The International Conference on Interdisciplinary Humanities and Communication Studies
DOI: 10.54254/2753-7048/4/2022124

Review of E-cigarette Use and Mental Health Among Young Adults in the United States

Shiqing Huang

JSerra Catholic High School, Junipero Serra Road, San Juan Capistrano, United States
emmahuang17155@gmail.com

Abstract: In recent years, e-cigarettes have become the most popular tobacco product among young adults, and the proportion of people experiencing mental health problems has risen dramatically. The purpose of this review is to summarize the previous studies that looked at the association between e-cigarette use and mental disorders among young adults in the United States. We used Google Scholar as our main database. The key search terms include electronic cigarettes, mental health, young adults, the United States, and other synonyms. We found 4,260 studies at the beginning. After removing duplicates and other irrelevant articles, 33 articles are left. After going through abstracts and titles, 9 articles are left and are included in our final review. The mental health disorders in our review included depression, anxiety, impulsivity, post-traumatic stress disorder, attention-deficit/hyperactivity disorder, and nicotine independence, and most papers showed that there was an association between e-cigarettes and mental health disorders among young adults. Among those who co-use e-cigarettes and other substances, dual users have a higher risk of developing depressive symptoms compared to those who only use e-cigarettes. There is an association between e-cigarette use as well as co-use and mental health disorders. More research should be done to understand the biological reasons behind the relationship between e-cigarette use and mental health disorders.

Keywords: E-cigarette, Mental Health Disorder, Depression, Young Adults, Co-use

1. Introduction

The electronic cigarette (E-cigarette) is a type of electronic device that transforms nicotine, and other chemical liquids (e.g. tetrahydrocannabinol) into aerosols [1]. With the rapid development of technology, e-cigarette products have increased their national-wide popularity among the younger generation [2]. From 2014 to 2018, the percentage of new e-cigarette smokers among young adults increased from 5.1% to 7.6% [2]. Some studies in 2017 also showed that young adults were the prime consumers of e-cigarette cartridges. Young adults had the highest rate of vaping (27.3%), since market advertisements targeted them and tended to promote e-cigarettes as an alternative to cigarettes [3,4].

The use of e-cigarettes, like cigarettes, can be followed by a series of health issues, including both physical and mental health issues [1,5]. Physical health problems relating to e-cigarette usage include e-cigarette or vaping use-associated lung injury (EVALI) and other respiratory diseases [1]. Up to 2020, the Centers for Disease Control and Prevention (CDC) reported 2602 cases of EVALI in America, and all patients were e-cigarette users, while 62% of them were between 18 and 34 years old [1]. Moreover, for mental health problems, e-cigarette use also triggers depression, bipolar disorder (BD),

DOI: 10.54254/2753-7048/4/2022124

and mood disorders [5]. Nicotine in e-cigarettes can lead to dysfunction in the amygdala and the nucleus accumbens of people's brains, which is one induction of depression and other mental health disorders [5,6].

Research has suggested the association between young adults' e-cigarette smoking behavior and their mental disorders is bidirectional [4,7,8]. Previous cross-sectional studies discovered a link between e-cigarette use and an increased risk of depression, and vice versa [4]. Besides, some longitudinal studies also showed the causality of mental disorders due to e-cigarette use [7,8]. Increasing the frequency of using only e-cigarettes appears to predispose depression in university students, after adjusting for the types of e-cigarettes [7]. On the other hand, anxiety and depression can also drive an individual to use an e-cigarette, since they may have less self-control or see e-cigarettes as a treatment for their symptoms [8].

In contrast to infrequent smokers, long-term dual users of e-cigarettes and multiple tobacco products (MTP) are more likely to experience depressive symptoms than only e-cigarette users [7]. Moreover, young adults have a propensity to consume e-cigarettes and other addictive substances if they suffer from mental disorders [9]. For instance, the dual use of e-cigarettes and alcohol appears to coexist among college students who have a psychiatric disorder [9].

