili, 2014; Vahedi et al., 2018), supporting their inclusion in larger prevention efforts.

Third, the perceived risk of using cannabis and e-cigarettes were the most influential protective factors in this study for those substances. Given this, we suggest that preventive interventions integrate accurate information about the known risks of substances to allow adolescents to make informed decisions about substance use. In general, adolescents tend to make less risky decisions when they have more accurate information and know the risks of their decisions (see Romer et al., 2017). Moreover, research suggests that adolescents want accurate information on the physical effects of using substances (Morton et al., 2015). Taking these points together, we suggest that preventive interventions integrate ways to provide adolescents with accurate information about the risk of substances in concert with examining their attitudes toward the use of substances. Our viewpoint is that being honest with adolescents about the potential risks of using substances is an important prevention strategy and may serve to influence their attitudes toward substance use in a positive way and support alternatives to use. In addition, we suggest that providing youth with direct and accurate information on the effects of substances can be used in concert with environmental strategies such as restricting e-cigarette flavors, increasing age limits, and media campaigns. Finally, positive family management practices were the more influential protective factor for alcohol use. This finding suggests family-based interventions for adolescent alcohol use, particularly those involving positive parenting strategies, may be the most effective strategy.

Limitations and future directions

As with all studies, there are certain limitations that need to be considered within the context of the current study. First, we only tested four risk and four protective factors that are identified in the literature across alcohol, cannabis, and e-cigarettes. However, there are upwards of 30 risk and protective factors identified in the literature for adolescent substance use (e.g., Beyers et al., 2004; Cleveland et al., 2008; Hawkins et al., 1992b); thus, future studies will do well to test additional risk and protective factors and examine how they predict alcohol, cannabis, and e-cigarette use by adolescents. Second, this study is cross-sectional and limited to a single point in time. Future research can expand beyond this limitation through examination of the longitudinal effects that risk and protective factors have on the three most frequently used substances by adolescents. Finally, most adolescents in the present study identified as White with a smaller portion identifying as Latinx. Thus, future research can test the set of risk and protective factors in the current study with a more diverse group of adolescents to examine the consistency of results.

Conclusions

The purpose of the current study was to examine the influence a specific set of risk and protective factors had on past 30-day us of alcohol, cannabis, and e-cigarettes among adolescents. Notwithstanding some exceptions, the results indicated that endorsement of

the four risk factors predicted *increases* in the use of each substance whereas endorsement of the four protective factors predicted *decreases* in use. The implications of these findings suggest that adolescents engaged in preventive interventions may be best served when risk and protective factors apply to multiple substances instead of interventions that focus on individual substances. The results of the present study require replication across additional risk and protective factors and in more diverse samples of adolescents.

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Compliance with Ethical Standards

Conflict of interest All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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