



## Exposure to adverse childhood experiences and early initiation of electronic vapor product use among middle school students in Nevada



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### ABSTRACT

**Introduction:** The use of electronic vapor products (EVPs) among youth has increased significantly in recent years, yet little is known about factors associated with initiation of EVPs during early adolescence. The purpose of this study was to explore the relationship between chronic exposure to adverse childhood experiences (ACEs) and early initiation of EVPs in a representative sample of middle school students.

**Methods:** 5,464 students from 113 middle schools (grades 6–8) completed the Nevada Youth Risk Behavior Survey (YRBS) in the spring of 2017. Six abuse and household dysfunction measures were used to calculate a cumulative ACE score (range 0–6). Initiation of EVPs (e-cigarettes, e-cigars, e-pipes, vape pipes, vaping pens, e-hookahs, and hookah pens) before age 11 was considered early initiation. Weighted logistic regression was used to assess the relationship between cumulative ACE exposure and early initiation of EVPs after controlling for sex, age, race/ethnicity, rurality, free or reduced lunch status, and military family involvement.

**Results:** Nearly 1 in 5 middle school students (18.6%) reported using EVPs, 6.7% had used EVPs during the past 30 days, and 5.1% started using EVPs before age 11. After controlling for sociodemographics, a strong graded relationship between cumulative ACE exposure and early initiation of EVPs was observed: 1 ACE (AOR = 1.60; 95% CI = 0.99–2.59), 2 ACEs (AOR = 2.29; 95% CI = 1.33–3.93), and 3–6 ACEs (AOR = 3.43, 95% CI = 2.20–5.36) compared to no ACEs.

**Conclusions:** Screening for ACEs in school-based settings may be a feasible approach for identifying students who may be at-risk for early initiation of EVPs.

### 1. Introduction

Adolescent use of electronic vapor products (EVPs), including e-cigarettes, e-cigars, e-pipes, vape pipes, vaping pens, e-hookahs, and hookah pens, has increased significantly since 2011 in the United States (Gentzke et al., 2019). Following alcohol use, EVP use is currently the second most common form of youth substance use (Miech et al., 2018). Data from the National Youth Tobacco Survey (NYTS) show that from 2017 to 2018, e-cigarette use increased 78% among high school students and 48% among middle school students (Cullen et al., 2018). The recent increase in nicotine vaping translates to an additional 1.3 million adolescents who vaped in 2018 compared to 2017 (Miech, Johnston, O'Malley Patrick, Bachman, & Patrick, 2019) and has been declared a public health epidemic among youth by the Surgeon General (US DHHS, 2018).

Multiple longitudinal studies have demonstrated that e-cigarette use among adolescents is associated with combustible cigarette initiation (Barrington-Trimis et al., 2018; Leventhal et al., 2015; Soneji et al.,

2017; Wills et al., 2017). EVP use may also promote initiation of other substances such as alcohol (Curran, Burk, Pitt, & Middleman, 2018; Westling, Rusby, Crowley, & Light, 2017), marijuana (Audrain-McGovern, Stone, Barrington-Trimis, Unger, & Leventhal, 2018; Curran et al., 2018; Westling et al., 2017), and prescription drugs (Curran et al., 2018). Moreover, Rubinstein, Delucchi, Benowitz, and Ramo (2018) found significantly higher concentrations of volatile organic compound toxicants in urine secretion when compared with controls. Research on the long-term health effects of toxicants from flavorings, humectants, and nicotine when delivered as an aerosol are limited, but there is rising concern about the health impacts among youth who begin using EVPs at an early age (NASEM, 2018).

Youth who report initiating tobacco use via e-cigarettes are significantly younger than those who initiate through other combustible tobacco products (Auf et al., 2018). Research has shown that early initiation of a range of tobacco products has an important impact on tobacco use behaviors including daily use and cravings (Sharapova et al., 2018). Earlier age of onset of EVPs is also concerning because the

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adolescent brain is still developing and is highly sensitive to the addictive properties of nicotine (Glantz & Bareham, 2018; US DHHS, 2016).