Based on the previous literature, there is sufficient research to support the binary direction between e-cigarettes and mental health concerns among adults and minors. However, we found that we still need to further summarize findings with risk factors for young adults (generally 18-25 years old) in the United States. Little was known about the association between the co-use of e-cigarettes and other substances among this population. We aimed to make a further assessment of the prior and current evidence about the relationship between e-cigarettes and mental health, specifically among American young adults.

2. Method

This review follows the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (See Figure 1).

2.1. Literature Search

The academic search engine used was Google Scholar. Search terms included: e-cigarettes, mental health, young people, United States, and other synonyms for these terms. All search results were limited to English and published from June 2018 to June 2022.

2.2. Study Selection

We found a total of 4,260 studies through our initial searching. We excluded 4,227 articles from our manual review because they contained unrelated or insignificant information to our topic. We then compared the rest to our inclusion and exclusion criteria and excluded another 24 articles. In the end, a total of 9 papers had the exact information we needed for the research keywords, so we considered including them in our results (See Table 2).

DOI: 10.54254/2753-7048/4/2022124

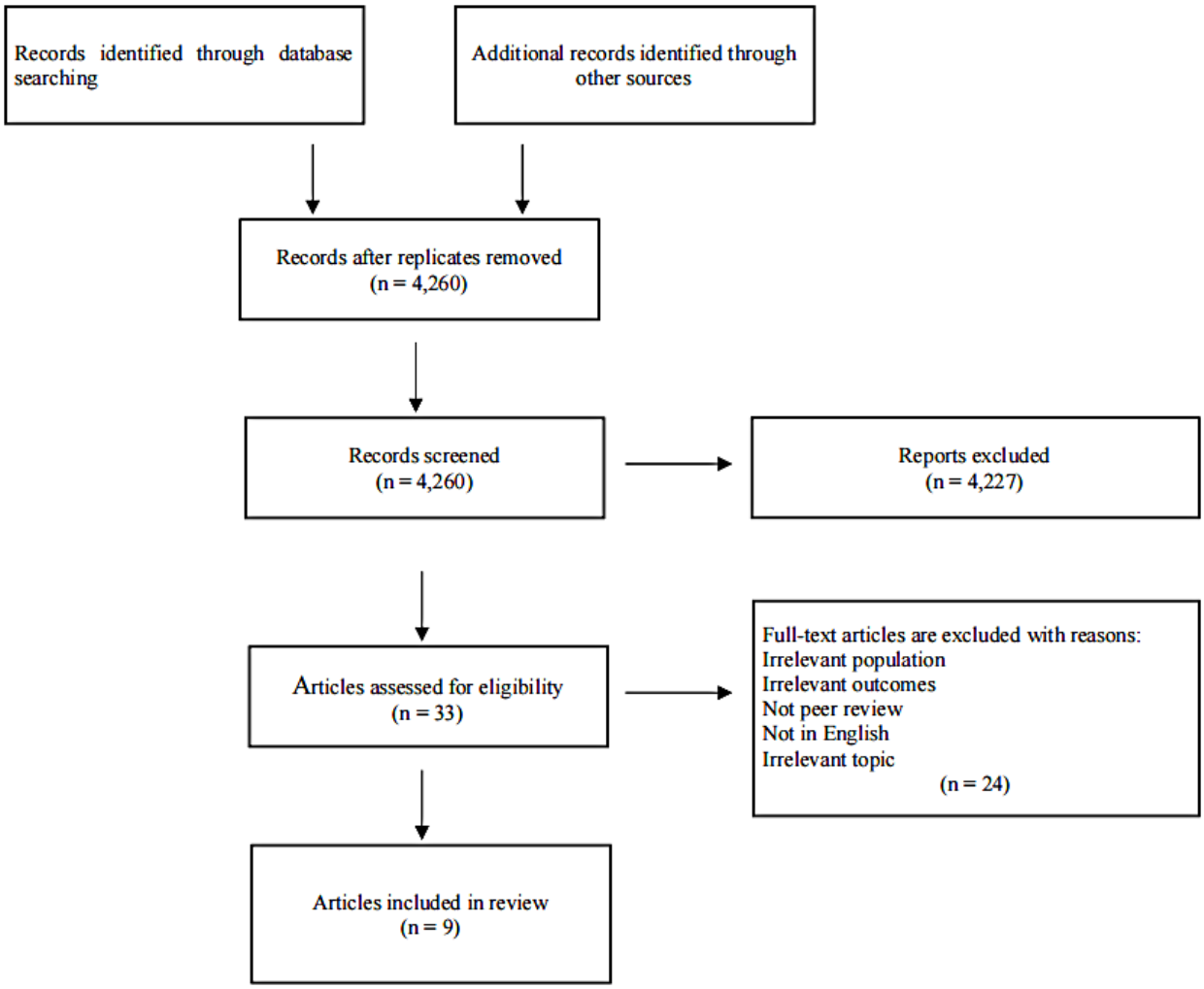

Figure 1: This caption has one line so it is centered.

Table 1: Inclusion and Exclusion Criteria.

Inclusion Criteria	Exclusion Criteria
Included population of young adults in the U.S	Had a small sample size that was not large enough to draw an association or a causality (n < 2000)
Published in English	Books or letters
Contained the association between e-cigarettes and mental health in the study	Did not include the mental health in the primary outcomes
Published dates between January 2017 to June 2022	Did not peer-review

DOI: 10.54254/2753-7048/4/2022124

2.3. Data Items

The general definition of a current e-cigarette smoker is having vaping behavior in the past 1 month [10]. This review focused on depression, anxiety, and impulsivity as mental health disorders [11].

2.4. Risk of Bias Across Studies

Since almost all of the studies (n=8 studies) used a self-reported measurement to examine the mental health condition of the subjects, it can lead to social desirability bias. However, at the same time, studies that used a self-reported scale were also guaranteed to keep the answer anonymous and not share any information with the public.

