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Review

Bidirectional Association Between E-Cigarette Use and Depression: A Meta-Analysis

Shiya Ji, MPH[1,†], Lu Chen, MMedSci[2,†], Susu Zhuang, MPH[1], Liwen Wei, Bsc[1], Lili Gou, MPH[1], Cheng Shi, MPH[1], Hanrui Jia, MPH[1], Xupeng Chen, MPH[1]

[1]Department of Health Education, Nanjing Municipal Center for Disease Control and Prevention, Nanjing, China
[2]Clinical Medical College, Yangzhou University, Yangzhou, China

Corresponding Author: Xupeng Chen, MPH, *Department of Health Education, Nanjing Municipal Center for Disease Control and Prevention, No. 16 Kunlun Road, Nanjing, Jiangsu 210003, China. Telephone: 86-13815850307; E-mail: 434543430@qq.com*

[†]These authors have contributed equally to this work.

Abstract

Introduction: Previous studies have indicated a potential bidirectional association between the use of e-cigarettes (ECs) and depression. However, this hypothesis has not yet been thoroughly investigated. In this meta-analysis, the two-way relationship is examined.
Aims and Methods: As of November 2024, major electronic databases were searched. Two sets of pooled risk estimates were computed by employing random effects models: one for EC use predicting depression and the other for depression predicting EC use. The forms of depressive presentation included in this study are major depressive disorder, dysthymia, and general depressive symptoms. The results were presented in terms of adjusted odds ratios (ORs) along with 95% confidence intervals (CIs).
Results: We identified a total of 1601 references and included 27 studies involving 1 671 773 participants. Both current EC use (OR: 1.96, 95% CI: 1.73 to 2.23) and ever EC use (OR: 1.88, 95% CI: 1.59 to 2.21) could notably forecast depression. Pooled results also indicated that depression might significantly predict current EC use (OR: 1.36, 95% CI: 1.15 to 1.61) and ever EC use (OR: 1.53, 95% CI: 1.25 to 1.88).
Conclusions: EC use may be a significant predictor of depression, and depression may be a significant predictor of EC use. This highlights the need for stronger mental health warnings on e-cigarettes and the integration of EC use screening into depression assessments.
Implications: Considering the bidirectional link between EC use and depression, clinical screening, public health interventions, and stricter marketing regulation are crucial to mitigate risks. Future research should focus on the mechanisms and causal pathways of e-cigarettes and depression.

Introduction

Electronic cigarettes (e-cigarettes or ECs) are battery-driven devices that heat a chemical liquid containing nicotine until it vaporizes, generating an aerosol.[1] Invented in China in 2003,[2] e-cigarettes were initially introduced into the United States in 2007 with the aim of helping patients quit smoking.[3] Over the last decade, the use of e-cigarettes has increased significantly worldwide, especially among younger people.[4] It is estimated that around 68 million people worldwide were e-cigarette users in 2020.[5] In the United States, 5.1% of adult population reported current e-cigarette use,[6] while the prevalence among youth and young adults ranged from 12.2% to 19.0% in 2020.[7]

Evidence indicates that e-cigarettes can lead to poisoning, lung injury, injuries related to device malfunctions, and other serious adverse events including e-cigarette or vaping product use-associated lung injury, cardiovascular disease, and seizures.[8] However, the mental health effects of e-cigarettes, including internalizing disorders, externalizing disorders, and transdiagnostic concepts, remain largely unexplored.[9] Available research suggests that e-cigarettes are related to mental health problems similar to those observed with combustible cigarettes (CCs), such as depression, anxiety, and suicidal behaviors.[10]

Depression is a prevalent and manageable mental disorder marked by alterations in mood, as well as cognitive and physical symptoms.[11] As of 2020, depression ranks as the second leading contributor to global disease burden and disability, with projections indicating that it will become the largest by 2030.[12] The DSM-5-TR (American Psychiatric Association, 2022) classifies depressive disorders into several major diagnostic categories: major depressive disorder (MDD), persistent depressive disorder (PDD), disruptive mood dysregulation disorder, premenstrual dysphoric disorder, substance or medication-induced depressive disorder, as well as other specified and unspecified depressive disorders.[13]

The World Health Organization has described the association between tobacco product use and mental health issues "a double burden on health".[14] Research indicating a higher risk of depression among e-cigarette users compared to non-users were reported, while some demonstrated no such relationship.[9,15] Studies have also established that individuals with mental health disorders, including depression, are more inclined to be susceptible to e-cigarette use and initiation.[16,17]

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Network theory posits that mental health conditions are interconnected through diverse biological, psychological, and societal mechanisms.[18] One potential neurobiological mechanism involves reward processing.[19] Individuals with depression may engage in substance use including nicotine as a form of self-medication or to seek pleasurable reinforcement.[19,20] Furthermore, substance use may contribute to MDD via neurophysiological and metabolic changes.[19] Given the addictive properties of nicotine in e-cigarettes, as well as prior evidence linking EC use to depression, we hypothesize a bidirectional relationship between these variables.

Prior research has predominantly employed individual cross-sectional or longitudinal designs examining specific populations (eg, those with mental health conditions or substance use behaviors). Notably, no existing meta-analysis has systematically examined the unidirectional relationship between EC use and depression. This study aims to perform the first meta-analysis synthesizing bidirectional evidence to address critical gaps in regarding the EC-depression relationship. We specifically focus on the associations between EC use and three forms of depressive presentation (depressive phenotypes): MDD, dysthymia (a specifier of PDD), and general depressive symptoms assessed using validated instruments. Existing studies exhibit mixed findings across multiple domains: geographic regions, population characteristics (adults, young adults, or adolescents), depression assessment methodologies (clinically diagnosed, validated scales or questions), and EC use patterns (exclusive versus dual use with CCs). Considerable variability also exists in their adjustment for key confounders including socioeconomic status (SES), other substance uses, and baseline health status.

Given the unresolved bidirectional EC-association relationship, our meta-analysis advances current knowledge by simultaneously evaluating two fundamental questions: whether e-cigarette use predicts depression and whether depression predicts e-cigarette use. Furthermore, we elucidate how these relationships may vary across diverse subgroups.

Methods

This report was developed following the guidelines set by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). The protocol has been registered on the website of the prospective register of systematic reviews (PROSPERO), with a registration number of CRD42024601119.

Inclusion and Exclusion Criteria

To be included in the analysis, studies needed to satisfy these criteria: (1) the study designs included cohort, case–control, cross-sectional, or longitudinal studies; (2) reported an association between e-cigarette use and depression, encompassing both depressive disorders (MDD and dysthymia) and general depressive symptoms, as defined by the original studies; (3) the association was quantified by adjusted odds ratios (ORs) and their 95% confidence intervals (CIs); (4) depression was analyzed as a dichotomous or nominal variable; and (5) published in the English language. The following exclusion criteria were applied: (1) duplicate publications; (2) randomized controlled trials, reviews, abstracts, case studies, in vitro studies, and animal research; and (3) depression was analyzed as a continuous variable. Studies analyzing depression as a continuous variable were excluded to ensure consistency in effect size metrics (eg, ORs) and comparability across studies, as continuous outcomes require different analytical approaches (eg, regression coefficients) that are not directly comparable to dichotomous outcomes.