Prevention programs targeting youth in late childhood and early adolescence provide greater opportunity to delay substance use (NIDA, 2016). While numerous studies have investigated factors associated with EVP use among adolescents (Perry et al., 2019), few studies have investigated factors associated with initiation of EVPs at an early age. One study using data from the NYTS found that Hispanic and non-Hispanic black youth initiated e-cigarette use at a younger age than white youth (Sharapova et al., 2018). Another longitudinal study of secondary school students found that being female, having ever used other tobacco products, and having a high e-cigarette susceptibility score predicted early initiation of e-cigarettes (Bold, Kong, Cavallo, Camenga, & Krishnan-Sarin, 2016). A third cross-sectional study with high school students found that self-regulation and behavioral impulsivity were associated with an earlier age of e-cigarette onset (Bold et al., 2017).

Despite these findings, there is a need for research exploring a wider range of risk factors associated with early initiation of EVPs, particularly among young adolescents. One underexplored risk factor is exposure to adverse childhood experiences (ACEs). ACEs are defined as childhood exposures to maltreatment and an array of household dysfunctions such as witnessing intimate partner violence and living with someone with a mental illness (Felitti, Anda, Nordenberg, & Williamson, 1998). Previous research with adults and older adolescents has demonstrated that exposure to childhood trauma is associated with tobacco use (Anda et al., 1999; Lewis et al., 2011; Mills, Alati, Strathearn, & Najman, 2014; Parks, Davis, Kinsbury, & Shlafer, 2018; Shin, Conley, Ksinan Jiskrova, & Wills, 2019) as well as early initiation of alcohol and other drug use (Chatterjee et al., 2018; Dube et al., 2003, 2006; Guarino et al., 2016; Ompad et al., 2005; Rothman, Edwards, Heeren, & Hingson, 2008). However, to our knowledge, studies have not explored the relationship between childhood trauma and early initiation of EVPs in younger samples of adolescents.

Using a population-based sample of 5464 middle school students, we explored whether cumulative ACE exposure is associated with initiation of EVPs before age 11, controlling for a range of socio-demographic characteristics including sex, age, race/ethnicity, rurality, qualification for free-reduced lunch, and living in a military family.

## 2. Methods

### 2.1. Participants and procedures

Nationally, the Youth Risk Behavior Survey (YRBS) is conducted with high school students on a bi-annual basis to monitor health risk behaviors. A few states also choose to conduct a modified middle school survey (CDC, 2018). In 2017, the Nevada Middle School YRBS was conducted in all middle schools statewide. A random cluster sampling procedure was used to select a representative sample of 6th through 8th grade students in regular public, charter, and alternative middle schools. First, we grouped all school districts into 8 regions, which align with the statewide prevention coalition structure. Next, we randomly sampled intact classes of either all second period or required English classes from each school based on the sample size required for each region. Active or passive parental permission was obtained for all students, depending on school district policy. After parental permission was obtained, the questionnaire was administered to all students in randomly selected classes (February to May 2017). Students could choose not to participate and could skip any questions they did not feel comfortable answering. Of the 120 middle schools in the state, 113 (94.2%) agreed to participate and 5464 youth completed the questionnaire resulting in an overall response rate (a combination of school and student participation) of 65.8% (Lensch et al., 2018). Data were weighted based on the sex, race/ethnicity, and grade level of students

in each region to control for any non-response at the regional level. The study was approved by the institutional review board at the University of Nevada, Reno and local school district institutional review board approval was obtained when required.

### 2.2. Measures

#### 2.2.1. ACEs

The 2017 Middle School YRBS survey included six lifetime ACE questions that were modified from the Behavioral Risk Factor Surveillance System (BRFSS) ACE module (CDC, 2019a). The lifetime ACE measures included: (1) physical abuse, (2) verbal abuse, (3) forced sex, (4) household domestic violence, (5) household mental illness, and (6) household substance abuse. All ACE measures were dichotomized as yes versus no, except verbal which was coded as “yes” if it occurred sometimes, most of the time, or always. An ACE score was developed by summing the six ACE questions (range 0–6) to represent cumulative exposure to ACEs. A small percentage of youth reported 4 or more ACEs (6.4%) so the highest ACE category used for analyses was 3 or more. This is also consistent with previous research (Clements-Nolle et al., 2018).