3. Results

3.1. Study Characteristics

Of the total of 9 articles, 5 of them were designed as national-wide research in the United States; the remaining 4 included Texas (n=2 studies), Hawaii (n=1 study), and midwestern states (n=1 study). Most of the studies are cross-sectional (n = 6 studies), and only 3 papers were longitudinal studies. The included population can be divided into three categories: specifically college students (n=6 studies), young adults regardless of education degree (n=1 study), and adults including the young adult group (n=6 studies). 4 studies defined young adults as 18 to 25 years old, 1 study defined young adults as 18 to 29 years old, 3 studies focused on all adults over 18 years old but included young adults as a part of the population, and 1 study did not mention. All of the studies were self-reported surveys, including telephone interviews and online questionnaires through email.

Most of the surveys were conducted from 2014 to 2020 (n=8 studies), while the remaining one was conducted in 2013. All of the longitudinal studies were conducted between 2014 and 2017. Response rates varied and were unstable in different studies, from 22.9% to 81.0%. All studies had a large sample size that at least included 2,000 participants.

All of the studies adopted self-reported measures of e-cigarette usage. The majority of papers (n=7 studies) showed the co-use of e-cigarettes and other substances, such as alcohol, cannabis, and tobacco products. Co-use of e-cigarettes and combustible cigarettes was most frequently mentioned in papers (n=7 studies).

The outcomes of mental health conditions were quantified for various types of mental disorders, and the most representative ones were depression (n=9 studies), anxiety (n=4 studies), impulsivity (n=2 studies), post-traumatic stress disorder (PTSD) (n=1 study), attention-deficit/hyperactivity disorder (ADHD) and nicotine independence (n=1 study). All of the studies used self-reported mental health measurements, including the self-reported scale (n=7 studies) and doctor's diagnosis (n=3 studies). Three papers were measured by the Center of Epidemiologic Studies for Depression Scale (CSD-10) and three papers were measured by the Patient Health Questionnaire (PHQ-9). The measurement of anxiety included the Generalized Anxiety Disorder scale (GAD) (n=3 studies) and Cohen's 10-item Perceived Stress Scale (n=1 study) to test if the subject had an anxiety disorder.