Search Strategy

Two researchers conducted separate searches of multiple databases, such as PubMed, Embase, Web of Science, Cochrane library, and PsyINFO databases. The search covered publications released until November 8, 2024. The search strategy included terms such as "Depression," "Depressive Symptoms," "Electronic Cigarettes," and "E-cigarettes." The comprehensive search strategy can be found in Table S1. Moreover, the references of all included studies were searched for and retrieved. Disputes over the inclusion of full-text articles were settled through arbitration or consultation with a third reviewer.

Data Extraction

Data extraction was carried out to obtain the following information: (1) name of the primary author; (2) the publication year; (3) the study area; (4) the study design; (5) age group; (6) the age range; (7) the sample size; (8) exposure to e-cigarettes; (9) the depression assessment method and cutoff score; (10) the statistical analysis method; and (11) the ORs and their 95% CIs. Exposure to e-cigarettes was classified as follows: (1) current (at least once in the past 30 days) or ever (at least once during a lifetime) use of e-cigarettes; (2) EC use only or dual use along with CCs. Depression in our study encompassed depressive disorders including MDD and dysthymia, as well as general depressive symptoms. Depressive disorders were characterized as formally diagnosed conditions based on established clinical criteria. Depressive symptoms were comprised of self-reported data collected through validated scales such as the Patient Health Questionnaire (PHQ), Center for Epidemiologic Studies Depression Scale (CES-D), Hopkins Symptom Checklist (HSC), and Depression Anxiety Stress Scales (DASS), as defined by the original studies. To counteract the confounding effects of other factors such as age, sex, and race, only adjusted ORs were extracted. Two reviewers independently extracted the data, and all discrepancies were resolved together by the team.

Quality Assessment

The quality of observational studies was assessed using an 11-item tool recommended by the Agency for Healthcare Research and Quality (AHRQ).[21] The total score was measured on a scale from 0 to 11. Scores ranging from 0 to 3 were classified as low quality, those between 4 and 7 as moderate quality, and scores of 8 or above as high quality.

Statistical Analysis

Given the potential heterogeneity across all included studies, we used a random effects model to obtain a pooled OR. Two distinct analyses were performed independently: one for EC use predicting depression, and the other for depression predicting EC use. The ORs and 95% CIs were used as the common measure. The Cochran Q test and I^2 indices were used to evaluate the heterogeneity among the included studies. Subgroup analyses were conducted to examine potential variability based on age group, study area, and EC use patterns, including exclusive EC use or dual use with CCs.

We also performed sensitivity analyses to test robustness and identify potential sources of heterogeneity. Publication bias was assessed using Begg's test. All statistical analyses were performed using STATA 17.0. A significance threshold of $p \leq .05$ was established prior to the analysis.

Results

Literature Search Results

Of the 1601 references identified, 1598 were sourced from electronic databases through November 2024, and three were retrieved from the reference lists of the included studies. Using the EndNote reference manager, 651 duplicates were excluded. By reading titles and abstracts, 686 ineligible studies were also excluded. Accordingly, 264 references were retrieved for further evaluation. Finally, 27 references were retained for meta-analysis (Figure 1), which included 25 cross-sectional studies and two longitudinal studies encompassing a total of 1 671 773 participants. The two studies had a longitudinal design, but the data used for analysis were cross-sectional. A total of 16 studies[22-37] were about EC use predicting depression and 11 studies[7,38-47] were about depression predicting EC use. The original studies assessed depression using validated scales, including PHQ, CES-D, HSC, and DASS. Alternatively, some studies employed questions such as "Have you ever felt too sad or desperate to have a daily life for two weeks straight during the past 12 months?" or "Has a doctor, nurse, or other health care provider ever told you that you have or had depression?". The depression assessment methods used in each study are summarized in Tables S2 and S3. The adjusted confounding factors varied across studies, where most accounted for age, sex, and race or ethnicity, whereas fewer controlled for BMI, SES (education and income), or other substance uses (alcohol and/or cannabis). The number of studies shown in the forest plots exceeded the total number of included studies. This discrepancy arose because some studies reported only subgroup results for both exclusive EC use and dual use of ECs and CCs, current and ever use of ECs, and different age groups. Among them, each subgroup was analyzed as a separate study.

Study Characteristics and Quality Assessment

The summary characteristics of the included studies are outlined in Table S2 (EC use predicting depression) and Table S3 (depression predicting EC use). The total number of participants in these studies amounted to 1 671 773. Among them, 1 532 796 were from studies on EC use predicting depression, while 138 977 were from studies on depression predicting EC use. The age group encompasses adults, young adults, and adolescents. The quality of all included studies, as assessed by AHRQ, was moderate to high.

E-Cigarette Use Predicting Depression

The meta-analysis of 14 studies revealed that current EC use significantly predicted depression (Figure 2a), and the combined OR was 1.96 (95% CI: 1.73 to 2.23). The analysis of four studies indicated that ever EC use also significantly predicted depression (Figure 2b), with a pooled OR of 1.88 (95% CI: 1.59 to 2.21). A notable heterogeneity was detected in both the current EC use group ($I^2 = 88.9\%$, $p < .001$) and the ever e-cigarette use group ($I^2 = 66.2\%$, $p = .002$).

Depression Predicting E-Cigarette Use

The combined results of 10 studies and five studies, respectively, demonstrated that depression may significantly predict current EC use (Figure 2c), with an OR value of 1.36 (95% CI: 1.19 to 1.56), and ever EC use (Figure 2d), with an OR value of 1.53 (95% CI: 1.25 to 1.88). The heterogeneity of the current e-cigarette use group ($I^2 = 89.6\%$, $p < .001$) and the ever e-cigarette use group ($I^2 = 84.1\%$, $p < .001$) was substantial.

Subgroup Analysis

As indicated in Tables 1 and 2, the studies were classified into subgroups based on the age group, the study area, and exclusive use of ECs or dual use with CCs. The adolescent group is typically defined as ages 10–19 globally,[48] which is consistent with the participants in our study. For young adults, the upper age limit is generally recognized as 39 years,[49] and this criterion was applied in our study. Young adults included in this study ranged from 18 to 29 years and adolescents and young adults (AYA) ranged from 14 to 34 years.

In the subgroup analyses of EC use predicting depression (Table 1, forest plots presented in Figures S1 and S2), current EC users of adults (OR: 2.46, 95% CI: 2.13 to 2.85) showed a substantially higher risk for depression than adolescents (OR: 1.80, 95% CI: 1.48 to 2.20) and young adults (OR: 1.27, 95% CI: 1.12 to 1.44). Similar outcomes were also observed in the EC ever use group for adults (OR: 1.95, 95% CI: 1.17 to 3.26) and adolescents (OR: 1.85, 95% CI: 1.54 to 2.23).