#### 2.2.2. EVP use

Before students completed the EVP questions, instructions indicated that EVPs include e-cigarettes, e-cigars, e-pipes, vape pipes, vaping pens, e-hookahs, and hookah pens. Examples of specific EVPs were also given for each question. Lifetime use was determined by asking students, “Have you ever used an electronic vapor product?” (yes vs. no). Early initiation of e-vapor products (the primary outcome variable) was assessed by asking the students “How old were you when you first tried an electronic vapor product?” Students who reported ever trying an e-vapor product before age 11 were categorized as “yes” and all other responses were categorized as “no” as recommended for the middle school YRBS by the Centers for Disease Control and Prevention (CDC, 2019b). Current use among those who initiated early was assessed with the following question: “During the past 30 days, on how many days did you use an electronic vapor product?” (0, 1 or 2, 3 to 5, 6 to 9, 10 to 19, 20 to 29, and all 30 days).

#### 2.2.3. Covariates

Demographic characteristics included sex, age, race/ethnicity, county of residence, receipt of free or reduced lunch, and military family. Race/ethnicity was grouped into four categories: Hispanic, non-Hispanic white, non-Hispanic black, and non-Hispanic other (American Indian/Alaska Native, Asian, and Native Hawaiian or other Pacific Islander). County of residence was coded as urban (50,000 or more people) or rural (< 50,000 people) using the Census Bureau’s classification of urban and rural counties (U.S. Census Bureau, 2018). Qualification for free or reduced lunch was used as a proxy for family income (yes vs. no). Military family involvement was assessed by asking students whether a parent or adult in the home was serving on active duty in the military (yes vs. no).

### 2.3. Statistical analysis

The weighted chi-square test was used to assess factors associated with early initiation of EVPs. Weighted logistic regression was used to evaluate the relationship between cumulative ACE exposure and early initiation of EVPs, while controlling for sex, age, race/ethnicity, county of residence, free or reduced lunch qualification, and military family. Adjusted odds ratios (AOR) and 95% confidence intervals (CI) were calculated. To account for the complex sampling design, all weighted analyses accounted for the cluster (classrooms) and stratum (region). Pairwise analyses were used to account for missing data which was assumed to be missing at random and minimal for all variables (< 4%) except early initiation of EVPs (6.2%) and military household (6.5%).

**Table 1**  
Characteristics of a representative sample of middle school students, 2017 Middle School YRBS.

Characteristics	#(%) <sup>a</sup>
	Total Sample 5464 <sup>b</sup>
<b>Sex</b>	
Female	2825 (49.09)
Male	2614 (50.91)
<b>Age</b>	
11 years old or younger	713 (16.91)
12 years old	1616 (30.31)
13 years old	1975 (34.02)
14 years old or older	1153 (18.76)
<b>Race/ethnicity</b>	
Hispanic	2162 (43.50)
Non-Hispanic black	285 (10.86)
Non-Hispanic other	831 (13.88)
Non-Hispanic white	2014 (31.76)
<b>County of residence</b>	
Rural	1785 (9.34)
Urban	3679 (90.66)
<b>Qualify for free or reduced lunch</b>	
Yes	1995 (42.86)
No	3401 (57.14)
<b>Military family</b>	
Yes	367 (7.10)
No	4739 (92.90)
<b>Physical Abuse</b>	
Yes	677 (12.85)
No	4708 (87.15)
<b>Verbal Abuse</b>	
Yes	1457 (27.25)
No	3884 (72.75)
<b>Sexual Abuse</b>	
Yes	211 (3.87)
No	5169 (96.13)
<b>Domestic Violence</b>	
Yes	787 (15.12)
No	4596 (84.88)
<b>Household Mental Illness</b>	
Yes	1049 (19.57)
No	4212 (80.43)
<b>Household Substance Use</b>	
Yes	1125 (21.13)
No	4130 (78.87)
<b>ACE Score</b>	
0 ACEs	2878 (52.59)
1 ACE	1218 (23.36)
2 ACEs	630 (11.97)
3–6 ACEs	665 (12.08)
<b>Lifetime EVP use</b>	
Yes	1020 (18.56)
No	4043 (81.44)
<b>Initiate EVP use before age 11</b>	
Yes	271 (5.05)
No	4855 (94.95)

<sup>a</sup> Weighted row percent.