3.2. Accessing the Association Between E-cigarette and Mental Disorders

Among cross-sectional studies, five studies showed that increasing the frequency of e-cigarettes was positively associated with the exacerbation of mental disorders (all p-values <0.05). On the other hand, two studies, including one national-wide study and one state-level study in Hawaii, identified that participants with depression were more likely to use e-cigarettes (AOR:2.10, 95% CI:1.98-2.23;

DOI: 10.54254/2753-7048/4/2022124

AOR:1.34, 95% CI:1.14-1.56). Furthermore, one national-wide study observed a bidirectional association between e-cigarette use and mental illness among young adults between 18 and 24 years old.

In three papers among longitudinal studies, two papers found that depressive symptoms can lead to e-cigarette use (β=0.74-0.81, $p<0.01$; AOR:1.03; 95% CI:1.02-1.04). However, one of these studies shows that e-cigarette use cannot predict subsequent depressive symptom development among college students. Besides, another national-wide study followed college participants for two years and observed no predictive relationship between psychological symptoms and e-cigarette use (depression: AOR:0.97; 95% CI:0.92-1.03, p=0.349; anxiety:AOR:1.02; 95% CI: 0.99-1.05, p=0.218).

In the situation of co-use, e-cigarette users are more likely to consume addictive substances in the future. Moreover, a study showed that dual users of e-cigarettes and other addictive substances have an even higher risk of developing depressive symptoms compared to sole e-cigarette users (AOR:1.42; 95% CI:1.11-1.81; AOR=1.56; 95% CI:1.20-2.02). A longitudinal study of frequent dual users found an association between combined substance use and more severe depressive symptoms than only e-cigarette use (95% CI:1.01-1.02, $p<0.001$). Similar to depression, anxiety occurred at a more severe and persistent stage among current co-users and poly-users of MTP and e-cigarettes (AOR:1.37; 95% CI:1.04-1.79).

4. Discussion

In nine existing studies, the authors evaluated the association between e-cigarette use and mental disorders among young adults in the United States. This review summarized the previous findings about the relationship between e-cigarettes and young adults' mental health, as well as facilitated regulations to increase the younger generation's awareness of the negative impact of e-cigarettes.

4.1. Main Findings

Young adults' e-cigarette use was positively associated with their depression, anxiety, PTSD, ADHD, impulsivity, and nicotine independence, and vice versa. These findings were consistent with prior evidence regarding e-cigarettes and mental health disorders. According to previous studies in this area among teenagers, vaping can lead to nicotine independence and other emotional disorders such as depression and suicidal ideation [12]. Besides, prior studies have mentioned that subjects with poor mental health make up a large proportion of current e-cigarette users [13]. This two-way association may reflect how the different sample populations and study aims modify the direction of the result. Since half of the cross-sectional studies were national level and the other half were state level, geographic location may be a confounding variable in our topic. Furthermore, different papers had different research objectives and study designs, resulting in different study results and conclusions.