Current (OR: 2.66, 95% CI: 2.29 to 3.10) and ever (OR: 2.00, 95% CI: 1.54 to 2.61) dual use of ECs and CCs were more inclined to experience depression than current (OR: 1.64, 95% CI: 1.36 to 1.98) and ever (OR: 1.77, 95% CI: 1.38 to 2.27) exclusive use of ECs, respectively. Current (OR: 2.80, 95% CI: 2.41 to 3.25) and ever (OR: 2.22, 95% CI: 2.07 to 2.39) EC users from Korea were more susceptible to depression than those from other areas.

In the subgroup analyses for depression predicting EC use (Table 2, forest plots presented in Figures S3 and S4), only one study was based on adult participants while others were based on AYA participants. Most subgroups demonstrated significance in depression predicting both current and ever EC use, but no significant association was observed in depression predicting ever EC use in the AYA subgroup (OR: 1.39, 95% CI: 0.98 to 1.97).

Sensitivity Analysis

We conducted leave-one-out sensitivity analyses to assess the influence of individual studies on the pooled effect estimates (ORs and their 95% CIs). The complete results are presented in Table S4 and Figure S6. The pooled estimates remained stable for: (1) current EC use predicting depression, (2) ever EC use predicting depression, and (3) depression predicting current EC use, demonstrating robustness across most included studies. For depression predicting ever EC use, the association became nonsignificant (OR: 1.39, 95% CI: 0.98 to 1.97) upon exclusion of the adult subgroup from Wiernik et al. (2018), which is the only adult group that consistent with our subgroup analysis findings.

Publication Bias

We evaluated potential publication bias for all primary associations, including current EC use predicting depression and

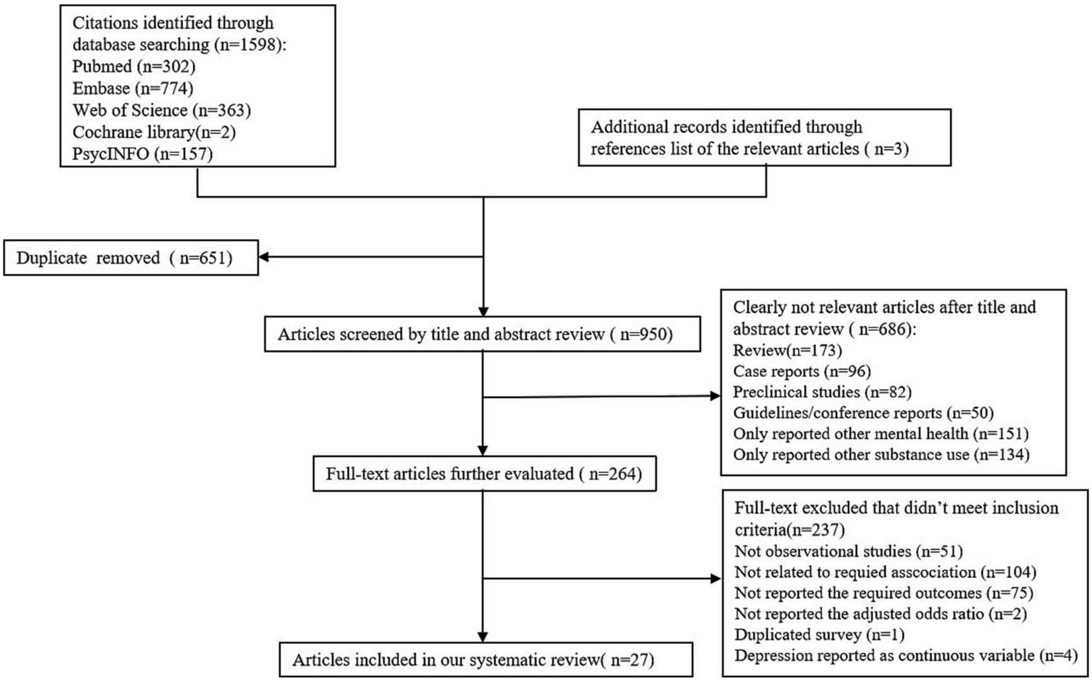

Figure 1. Study flow diagram.