<sup>b</sup> Missing data: sex (0.46%), age (0.13%), race/ethnicity (3.14%), county of residence (0%), qualify for free or reduced lunch (1.24%), military family (6.55%), physical abuse (1.44%), verbal abuse (2.25%), sexual abuse (1.54%), domestic violence (1.48%), household mental illness (3.71%), household substance use (3.82%), ACE score (1.34%), lifetime EVP use (7.34%), initiate EVP use before age 11 (6.18%).

SAS version 9.4 (SAS Institute, Cary, NC) was used for all analyses.

### 3. Results

The descriptive characteristics of the sample are presented in [Table 1](#). About half of the participants were male and 12 years or younger. Self-reported race/ethnicity included Hispanic (43.5%), non-Hispanic white (31.8%), non-Hispanic black (10.9%), and non-Hispanic other (13.9%). Rural counties accounted for 9.3% of the study sample, 42.9% qualified for free or reduced lunch, and 7.1% lived with an adult on active duty in the military. Almost one quarter of students had been exposed to two or more ACEs. Nearly, 1 in 5 middle school students (18.6%) reported ever using EVPs and 5.1% started using EVPs before age 11. Among early initiators, 40.2% reported EVP use in the past 30 days with 13.7% vaping 6 days or more (data not shown in table).

[Table 2](#) shows the unadjusted and adjusted relationship between demographics, cumulative ACE exposure, and early initiation of EVPs. In the fully adjusted model, the odds of early initiation of EVPs was elevated among Hispanic students compared to non-Hispanic white students (AOR = 1.89; 95% CI = 1.27–2.83), students residing in a rural county versus an urban county (AOR = 1.48; 95% CI = 1.02–2.14), and students living with a parent or another adult serving on active duty in the military (AOR = 1.72; 95% CI = 1.05–2.82). A graded relationship between the number of ACEs and early initiation of EVPs was also observed: 1 ACE (AOR = 1.60; 95% CI = 0.99–2.59), 2 ACEs (AOR = 2.29; 95% CI = 1.33–3.93), and 3–6 ACEs (AOR = 3.43, 95% CI = 2.20–5.36).

### 4. Discussion

In our study of middle school students, 5.1% initiated EVP use before age 11, which is typically before the transition to a secondary school. Furthermore, 40.2% of early initiators reported EVP use in the past 30 days and many could be considered regular EVP users versus experimenters ([Amato, Boyle, & Levy, 2016](#)). Understanding the factors that contribute to early initiation of EVPs is critical to guide prevention efforts. We found a strong, graded relationship between cumulative ACE exposure and early initiation. To our knowledge, this is the first study to investigate the influence of ACEs on early initiation of EVPs, but our findings are consistent with published studies focusing on older adolescents and adults investigating the relationship between ACEs and tobacco use ([Anda et al., 1999; Parks et al., 2018; Shin et al., 2019](#)).

While we were not able to ascertain the mechanism tying ACE exposure to early initiation of EVPs, other research has shown that youth with high exposure to ACEs were more likely to report that they initiated substance use to cope with problems ([Rothman et al., 2008](#)). Screening for ACEs in school may be an effective way to identify children who are at-risk for early initiation of EVPs. Our findings also suggest that EVP prevention efforts during early adolescence should be tailored for youth who are Hispanic, living in rural settings, and from military families.

#### 4.1. Limitations and strengths

Our findings should be interpreted in consideration of the following limitations. First, youth may not remember when they first used EVPs and utilizing the same self-report instrument to measure ACEs and EVP initiation may result in dependent misclassification of the exposure and outcome. Future research using records of abuse from child protective services could minimize dependent error. Second, the ACE variables assessed lifetime exposure and we do not know the frequency of abuse or household dysfunction. Furthermore, parental incarceration is a strong risk factor for tobacco use ([Anda et al., 1999; Parks et al., 2018](#)), but we did not have this ACE measure available. Third, while we were able to characterize the amount of recent EVP use among early initiators our lifetime EVP use measure did not allow us differentiate

**Table 2**  
Factors associated with early initiation of electronic vapor products among middle school students, 2017 Middle School YRBS.