In three longitudinal studies, we observed contradictory findings. The first paper by Frank Bandiera et al. found that depressive symptoms can lead to future e-cigarette use, but e-cigarette use cannot lead to depressive symptoms. These conflicts could be explained by two hypotheses. First, Bandiera's team conducted the sampling studies among college students, who often experienced higher emotional stress and tended to seek e-cigarettes as a solution [14]. Second, young adults may use e-cigarettes to replace combustible cigarettes, and they were also more vulnerable to new advertisements in the tobacco market [4,14]. Interestingly, the second paper by Jennifer Bierhoff et al. concluded that psychological disorders could not predict e-cigarette use, which was inconsistent with most previous studies. For a relatively small sample size of only 82 e-cigarette smokers in this research, the variability of the results might increase, leading to divergent findings from other papers [15]. The third paper by David Marsden et al. highlighted the association between using refillable e-cigarettes and depression. Marsden's team also refined the previous finding by separating the disposable e-cigarettes and the refillable e-cigarettes in the research, which have similar observations [7]. Moreover,

DOI: 10.54254/2753-7048/4/2022124

Marsden also supported that co-use of e-cigarettes and other addictive products can lead to severer mental health concerns, and this can be explained by the higher amount of nicotine the co-users ingest [7].

4.2. Risk Factors

In a cross-sectional study by Baksun Sung, gender was examined and found not to be a risk factor for e-cigarette use and depression [3]. However, there was still room for discussion on whether gender would affect the results. For instance, a previous cross-sectional study identified that 23.6% of the male adults self-reported their depression symptoms, while only 13.0% of the female adults reported the same, indicating that gender may be associated with a depression diagnosis [13].

Moreover, the subject's household income may also be a risk factor. One cross-sectional study in our results showed that people who have an annual household income of less than $60,000 made up 42.9% of the e-cigarette smokers [11]. Moreover, a prior study found that adults with an annual household income of less than $100,000 in the United States were more likely to become e-cigarette users [16].

4.3. Limitation of Evidence

The three longitudinal studies took less than half the proportion of all studies, and they observed different outcomes that are contrary to each other. Moreover, all cross-sectional studies supported the hypothesis that e-cigarette usage is associated with mental health disorders. However, given the cross-sectional risks, the questions about the causality between vaping and mental disorder development are still unaddressed. Further longitudinal studies remain necessary.

Although all of the studies highlight the randomness of sampling during the survey process, most of their samples were based on college students, increasing the risk of sampling bias. Considering some participants may not always respond with the truth, even in an anonymous survey, the self-reported way of collecting participants' data can also result in response bias. Furthermore, some studies did not make the response rate public, so we cannot measure the effectiveness of the survey. Some studies also included relatively small sample spaces for e-cigarette users.

4.4. Limitation of the Review

Our review was based only on previous English studies, so we might have missed some relevant studies in other languages. However, our main focus population is focused in the United States, where the most commonly used national language is English. Furthermore, we only included 9 papers in our review, resulting in the possibility of the data not being representative. However, very little research has been conducted because the relationship between e-cigarettes and mental health is a new topic.

4.5. Strength of the Review

This review is unique because it is the first literature review that focused on young adults' mental health problems related to e-cigarettes. Young adults, especially considering they have just come of age, usually need more transition periods because they are more likely to have mental health disorders as well as try new emerging tobacco products (i.e., e-cigarettes). We included studies on mental health and vaping to get a broad perspective on this issue.

DOI: 10.54254/2753-7048/4/2022124

5. Conclusion

This review finds that mental health disorders are related to e-cigarette use, and this association is binary. Co-use of e-cigarettes and other substances is more likely to develop mental health problems. The subject's gender can be a risk factor in the studies because males may have a higher rate of depression than females. The subject's income level can also become a risk factor for their choices of e-cigarette use. More studies need to be done to understand the biological mechanism between vaping and mental health disorders.