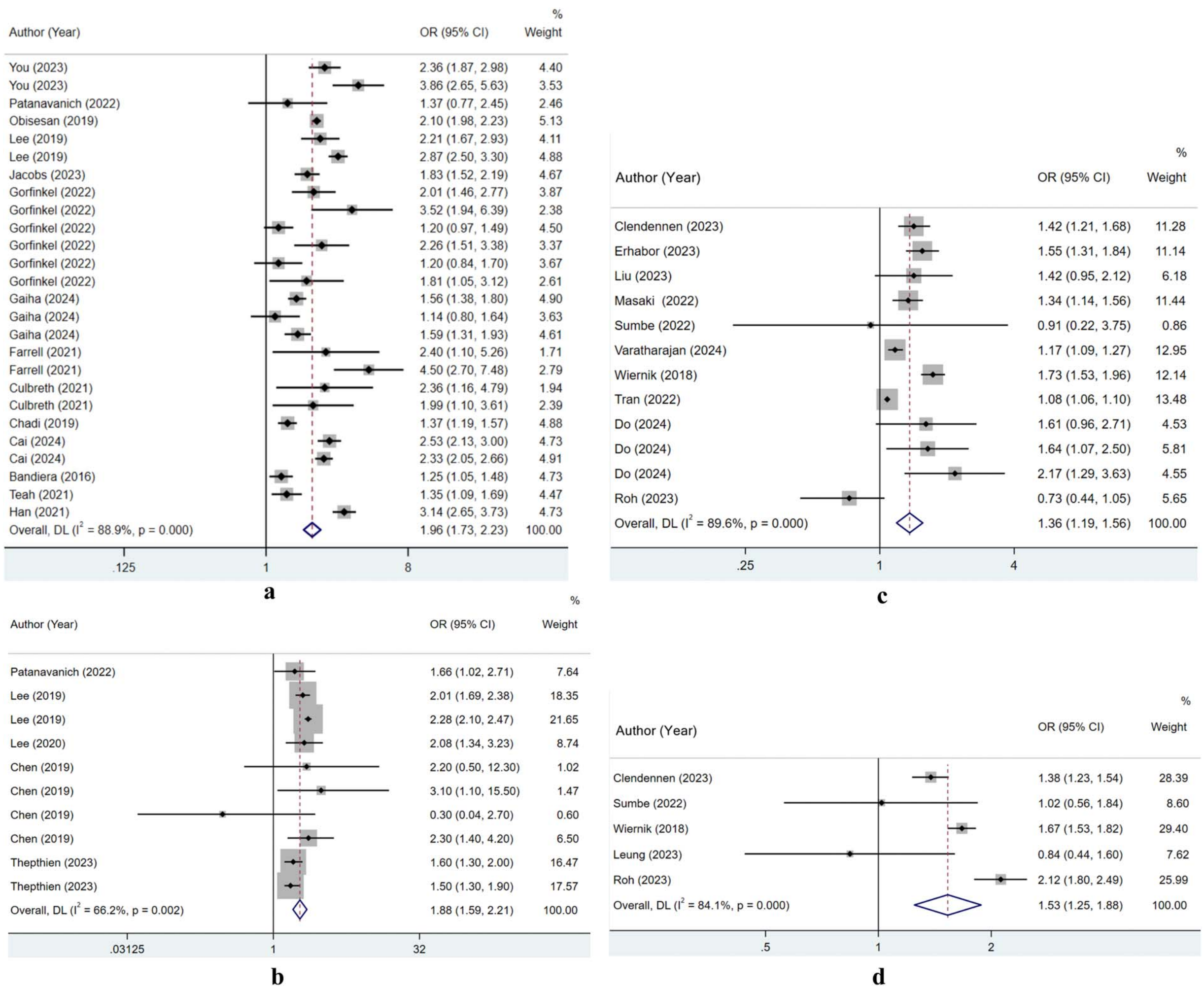

Figure 2. Forest plots of (a) current e-cigarette use predicting depression, (b) ever e-cigarette use predicting depression, (c) depression predicting current e-cigarette use, and (d) depression predicting ever e-cigarette use.

Table 1. Subgroup results of e-cigarette use predicting depression

Group	Number of subgroups	OR	95% CI	I^2 (%)	Heterogeneity within each subgroup (*p*)	Heterogeneity between subgroups (*p*)	Number of subgroups	OR	95% CI	I^2 (%)	Heterogeneity within each subgroup (*p*)	Heterogeneity between subgroups (*p*)
	Current use of e-cigarettes						Ever use of e-cigarettes					
Age group												
Adults	11	2.46	2.13–2.85	79.8	<.001	<.001	3	1.95	1.17–3.26	74.2	.001	.850
Adolescents	12	1.80	1.48–2.20	87.9	<.001		7	1.85	1.54–2.23	40.7	.185	
Young adults	3	1.27	1.12–1.44	0	.706		–					
Study area												
The United States	19	1.83	1.61-2.09	86.0	<.001	<.001	2	1.54	1.34–1.78	0	.659	<.001
Korea	5	2.80	2.41–3.25	57.3	.052		3	2.22	2.07–2.39	0	.408	
Thailand	2	1.36	1.10–1.67	0	.968		1	1.66	1.02–2.71	0	–	
Taiwan	–						4	2.04	1.09–3.84	19.2	.294	
Dual and exclusive use												
EC and CC dual use	9	2.66	2.29–3.10	55.4	.022	<.001	5	2.00	1.54–2.61	75.3	.003	.723
Exclusive EC use	8	1.64	1.36–1.98	71.9	.001		4	1.77	1.38–2.27	45.8	.137	
NR	9	1.73	1.42–2.11	92.5	<.001		1	1.66	1.02–2.71	–	–	

NR = not report.

Table 2. Subgroup results of depression predicting e-cigarette use

Group	Number of subgroups	OR	95% CI	I^2 (%)	Heterogeneity within each subgroup (*p*)	Heterogeneity between subgroups (*p*)	Number of subgroups	OR	95% CI	I^2 (%)	Heterogeneity within each subgroup (*p*)	Heterogeneity between subgroups (*p*)
	Current use of e-cigarettes						Ever use of e-cigarettes					
Age group												
AYA	11	1.30	1.16–1.47	87.4	<.001	.001	4	1.39	0.98–1.97	87.4	<.001	.321
Adults	1	1.73	1.53–1.96	–	–		1	1.67	1.53–1.82	0.0	–	
Study area												
The United States	10	1.35	1.14–1.59	82.5	<.001	<.001	3	1.53	1.06–2.23	90.1	<.001	.110
Canada	1	1.17	1.08–1.26	–	–		-					
France	1	1.73	1.53–1.96	–	–		1	1.67	1.53–1.82	–	.0	
Australia	–						1	0.84	0.44–1.60	–	.0	

AYA = adolescent and young adults; NR = not report.

depression predicting current EC use. The funnel plots (Figure S6) and Begg's test indicated no obvious publication bias in all the analyzed groups including current EC use predicting depression (Begg's test, $p = .802$), current EC use only predicting depression (Begg's test, $p = 1.000$), current dual use of EC and CC predicting depression (Begg's test, $p = .805$), ever EC use predicting depression (Begg's test, $p = .788$),ever EC use only predicting depression (Begg's test, $p = .174$), ever dual use of EC and CC predicting depression (Begg's test, $p = .624$); depression predicting current EC use (Begg's test, $p = .537$), and depression predicting ever EC use (Begg's test, $p = .624$).

Discussion

To our knowledge, this is the first meta-analysis to investigate the bidirectional association between EC use and depression. Our findings suggest a strong association between EC use and depression, but future longitudinal research is needed to establish causality. The association strength was greater for EC use (current or ever) predicting depression compared to depression predicting EC use. The bidirectional association remained statistically significant in most subgroup analyses across age groups and EC use patterns. However, no significant association was found between depression and ever EC use (OR: 1.39, 95% CI: 0.98 to 1.97) in the AYA subgroup. Among the four studies analyzed, Leung et al. (2023) reported an effect size contradicting the overall trend (OR: 0.84, 95% CI: 0.44 to 1.60). This discrepancy could stem from regional variations (eg, it was the only Australian study) or other factors such as differences in severity levels of depression or EC exposure duration that could not be measured. In addition, the small sample size ($n = 4$) in this subgroup analysis heightens susceptibility to random error.

The self-medication hypothesis posits that individuals with mental health disorders may use e-cigarettes for symptom alleviation.[50] Among adolescents, EC use may function as either an emotional coping strategy or recreational activity. Regardless of exposure route, nicotine conversely contributes to the development or exacerbation of depressive symptoms.[51] Chronic exposure to nicotine may lower serotonin levels, potentially exacerbating depressive symptomatology.[52] Studies also found that prolonged nicotine exposure might dysregulate cerebral dopamine pathways, heighten stress sensitivity, and compromise cognitive-emotional protective mechanisms against depression.[24] Adolescent nicotine exposure significantly harms neurodevelopment, potentially leading to cognitive deficits and psychiatric sequelae including depression, anxiety, substance use disorders, and elevated suicide risk.[53] Apart from nicotine, e-cigarettes also contain various levels of trace metals. Particularly, lead and aluminum affect both the central and peripheral nervous systems, potentially playing a role in the connection between e-cigarette use and depression.[54] A recent investigation disclosed that daily use of flavored nicotine e-cigarettes might trigger neuroinflammation in brain areas associated with depressive behaviors.[55] In addition, EC use adversely impacts sleep health.[56] Proposed mechanisms include nicotine-mediated disruption of sleep-regulating neurotransmitters and respiratory-related sleep disturbances.[56] Poor sleep quality correlates strongly with increased EC dependence, as sleep deprivation impairs both emotion regulation capacity and impulse control.[57] As impaired sleep is a well-established depression risk factor,[58] this interaction potentiates EC's pro-depressive effects. In summary, these findings indicate bidirectional EC-depression reinforcement, creating a self-perpetuating cycle via potential mediating or synergistic mechanisms. Although these mechanisms offer plausible EC-depression pathways, they remain hypothetical without direct empirical validation in the included studies. Future experimental, clinical, and longitudinal studies should directly test these mechanistic hypotheses.