Characteristics	Early Initiation EVPs (before 11 yrs)		p	Early Initiation of EVPs (before 11 yrs) AOR (95% CI) <sup>b</sup>
	Yes # (%) <sup>a</sup>	No # (%) <sup>a</sup>		
<b>Sex</b>				
Female	120 (4.52)	2529 (95.48)	0.184	0.77 (0.55–1.07)
Male	149 (5.49)	2305 (94.51)		Ref
<b>Age</b>				
11 years old or younger	40 (6.00)	616 (94.00)	0.064	1.42 (0.89–2.26)
12 years old	90 (5.95)	1418 (94.05)		1.12 (0.71–1.77)
13 years old	85 (3.75)	1778 (96.25)		0.71 (0.45–1.12)
14 years old or older	56 (5.12)	1037 (94.88)		Ref
<b>Race/ethnicity</b>				
Hispanic	127 (6.33)	1897 (93.67)	<b>0.029</b>	<b>1.89 (1.27–2.83)</b>
Non-Hispanic black	11 (3.52)	252 (96.48)		0.95 (0.41–2.22)
Non-Hispanic other	41 (4.98)	743 (95.02)		1.55 (0.99–2.43)
Non-Hispanic white	82 (3.82)	1821 (96.18)		Ref
<b>County of residence</b>				
Rural	98 (6.39)	1578 (93.61)	0.119	<b>1.48 (1.02–2.14)</b>
Urban	173 (4.91)	3277 (95.09)		Ref
<b>Qualify for free or reduced lunch</b>				
Yes	128 (5.93)	1745 (94.07)	<b>0.048</b>	1.16 (0.83–1.62)
No	142 (4.48)	3064 (95.52)		Ref
<b>Military family</b>				
Yes	27 (8.66)	312 (91.34)	<b>0.007</b>	<b>1.72 (1.05–2.82)</b>
No	216 (4.64)	4256 (95.36)		Ref
<b>ACE Score</b>				
0 ACEs	86 (3.23)	2607 (96.77)	< <b>0.0001</b>	Ref
1 ACE	70 (5.92)	1075 (94.08)		1.60 (0.99–2.59)
2 ACEs	50 (7.07)	553 (92.93)		<b>2.29 (1.33–3.93)</b>
3–6 ACEs	63 (9.47)	568 (90.53)		<b>3.43 (2.20–5.36)</b>

AOR = Adjusted Odds Ratio.

95% CI = 95% Confidence Interval.

<sup>a</sup> Weighted row percent.

<sup>b</sup> Among those with complete data for all variables N = 4,565 (83.55%).

between experimentation and regular use. It is possible that some youth initiated early, but only used one or two times. Fourth, residual confounding may be present as a number of potentially confounding variables were not measured such as parental education, parental EVP use, and child conduct problems. Fifth, the study design was cross-sectional, hindering the ability to establish temporality. Finally, this study was conducted in a western state with limited tobacco control policies (Marynak et al., 2017) and the results may not generalize to other states. Despite these limitations there are a number of study strengths, including a large representative sample of middle school students, examination of cumulative exposure to abuse and household dysfunction, and the ability to assess initiation of EVPs at a very early age.

## 5. Conclusions

We found a strong, graded relationship between cumulative ACE exposure and early initiation of EVPs. Integrating trauma-informed interventions into the educational system may promote healing and possibly prevent early initiation of EVPs.

### CRediT authorship contribution statement

**Lauren Williams:** Conceptualization, Fromal anaysis, Writing - original draft. **Kristen Clements-Nolle:** Conceptualization, Funding aquisition, Supervision, Writing - review & editing. **Taylor Lensch:** Formal analysis, Project administration, Writing - review & editing. **Wei Yang:** Funding aquisition, Methodology.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## References