References

[1] *King, Brian A., et al. "The EVALI and youth vaping epidemics—implications for public health." New England Journal of Medicine 382.8 (2020): 689-691.*

[2] *Dai, Hongying, and Adam M. Leventhal. "Prevalence of e-cigarette use among adults in the United States, 2014-2018." Jama 322.18 (2019): 1824-1827.*

[3] *Sung, Baksun. "Gender Difference in the Association Between E-Cigarette Use and Depression among US Adults." Osong public health and research perspectives 12.1 (2021): 13.*

[4] *Obisesan, Olufunmilayo H., et al. "Association between e-cigarette use and depression in the behavioral risk factor surveillance system, 2016-2017." JAMA network open 2.12 (2019): e1916800-e1916800.*

[5] *Drevets, Wayne C., Joseph L. Price, and Maura L. Furey. "Brain structural and functional abnormalities in mood disorders: implications for neurocircuitry models of depression." Brain structure and function 213.1 (2008): 93-118.*

[6] *Herman, Melissa, and Robert Tarran. "E-cigarettes, nicotine, the lung and the brain: multi-level cascading pathophysiology." The Journal of physiology 598.22 (2020): 5063-5071.*

[7] *Marsden, David G., et al. "Associations between frequency of cigarette and alternative tobacco product use and depressive symptoms: A longitudinal study of young adults." Addictive behaviors 99 (2019): 106078.*

[8] *Riehm, Kira E., et al. "Mental health problems and initiation of e-cigarette and combustible cigarette use." Pediatrics 144.1 (2019).*

[9] *Hefner, Kathryn R., et al. "E-cigarettes, alcohol use, and mental health: Use and perceptions of e-cigarettes among college students, by alcohol use and mental health status." Addictive behaviors 91 (2019): 12-20.*

[10] *King, Jessica L., et al. "Tobacco product use and mental health status among young adults." Addictive behaviors 77 (2018): 67-72.*

[11] *Masaki, Kelly, et al. "Relationships Between Depressive Symptoms, Anxiety, Impulsivity and Cigarette and E-cigarette Use Among Young Adults." Hawai'i Journal of Health & Social Welfare 81.3 (2022): 51.*

[12] *Livingston, Jennifer A., et al. "Physical and mental health outcomes associated with adolescent E-cigarette use." Journal of Pediatric Nursing 64 (2022): 1-17.*

[13] *Saeed, Omar B., Bhakti Chavan, and Zelalem T. Haile. "Association between e-cigarette use and depression in US adults." Journal of Addiction Medicine 14.5 (2020): 393-400.*

[14] *Bandiera, Frank C., et al. "Depressive symptoms predict current e-cigarette use among college students in Texas." Nicotine & Tobacco Research 19.9 (2017): 1102-1106.*

[15] *Bierhoff, Jennifer, et al. "Psychological risk factors for alcohol, cannabis, and various tobacco use among young adults: a longitudinal analysis." Substance use & misuse 54.8 (2019): 1365-1375.*

[16] *Patel, Deesha, et al. "Reasons for current E-cigarette use among US adults." Preventive medicine 93 (2016): 14-20.*

DOI: 10.54254/2753-7048/4/2022124

Appendix

Study	Study level	Study Design	Response Rate	Survey time	Sample size (n)	Assessment of e-cigarette smoker	Assessment of Co-use	Assessment and the cut off value of mental health		
								Depression	Anxiety	Other mental illness
Baksun Sung. 2021.	National	CS	land-line: 45.3%. cell phone: 44.5%.	2017	174,351	current smoker / formal smoker / never smoked	-	Assessment - doctor diagnosis. Cut off - answer yes to been diagnosed by depression.	-	-
Olufunmilayo H. Obisesan; et, al. 2019	National	CS	-	2016~2017	892,394	everyday smoker / some days smokers / former smokers / non smokers	-	Assessment - diagnosis & self-report. Cut off - answer yes to been diagnosed by depression & report at least 1 day of poor mental health per month	-	-
Jon E. Grant; et, al. 2019.	State (Midwest)	CS	38.7%.	2016	3572	use e-cigarette in past 12 month / use e-cigarette more than 12 month ago / never use e-cigarette	Alcohol: Assessment - AUDIT. Cut off - score ≥8 Drug: Assessment - self-report. Cut off - report past drug using except e-cigarette	Assessment - self-report PHQ-9 scale. Cut off - score ≥ 5	Assessment - self-report GAD-7 scale. Cut off - score ≥ 10	PTSD: Assessment - self-report PC-PTSD scale. Cut off - score ≥ 3 Impulsivity: Assessment - self-report Rosenberg Self-Esteem Scale. Cut off - score < 15
Kelly Masaki; et, al. 2022.	State (Hawaii)	CS	60.0%	2018~2020	2622	no use / cigarette-only use / e-cigarette-only use / dual use	Cigarette: Assessment - self-report. Cut off - report past cigarette using except e-cigarette	Assessment - self-report CES-D scale. Cut off - score ≥ 16	Assessment - self-report GAD-7 scale. Cut off - score ≥ 10	Impulsivity: Assessment - self-report Kendall Wilcox Impulsivity Scale. Cut off - score ≥ 10
Sam N. Cwalina; et, al. 2021.	National	CS	-	2019	2348	exclusive e-cigarette smoker / dual tobacco product smokers / poly tobacco product smokers	Tobacco product (e.g. cigarettes, water pipe, cigarillos): Assessment - self-report. Cut off - report past other tobacco product except e-cigarette using in past 30 days	Assessment - self-report PHQ-9 scale. Cut off - score ≥ 10	Assessment - self-report GAD-7 scale. Cut off - score ≥ 10	-