Our study reported substantial heterogeneity, with one major source stemming from different age groups. The bidirectional EC-depression association demonstrated greater magnitude in adults compared to AYA. Evidence suggests adolescents (<20 years) develop lower nicotine dependence levels than adults (≥20 years).[59] Studies demonstrate an interdependent relationship between nicotine dependence and depression, where nicotine withdrawal exacerbates mental health conditions[51] and depression conversely serves as a significant risk factor for developing dependence.[60,61] This pattern may reflect differential usage motivations—AYAs primarily initiate EC use out of curiosity or for flavor preferences, while adults more frequently employ them for smoking cessation.[62] Consequently, the EC-depression association appears attenuated in the younger population. Geographic variation represented an additional source of heterogeneity, likely reflecting differential EC accessibility and regulatory frameworks. For instance, South Korea's stringent policies may yield higher detection rates of high-risk users compared to more permissive markets like the United States,[63] which may result in a stronger observed association.

Both EC use and depression were primarily assessed as binary (yes or no) variables in the included studies, potentially introducing population heterogeneity because of varying exposure levels and depression severity. Usage patterns further contributed to variability—our findings indicate dual EC and CC use demonstrate stronger depression associations than exclusive EC use. Notably, Goniewicz et al.[64] investigated dual users typically exhibit higher consumption frequencies and quantities, potentially exacerbating nicotine dependence severity and consequent mental health risks.[61,65] While evidence suggests comparable urinary cotinine levels between EC and CC users,[66] future investigations should systematically evaluate their distinct mental health impacts.

Of the 11 included studies assessing depression as a predictor of EC use, nine employed cross-sectional designs, while two used longitudinal approaches. The limited number of studies precluded subgroup analyses due to potential random error. While longitudinal studies provided only cross-sectional data, their designs typically incorporated stricter variable definitions and superior confounding control compared to cross-sectional investigations, which remain vulnerable to information biases (eg, recall bias). Furthermore, longitudinal studies implemented more rigorous participant screening (eg, excluding high dropout-risk individuals), whereas cross-sectional samples better reflected real-world populations. In short, the inclusion of both study designs might introduce methodological heterogeneity. In addition, self-reported measures for both EC use and depression constituted a significant source of heterogeneity, warranting careful interpretation. While biochemical verification demonstrates moderate-to-high validity for self-reported cigarette use (sensitivity: 89.2%; specificity: 87.5%),[67] adolescents exhibit greater reporting inaccuracies due to social desirability and memory limitations.[67,68] For depression assessment, self-reported questionnaires may overestimate prevalence rates,[69] with meta-analytic evidence identifying catastrophizing and interpretive biases as particularly prevalent.[70] Such depression measurement error could artificially inflate the observed depression-to-EC use association.

Inconsistent control of confounding variables across original studies represents another significant source of heterogeneity, although nearly all studies adjusted for age and sex. In our study, SES is a critical confounder for consideration. Specifically, a meta-analysis[71] of 58 studies identified a negative correlation between SES and depression, supported by Canadian national data demonstrating significant associations between low education or income and major depressive disorder.[72] While US and Korean national surveys[73,74] reported higher EC use prevalence among low-SES populations, adolescent studies[75] reported no significant SES-EC association. Importantly, inadequate adjustment could inflate the EC-depression association, particularly among adults. Furthermore, studies[76,77] indicate that AYA EC users face elevated risks of polysubstance use. Given established substance-depression associations (eg, cannabis, alcohol),[78,79] comorbidities might artificially strengthen depression-specific associations. Moreover, most included studies lacked baseline mental health status adjustment. Since pre-existing depression may drive EC initiation rather than resulting from it, this omission could presume causal direction. EC use also correlated with other mental health conditions (internalizing or externalizing problems, stress, suicidality, ADHD, etc.),[9] suggesting comorbidities may lead to the observed association being erroneously attributed solely to depression. Physical inactivity[80,81] and obesity[82-84]—both linked to depression and EC use—were similarly unaddressed in most studies, potentially obscuring their true bidirectional relationship. Collectively, these unmeasured confounders are likely to contribute to residual bias. Future large-scale analyses should therefore implement comprehensive covariate adjustment to clarify the genuine EC-depression association.

An analysis of highly viewed videos related to e-cigarettes on TikTok found that 63% described e-cigarettes in a positive way, and only 11% were warnings.[85] The tobacco industry repeatedly promotes deceptive claims suggesting that nicotine alleviates anxiety, stress, and depression.[86] Unsurprisingly, stress relief was the primary reason cited by adolescents for using e-cigarettes, unaware that it could potentially exacerbate their mental health issues.[87] Individuals with depression are more likely to smoke heavily and face greater challenges in quitting, potentially because of the worsening of depressive symptoms during attempts to quit and a low tolerance for nicotine withdrawal.[15,43,88] Given the similarities between e-cigarettes and cigarettes, individuals with depression may be more prone to continued e-cigarette use and could struggle more with reducing or quitting their usage. Cummins et al.[89] indicated that individuals with mental health issues were more likely to experiment with e-cigarettes, be current smokers, be at increased risk for future use, and exhibit higher levels of nicotine dependence compared to those without such conditions. Earlier studies have also suggested that higher levels of depression are linked to a rise in e-cigarette use among young adults.[7,90,91]

Implications

Our study highlights the bidirectional association between EC use and depression, and it emphasizes the importance of healthcare practitioners to screen for EC use in individuals with depression and provide timely interventions. Adolescents are particularly vulnerable due to the impact of nicotine and other substances on the developing brain, which underscores the importance of targeted education to prevent initiation and sustained use of e-cigarettes. Public health efforts should counter misleading information about e-cigarettes' stress-relieving effects and enforce stricter regulations on marketing. In addition, integrating smoking cessation programs with mental health services could further support affected individuals. Finally, future research could focus on exploring the mechanisms underlying this association and clarifying causal relationships to guide effective prevention and intervention strategies.

Limitations

There are several important limitations to acknowledge in our study. First and foremost, since our analysis was based primarily on cross-sectional data, the findings cannot establish a causal relationship between EC use and depression. Furthermore, both EC use and depression were assessed through self-reported measures, introducing potential biases such as recall bias, catastrophizing, and interpretive biases. Another significant limitation is that our study focused solely on the binary association between EC use status and depression, without analyzing frequency and severity stratification. While our assessment method was sensitive in detecting minimal EC use (defined as at least once within the past 30 days or lifetime), it lacked the granularity to differentiate usage patterns or intensity. In addition, methodological constraints prevented us from analyzing depression as a continuous variable.