- Amato, M. S., Boyle, R. G., & Levy, D. (2016). How to define e-cigarette prevalence? Finding clues in the use frequency distribution. *Tobacco Control*, 25(e1), e24–e29. <https://doi.org/10.1136/tobaccocontrol-2015-052236>.
- Anda, R. F., Croft, J. B., Felitti, V. J., Nordenberg, D., Giles, W. H., Williamson, D. F., & Giovino, G. A. (1999). Adverse childhood experiences and smoking during adolescence and adulthood. *JAMA*, 282(17), 1652–1658. <https://doi.org/10.1001/jama.282.17.1652>.
- Audrain-McGovern, J., Stone, M. D., Barrington-Trimis, J., Unger, J. B., & Leventhal, A. M. (2018). Adolescent e-cigarette, hookah, and conventional cigarette use and subsequent marijuana use. *Pediatrics*, 142(3), e20173616. <https://doi.org/10.1542/peds.2017-3616>.
- Auf, R., Trepka, M. J., Selim, M., Ben Taleb, Z., De La Rosa, M., Bastida, E., & Cano, M. A. (2018). E-cigarette use is associated with other tobacco use among US adolescents. *International Journal of Public Health*, 64(1), 125–134. <https://doi.org/10.1007/s00038-018-1166-7> 1–10.