Jessica L King; et al. 2018.	State (North Carolina & Virginia)	CS	-	2013	2370	past 30 days tobacco use / non-tobacco use	Tobacco product (e.g. cigarettes, water pipe, cigarillos): Assessment - self-report. Cut off - report past other tobacco product using except e-cigarette in past 30 days	Assessment - diagnosis & self-report Center for Epidemiological Studies Depression Iowa Short Scale. Cut off - answer yes to been diagnosed by depression	Assessment - diagnosis & self-report Cohen's 10 item Perceived Stress Scale. Cut off - answer yes to been diagnosed by stress disorder.	Bad mental health condition: Assessment - doctor diagnosis. Cut off - answer yes to been diagnosed by mental illness
Frank C. Bandiera; et al. 2017.	State (Texas)	LS	79%	2014-2015	5445	past 30 days e-cigarette use / non e-cigarette use	Tobacco product (e.g. cigarettes, smokeless or snus tobacco, cigarillos): Assessment - self-report. Cut off - report past other tobacco product using except e-cigarette in past 30 days	Assessment - self-report CES-D 10 scale. Cut off - score ≥ 10	-	-
Jennifer Bierhoff; et al. 2019.	National	LS	22.9%	2014~2016	2397	past 30-days substance use / non-substance use	Substance (e.g. alcohol, cannabis, cigarettes): Assessment - self-report. Cut off - report past substance using except e-cigarette in past 30 days	Assessment - self-report PHQ-9 scale. Cut off - 0~4 is no or minimal symptomatology, / 5~9 mild / 10~14 moderate / 15~19 moderately severe / 20~27 severe	-	Nicotine dependence: Assessment - self-report Hooked-on Nicotine Checklist. Cut off - each waves ADHD: Assessment - Adult ADHD Self-Report Scale. Cut off - each waves
David G. Marsden; et al. 2019.	State (Texas)	LS	78~81%	2014~2017	5236	5 days of tobacco use in past 30 days / 15 days of tobacco use in past 30 days / no tobacco use	Tobacco product (e.g. cigarettes, hookah, cigarillos): Assessment - self-report. Cut off - report past other tobacco product using except e-cigarette in past 30 days	Assessment - CES-D-10 measure. Cut off - each waves	-	-

Note: CS, cross-sectional study; LS, longitudinal study; AUDIT, Alcohol Use Disorders Identification Test; PHQ, Patient Health Questionnaire; PTSD, Post-Traumatic Stress Disorder; GAD, Generalized Anxiety Disorder scale; CES-D, Center for Epidemiologic Studies-Depression; ADHD, Attention-Deficit/Hyperactivity Disorder