A notable geographical limitation is that the current evidence base is predominantly derived from high-income countries, with scarce data from low- and middle-income countries (LMICs) where both EC use patterns and mental health profiles may differ substantially. This imbalance significantly limits the generalizability of our findings to certain regions. It's particularly concerning that despite EC prohibitions in some LMICs like Thailand and India, these products remain accessible and pose health risks, especially to youth populations.[23] Future research should prioritize large-scale population surveys in these underrepresented regions to address this critical evidence gap.

With regard to methodological challenges, our meta-analysis revealed substantial heterogeneity that persisted despite our comprehensive efforts to identify potential sources. Although we thoroughly examined possible contributors—including geographical variations, population demographics (adults vs. adolescents or young adults), EC use patterns (exclusive vs. dual use with conventional cigarettes), and diverse depression measurement tools—our subgroup and sensitivity analyses failed to significantly reduce this heterogeneity.

Finally, while we analyzed adjusted ORs, we identified important inconsistencies in confounding factor control across studies. Several key confounders—including SES indicators (income and education), concurrent substance use (alcohol and or cannabis), physical activity levels, and health status markers (eg, BMI)—were not uniformly adjusted for in all included studies. This inconsistency may obscure the true effect size of the observed associations. Consequently, future research should incorporate more high-quality studies with standardized covariate adjustment to validate and extend our findings.

Conclusion

Our findings suggest a significant bidirectional association between EC use and depression. Both current and ever EC use predicting depression showed a stronger association than depression predicting EC use. However, this study cannot infer causality based on cross-sectional data. Discrepancies in study designs and unmeasured confounders may contribute to the high heterogeneity observed. Future research should focus on mechanisms and prioritize high-quality longitudinal studies across countries with varying income levels to further elucidate causal relationships. It is recommended to integrate inquiries about EC use history into depression counseling and implement mental health screenings for EC users, especially adolescents and young adults. Future policies should strengthen the regulation of e-cigarette marketing and incorporate mental health warnings associated with e-cigarettes.

Author Contributions

Shiya Ji (Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing—original draft, Writing—review & editing [lead]), Lu Chen (Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing—original draft, Writing—review & editing [lead]), Susu Zhuang (Data curation, Formal analysis, Investigation [equal]), Liwen Wei (Data curation, Formal analysis, Investigation [equal]), Lili Gou (Data curation, Formal analysis, Investigation [equal]), Cheng Shi (Data curation, Formal analysis, Investigation [equal]), Hanrui Jia (Data curation, Formal analysis, Investigation [equal]), and Xupeng Chen (Conceptualization, Data curation, Formal analysis, Project administration, Supervision, Writing—review & editing [lead])

Supplementary Material

Supplementary material is available at *Nicotine and Tobacco Research* online.

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Declaration of Interests

The authors have no relevant financial or non-financial interests to disclose.

Data Availability

All data relevant to the study are included in the article or uploaded as supplementary information.

Ethical Standards

This is a meta-analysis; therefore, ethics approval and consent to participate are not applicable.

References

1. Stratton K, Kwan LY, Eaton DL. *Public Health Consequences of E-cigarettes: Consensus Study Report*. Washington, DC: National Academies Press; 2018.
2. Gordon T, Karey E, Rebuli ME, Escobar YNH, Jaspers I, Chen LC. E-cigarette toxicology. *Annu Rev Pharmacol Toxicol*. 2022;**62**(1):301-322.
3. Jones K, Salzman GA. The vaping epidemic in adolescents. *Mo Med*. 2020;**117**(1):56-58.
4. Martins BNFL, Normando AGC, Rodrigues-Fernandes CI, *et al.* Global frequency and epidemiological profile of electronic cigarette users: a systematic review. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2022;**134**(5):548-561.
5. Jerzyński T, Stimson GV, Shapiro H, Król G. Estimation of the global number of e-cigarette users in 2020. *Harm Reduct J*. 2021;**18**(1):1-10.
6. Boakye E, Osuji N, Erhabor J, *et al.* Assessment of patterns in e-cigarette use among adults in the US, 2017-2020. *JAMA Netw Open*. 2022;**5**(7):e2223266.
7. Clendennen SL, Chen B, Sumbe A, Harrell MB. Patterns in mental health symptomatology and cigarette, e-cigarette, and marijuana use among Texas youth and young adults amid the coronavirus disease 2019 pandemic. *Nicotine Tob Res*. 2023;**25**(2):266-273.
8. Banks E, Yazidjoglou A, Brown S, *et al.* Electronic cigarettes and health outcomes: umbrella and systematic review of the global evidence. *Med J Aust*. 2023;**218**(6):267-275.
9. Becker TD, Arnold MK, Ro V, Martin L, Rice TR. Systematic review of electronic cigarette use (vaping) and mental health comorbidity among adolescents and young adults. *Nicotine Tob Res*. 2021;**23**(3):415-425.
10. Patten SB. Vaping and mental health. *J Can Acad Child Adolesc Psychiatry*. 2021;**30**(1):3-5.
11. Brody DJ, Pratt LA, Hughes JP. Prevalence of depression among adults aged 20 and over: United States, 2013-2016. NCHS Data Brief No. 303. *National Center for Health Statistics*. 2018.
12. World Health Organization. *Depression: A Global Crisis*. WHO; 2012.
13. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed, text rev. ed. American Psychiatric Publishing; 2022.
14. World Health Organization. *The Vicious Cycle of Tobacco Use and Mental Illness: A Double Burden on Health*. WHO; 2021.
15. Spears CA, Jones DM, Weaver SR, Pechacek TF, Eriksen MP. Use of electronic nicotine delivery systems among adults with mental health conditions, 2015. *Int J Environ Res Public Health*. 2016;**14**(1):E10.
16. Kwon E, Seo DC, Lin HC, Chen Z. Predictors of youth e-cigarette use susceptibility in a U.S. nationally representative sample. *Addict Behav*. 2018;**82**(7):79-85.
17. Lechner WV, Janssen T, Kahler CW, Audrain-McGovern J, Leventhal AM. Bi-directional associations of electronic and combustible cigarette use onset patterns with depressive symptoms in adolescents. *Prev Med*. 2017;**96**(3):73-78.
18. Borsboom D. A network theory of mental disorders. *World Psychiatry*. 2017;**16**(1):5-13.
19. Baskin-Sommers AR, Foti D. Abnormal reward functioning across substance use disorders and major depressive disorder: considering reward as a transdiagnostic mechanism. *Int J Psychol*. 2015;**98**(2):227-239.
20. Gehricke JG, Loughlin SE, Whalen CK, *et al.* Smoking to self-medicate attentional and emotional dysfunctions. *Nicotine Tob Res*. 2007;**9**(suppl 4):S523-S536.
21. Rostom A, Dubé C, Cranney A, *et al.* Celiac disease. Evidence report/technology assessment no. 104. *AHRQ*. 2004.
22. You MA, Choi J, Son YJ. Associations of dual use of tobacco cigarettes and e-cigarettes, sleep duration, physical activity and depressive symptoms among middle-aged and older Korean adults. *Nurs Open*. 2023;**10**(6):4071-4082.