- Barrington-Trimis, J. L., Kong, G., Leventhal, A. M., Liu, F., Mayer, M., Cruz, T. B., & McConnell, R. (2018). E-cigarette use and subsequent smoking frequency among adolescents. *Pediatrics*, 142(6), e20180486. <https://doi.org/10.1542/peds.2018-0486>.
- Bold, K. W., Kong, G., Cavallo, D. A., Camenga, D. R., & Krishnan-Sarin, S. (2016). E-cigarette susceptibility as a predictor of youth initiation of e-cigarettes. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*, 20(1), 140. <https://doi.org/10.1093/ntr/ntw393>.
- Bold, K. W., Morean, M. E., Kong, G., Simon, P., Camenga, D. R., Cavallo, D. A., & Krishnan-Sarin, S. (2017). Early age of e-cigarette use onset mediates the association between impulsivity and e-cigarette use frequency in youth. *Drug and Alcohol Dependence*, 181, 146–151. <https://doi.org/10.1016/j.drugalcdep.2017.09.025>.
- Centers for Disease Control and Prevention (2018). Adolescent and school health. Retrieved from <https://www.cdc.gov/healthyyouth/data/yrbps/overview.htm>.
- Centers for Disease Control and Prevention (2019a). About behavioral risk factor surveillance system ACE data. Retrieved from [https://www.cdc.gov/violenceprevention/acestudy/ace\\_brfs.html](https://www.cdc.gov/violenceprevention/acestudy/ace_brfs.html).
- Centers for Disease Control and Prevention (2019b). 1995–2017 Middle School Youth Risk Behavior Survey Data. Retrieved from <http://nccd.cdc.gov/youthonline/>.
- Chatterjee, D., McMorris, B., Gower, A. L., Forster, M., Borowsky, I. W., & Eisenberg, M. E. (2018). Adverse childhood experiences and early initiation of marijuana and alcohol use: The potential moderating effects of internal assets. *Substance Use & Misuse*, 53(10), 1624.
- Clements-Nolle, K., Lensch, T., Baxa, A., Gay, C., Larson, S., & Yang, W. (2018). Sexual identity, adverse childhood experiences, and suicidal behaviors. *Journal of Adolescent Health*, 62(2), 198–204. <https://doi.org/10.1016/j.jadohealth.2017.09.022>.
- Cullen, K. A., Ambrose, B. K., Gentzke, A. S., Apelberg, B. J., Jamal, A., & King, B. A. (2018). Notes from the field: Use of electronic cigarettes and any tobacco product among middle and high school students - United States, 2011–2018. *MMWR. Morbidity and Mortality Weekly Report*, 67(45), 1276–1277. <https://doi.org/10.15585/mmwr.mm6745a5>.
- Curran, K. A., Burk, T., Pitt, P. D., & Middleman, A. B. (2018). Trends and substance use associations with e-cigarette use in US adolescents. *Clinical Pediatrics*, 57(10), 1191–1198. <https://doi.org/10.1177/0009922818769405>.
- Dube, S. R., Felitti, V. J., Dong, M., Chapman, D. P., Giles, W. H., & Anda, R. F. (2003). Childhood abuse, neglect, and household dysfunction and the risk of illicit drug use: The adverse childhood experiences study. *Pediatrics*, 111(3), 564–572. <https://doi.org/10.1542/peds.111.3.564>.
- Dube, S. R., Miller, J. W., Brown, D. W., Giles, W. H., Felitti, V. J., Dong, M., & Anda, R. F. (2006). Adverse childhood experiences and the association with ever using alcohol and initiating alcohol use during adolescence. *Journal of Adolescent Health*, 38(4), 444.e1–444.e10. <https://doi.org/10.1016/j.jadohealth.2005.06.006>.
- Felitti, V. J., Anda, R. F., Nordenberg, D., & Williamson, D. F. (1998). Adverse childhood experiences and health outcomes in adults: The ACE study. *Journal of Family and Consumer Sciences*, 90(3), 31.
- Gentzke, A., Creamer, M., Cullen, K., Ambrose, B., Willis, G., Jamal, A., King, B. (2019). Tobacco Product Use Among Middle and High School Students — United States, 2011–2018. *Morbidity and Mortality Weekly Report (MMWR)*.
- Glantz, S. A., & Bareham, D. W. (2018). E-cigarettes: Use, effects on smoking, risks, and policy implications. *Annual Review of Public Health*, 39(1), 215–235. <https://doi.org/10.1146/annurev-publhealth-040617-013757>.
- Guarino, H., Mateu-Gelabert, P., Sirikantraporn, S., Ruggles, K., Syckes, C., Goodbody, E., & Friedman, S. R. (2016). The role of adverse childhood experiences in initiation of substance use and sexual behaviors among opioid-using young adults. *e79-e79 Drug and Alcohol Dependence*, 171. <https://doi.org/10.1016/j.drugalcdep.2016.08.224>.
- Lensch, T., Martin, H., Zhang, F., Parrish, B., Clements-Nolle, K., Yang, W. State of Nevada, Division of Public and Behavioral Health and the University of Nevada, Reno (2018). 2017 Nevada Middle School Youth Risk Behavior Survey (YRBS) Report.
- Leventhal, A. M., Strong, D. R., Kirkpatrick, M. G., Unger, J. B., Sussman, S., Riggs, N. R., & Audrain-McGovern, J. (2015). Association of electronic cigarette use with initiation of combustible tobacco product smoking in early adolescence. *JAMA*, 314(7), 700–707. <https://doi.org/10.1001/jama.2015.8950>.
- Lewis, T. L., Kotch, J., Wiley, T. R., Litrownik, A. J., English, D. J., Thompson, R., ... Dubowitz, H. (2011). Internalizing problems: A potential pathway from childhood maltreatment to adolescent smoking. *Journal of Adolescent Health*, 48(3), 247–252. <https://doi.org/10.1016/j.jadohealth.2010.07.004>.
- Marynak, K., Kenemer, B., King, B., Tynan, M., MacNeil, A., & Reimels, E. (2017). State laws regarding indoor public use, retail sales, and prices of electronic cigarettes - US states, Guam, Puerto Rico, and US Virgin Islands, September 30, 2017. *MMWR - Morbidity and Mortality Weekly Report*, 66(49), 1341–1346. <https://doi.org/10.15585/mmwr.mm6649a1>.
- Miech, R., Johnston, L., O'Malley Patrick, M., Bachman, J. G., & Patrick, M. E. (2019). Adolescent vaping and nicotine use in 2017–2018 — U.S. national estimates. *The New England Journal of Medicine*, 380(2), 192. <https://doi.org/10.1056/NEJMc1814130>.
- Miech, R. A., Schulenberg, J. E., Johnston, L. D., Bachman, J. G., O'Malley, P. M., & Patrick, M. E. (2018). *National Adolescent Drug Trends in 2018*. Ann Arbor, MI: Monitoring the Future.
- Mills, R., Alati, R., Strathearn, L., & Najman, J. M. (2014). Alcohol and tobacco use among maltreated and non-maltreated adolescents in a birth cohort. *Addiction*, 109(4), 672–680. <https://doi.org/10.1111/add.12447>.
- National Academies of Sciences, Engineering, and Medicine (2018). *Public health consequences of e-cigarettes*. Washington, DC: The National Academies Press.
- National Institute on Drug Abuse. (NIDA) (2016). *Principles of substance abuse prevention for early childhood: A research-based guide*. North Bethesda, Md.: National Institute on Drug Abuse.
- Ompad, D. C., Ikeda, R. M., Shah, N., Fuller, C. M., Bailey, S., & Morse, E. for The Collaborative Injection Drug Users Study II. (2005). Childhood sexual abuse and age at initiation of injection drug use. *American Journal of Public Health*, 95(4), 703–709. <https://doi.org/10.2105/AJPH.2003.019372>.
- Parks, M. J., Davis, L., Kingsbury, J. H., & Shlafer, R. J. (2018). Adverse childhood experiences and youth cigarette use in 2013 and 2016: Emerging disparities in the context of declining smoking rates. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*. <https://doi.org/10.1093/ntr/nty178>.
- Perry, C. L., Creamer, M. R., Chaffee, B. W., Unger, J. B., Sutfin, E. L., Kong, G., ... Pentz, M. A. (2019). Research on youth and young adult tobacco use, 2013–2018, from the food and drug administration-national institutes of health tobacco centers of regulatory science. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*. <https://doi.org/10.1093/ntr/ntz059>.
- Rothman, E. F., Edwards, E. M., Heeren, T., & Hingson, R. W. (2008). Adverse childhood experiences predict earlier age of drinking onset: Results from a representative US sample of current or former drinkers. *Pediatrics*, 122(2), e298–e304. <https://doi.org/10.1542/peds.2007-3412>.
- Rubinstein, M. L., Delucchi, K., Benowitz, N. L., & Ramo, D. E. (2018). Adolescent exposure to toxic volatile organic chemicals from E-cigarettes. *Pediatrics*, 141(4), e20173557. <https://doi.org/10.1542/peds.2017-3557>.
- Sharapova, S., Reyes-Guzman, C., Singh, T., Phillips, E., Marynak, K. L., & Agaku, I. (2018). Age of tobacco use initiation and association with current use and nicotine dependence among US middle and high school students, 2014–2016. *Tobacco Control*. <https://doi.org/10.1136/tobaccocontrol-2018-054593>.
- Shin, S. H., Conley, D., Ksinan Jiskrova, G., & Wills, T. A. (2019). Adverse childhood experiences and E-Cigarette use during young adulthood. *The American Journal on Addictions*, 28(4), 303–310. <https://doi.org/10.1111/ajad.12890>.
- Soneji, S., Barrington-Trimis, J. L., Wills, T. A., Leventhal, A. M., Unger, J. B., Gibson, L. A., ... Sargent, J. D. (2017). Association between initial use of e-cigarettes and subsequent cigarette smoking among adolescents and young adults: A systematic review and meta-analysis. *JAMA Pediatrics*, 171(8), 788–797. <https://doi.org/10.1001/jamapediatrics.2017.1488>.
- U.S. Census Bureau. Geography – Urban and Rural Classification. (2018). Available at <https://www.census.gov/geo/reference/urban-rural.html>.
- U.S. Department of Health and Human Services. (2016). E-Cigarette use among youth and young adults. A report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. [https://e-cigarettes.surgeongeneral.gov/documents/2016\\_SGR\\_Full\\_Report\\_non-508.pdf](https://e-cigarettes.surgeongeneral.gov/documents/2016_SGR_Full_Report_non-508.pdf).
- U.S. Department of Health and Human Services. (2018). Surgeon General's Advisory on E-Cigarette Use Among Youth. Available at <https://e-cigarettes.surgeongeneral.gov/documents/surgeon-generals-advisory-on-e-cigarette-use-among-youth-2018.pdf>.
- Westling, E., Rusby, J. C., Crowley, R., & Light, J. M. (2017). Electronic cigarette use by youth: Prevalence, correlates, and use trajectories from middle to high school. *Journal of Adolescent Health*, 60(6), 660–666. <https://doi.org/10.1016/j.jadohealth.2016.12.019>.
- Wills, T. A., Knight, R., Sargent, J. D., Gibbons, F. X., Pagano, I., & Williams, R. J. (2017). Longitudinal study of e-cigarette use and onset of cigarette smoking among high school students in Hawaii. *Tobacco Control*, 26(1), 34–39. <https://doi.org/10.1136/tobaccocontrol-2015-052705>.