23. Patanavanich R, Vityananan P, Neelapaichit N, *et al.* Association between electronic cigarette use and depression among Thai adolescents: the Thailand National Health Examination Survey 2019-2020. *Tob Induc Dis*. 2022;**20**(November):1-8.
24. Obisesan OH, Mirbolouk M, Osei AD, *et al.* Association between e-cigarette use and depression in the behavioral risk factor surveillance system, 2016-2017. *JAMA Netw Open*. 2019;**2**(12):e1916800.
25. Lee Y, Lee KS. Association of depression and suicidality with electronic and conventional cigarette use in South Korean adolescents. *Subst Use Misuse*. 2019;**54**(6):934-943.
26. Lee S, Oh Y, Kim H, Kong M, Moon J. Implications of electronic cigarette use for depressive mood: a nationwide cross-sectional study. *Medicine*. 2020;**99**(40):e22514.
27. Jacobs W, Orozco G, Villanueva G, Merianos AL. E-cigarette and cannabis use patterns, depression, and suicide behaviors among US youth: analysis of 2019 youth risk behavior survey data. *Am J Health Promot*. 2023;**37**(1):77-83.
28. Gorfinkel L, Hasin D, Miech R, Keyes KM. The link between depressive symptoms and vaping nicotine in U.S. adolescents, 2017-2019. *J Adolesc Health*. 2022;**70**(1):133-139.
29. Gaiha SM, Wang M, Baiocchi M, Halpern-Felsher B. Depression screening outcomes among adolescents, young adults, and adults reporting past 30-day tobacco and cannabis use. *Addict Behav*. 2024;**156**(7):108076.
30. Farrell KR, Karey E, Xu S, Gibbon G, Gordon T, Weitzman M. E-cigarette use, systemic inflammation, and depression. *Int J Environ Res Public Health*. 2021;**18**(19):10402.
31. Culbreth RE, Spears CA, Brandenberger K, *et al.* Dual use of electronic cigarettes and traditional cigarettes among adults: psychosocial correlates and associated respiratory symptoms. *Respir Care*. 2021;**66**(6):951-959.
32. Chadi N, Li G, Cerda N, Weitzman ER. Depressive symptoms and suicidality in adolescents using e-cigarettes and marijuana: a secondary data analysis from the Youth Risk Behavior Survey. *J Addict Med*. 2019;**13**(5):362-365.
33. Cai J, Bidulescu A. E-cigarette use or dual use of e-cigarette and combustible cigarette and mental health and cognitive impairment: findings from the National Health Interview Survey, 2020-2021. *J Affect Disord*. 2024;**351**(4):878-887.
34. Bandiera FC, Loukas A, Wilkinson AV, Perry CL. Associations between tobacco and nicotine product use and depressive symptoms among college students in Texas. *Addict Behav*. 2016;**63**(12):19-22.
35. Thepthien B-o, Tinn CS, Sharma R. Establishing the association between traditional tobacco, e-cigarette and dual use and mental health problems among high school students: results from a 2022 behavioral surveillance survey. *Int J Ment Health Addict*. 2024;**22**(6):4148-4168.
36. Han MA. Smoking cessation and mental health according to use of e-cigarettes and heated tobacco products by Korean adults. *Int J Ment Health Addict*. 2022;**20**(4):2559-2570.
37. Chen YL, Wu SC, Chen YT, *et al.* E-cigarette use in a country with prevalent tobacco smoking: a population-based study in Taiwan. *J Epidemiol*. 2019;**29**(4):155-163.
38. Erhabor J, Boakye E, Osuji N, *et al.* Psychosocial stressors and current e-cigarette use in the Youth Risk Behavior Survey. *BMC Public Health*. 2023;**23**(1):1080.
39. Liu J, Tan ASL, Winickoff JP, Rees VW. Correlates of adolescent sole-, dual- and poly-use of cannabis, vaped nicotine, and combusted tobacco. *Addict Behav*. 2023(11);**146**:107804.
40. Masaki K, Taketa RM, Nakama MK, Kawamoto CT, Pokhrel P. Relationships between depressive symptoms, anxiety, impulsivity and cigarette and e-cigarette use among young adults. *Hawaii J Health Soc Welf*. 2022;**81**(3):51-57.
41. Sumbe A, Wilkinson AV, Clendennen SL, *et al.* Association of tobacco and marijuana use with symptoms of depression and anxiety among adolescents and young adults in Texas. *Tob Prev Cessat*. 2022;**8**(January):1-11.
42. Varatharajan T, Patte KA, de Groh M, Jiang Y, Leatherdale ST. Exploring differences in substance use behaviours among gender minority and non-gender minority youth: a cross-sectional analysis of the COMPASS study. *Health Promot Chronic Dis Prev Can*. 2024;**44**(4):179-190.
43. Wiernik E, Airagnes G, Lequy E, *et al.* Electronic cigarette use is associated with depressive symptoms among smokers and former smokers: cross-sectional and longitudinal findings from the Constances cohort. *Addict Behav*. 2019;**90**(3):85-91.
44. Leung J, Tisdale C, Choi J, *et al.* E-cigarette use among high school students-a cross-sectional study of associated risk factors for the use of flavour-only and nicotine vapes. *Int J Ment Health Addict*. 2023;**23**(1):236-250.
45. Tran DD, Oh H, Zhou S, Pedersen ER. Depression and perceptions of social norms and harms for electronic and combustible cigarette use: associations with tobacco use in college students. *Psychiatry Res Commun*. 2022;**2**(3):100053.
46. Do EK, Tulsiani S, Koris K, Minter T, Hair EC. Depression, anxiety, stress, and current e-cigarette use: results from the truth longitudinal cohort of youth and young adults (2022–2023). *Article J Affect Disord*. 2024;**365**(11):628-633.
47. Roh T, Uyamasi K, Aggarwal A, Obeng A, Carrillo G. Association between e-cigarette use and asthma among US adolescents: Youth Risk Behavior Surveillance System 2015-2019. *Prev Med*. 2023;**175**(10):107695.
48. McDonagh JE, Ambresin A-E, Boisen KA, *et al.* The age of adolescence...and young adulthood. *Lancet Child Adolesc Health*. 2018;**2**(4):e6.
49. Lang MJ, David V, Giese-Davis J. The age conundrum: a scoping review of younger age or adolescent and young adult as a risk factor for clinical distress, depression, or anxiety in cancer. *J Adolesc Young Adult Oncol*. 2015;**4**(4):157-173.
50. Ibrahim FM, Shahrour G, Hashim A, Yasin A, Allam AR. E-cigarette usage and mental health among undergraduate medical and health sciences students. *Sci Rep*. 2025;**15**(1):13169.
51. Bainter T, Selya AS, Oancea SCJPO. A key indicator of nicotine dependence is associated with greater depression symptoms, after accounting for smoking behavior. *PLoS One*. 2020;**15**(5):e0233656.
52. Simonnet A, Zamberletti E, Cador M, Rubino T, Caillé SJN. Chronic FAAH inhibition during nicotine abstinence alters habenular CB1 receptor activity and precipitates depressive-like behaviors. *Neuropharmacology*. 2017;**113**(Pt A):252-259.
53. Demissie Z, Everett Jones S, Clayton HB, King BAJP. Adolescent risk behaviors and use of electronic vapor products and cigarettes. *Pediatrics*. 2017;**139**(2):e20162921.
54. Gaur S, Agnihotri R. Health effects of trace metals in electronic cigarette aerosols—a systematic review. *Biol Trace Elem Res*. 2019;**188**(2):295-315.
55. Moshensky A, Brand CS, Alhaddad H, *et al.* Effects of mango and mint pod-based e-cigarette aerosol inhalation on inflammatory states of the brain, lung, heart, and colon in mice. *eLife*. 2022;**11**(April):e67621.
56. Kang SG, Bae SM. The effect of cigarette use and dual-use on depression and sleep quality. *Subst Use Misuse*. 2021;**56**(12):1869-1873.
57. Goldstein AN, Walker MP. The role of sleep in emotional brain function. *Annu Rev Clin Psychol*. 2014;**10**(1):679-708.
58. Steiger A, Pawlowski M. Depression and sleep. *Int J Mol Sci*. 2019;**20**(3):607.
59. Park S, Lee JY, Song TM, Cho SI. Age-associated changes in nicotine dependence. *Public Health*. 2012;**126**(6):482-489.
60. Jamal M, Willem Van der Does AJ, Cuijpers P, Penninx BW. Association of smoking and nicotine dependence with severity and course of symptoms in patients with depressive or anxiety disorder. *Drug Alcohol Depend*. 2012;**126**(1–2):138-146.

61. Dierker L, Rose J, Selya A, Piasecki TM, Hedeker D, Mermelstein R. Depression and nicotine dependence from adolescence to young adulthood. *Addict Behav*. 2015;**41**(2):124-128.
62. Thoonen KAHJ, Jongenelis MI. Motivators of e-cigarette use among Australian adolescents, young adults, and adults. *Soc Sci Med*. 2024;**340**(1):116411.
63. Cho H-J, Dutra LM, Glantz SA. Differences in adolescent e-cigarette and cigarette prevalence in two policy environments: South Korea and the United States. *Nicotine Tob Res*. 2017;**20**(8):949-953.
64. Goniewicz ML, Leigh NJ, Gawron M, *et al.* Dual use of electronic and tobacco cigarettes among adolescents: a cross-sectional study in Poland. *Int J Public Health*. 2016;**61**(2):189-197.
65. Lee JA, Lee S, Cho H-J. The relation between frequency of e-cigarette use and frequency and intensity of cigarette smoking among South Korean adolescents. *Int J Environ Res Public Health*. 2017;**14**(3):305.
66. Göney G, Çok İ, Tamer U, Burgaz S, Şengezer T. Urinary cotinine levels of electronic cigarette (e-cigarette) users. *Toxicol Mech Methods*. 2016;**26**(6):441-445.
67. Patrick DL, Cheadle A, Thompson DC, Diehr P, Koepsell T, Kinne S. The validity of self-reported smoking: a review and meta-analysis. *Am J Public Health*. 1994;**84**(7):1086-1093.
68. Brener ND, Billy JO, Grady WR. Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *J Adolesc Health*. 2003;**33**(6):436-457.
69. Thombs BD, Kwakkenbos L, Levis AW, Benedetti A. Addressing overestimation of the prevalence of depression based on self-report screening questionnaires. *CMAJ*. 2018;**190**(2):E44-E49.
70. Nieto I, Robles E, Vazquez C. Self-reported cognitive biases in depression: a meta-analysis. *Clin Psychol Rev*. 2020;**82**(11): 101934.
71. Zhang Y, Zhang J, Li H, Jiang Y. The relationship between socioeconomic status and depression: a systematic review and meta-analysis. *Adv Psychol Sci*. 2022;**30**(12):2650-2665.
72. Wang JL, Schmitz N, Dewa CS. Socioeconomic status and the risk of major depression: the Canadian National Population Health Survey. *J Epidemiol Community Health*. 2010;**64**(5): 447-452.
73. Chang Y, Cho S, Kim I, Khang Y-H. Socioeconomic inequalities in e-cigarette use in Korea: comparison with inequalities in conventional cigarette use using two national surveys. *Int J Environ Res Public Health*. 2019;**16**(22):4458.
74. Jaber RM, Mirbolouk M, DeFilippis AP, *et al.* Electronic cigarette use prevalence, associated factors, and pattern by cigarette smoking status in the United States from NHANES (National Health and Nutrition Examination Survey) 2013-2014. *J Am Heart Assoc*. 2018;**7**(14):e008178.
75. Azagba S, Ebling T, Shan L. Is socioeconomic status related to youth e-cigarette use? Examining family affluence and sexual identity. *Addict Behav*. 2023;**141**(6):107636.
76. Park E, Livingston JA, Wang W, Kwon M, Eiden RD, Chang Y-P. Adolescent e-cigarette use trajectories and subsequent alcohol and marijuana use. *Addict Behav*. 2020;**103**(4): 106213.
77. Evans-Polce RJ, Patrick ME, McCabe SE, Miech RA. Prospective associations of e-cigarette use with cigarette, alcohol, marijuana, and nonmedical prescription drug use among US adolescents. *Drug Alcohol Depend*. 2020;**216**(11):108303.
78. Wright NE, Scerpella D, Lisdahl KM. Marijuana use is associated with behavioral approach and depressive symptoms in adolescents and emerging adults. *PLoS One*. 2016;**11**(11):e0166005.
79. Caldwell TM, Rodgers B, Jorm AF, *et al.* Patterns of association between alcohol consumption and symptoms of depression and anxiety in young adults. *Addiction*. 2002;**97**(5): 583-594.
80. Miller C, Smith DM, Goniewicz ML. Physical activity among adolescent tobacco and electronic cigarette users: cross-sectional findings from the population assessment of tobacco and health study. *Prev Med Rep*. 2019;**15**(9):100897.
81. Dinas PC, Koutedakis Y, Flouris AD. Effects of exercise and physical activity on depression. *Ir J Med Sci*. 2011;**180**(2): 319-325.
82. Pereira-Miranda E, Costa PRF, Queiroz VAO, Pereira-Santos M, Santana MLP. Overweight and obesity associated with higher depression prevalence in adults: a systematic review and meta-analysis. *J Am Coll Nutr*. 2017;**36**(3):223-233.
83. Cho B-Y, Seo D-C, Lin H-C, *et al.* Adolescent weight and electronic vapor product use: comparing BMI-based with perceived weight status. *Am J Prev Med*. 2018;**55**(4):541-550.
84. Delk J, Creamer MR, Perry CL, Harrell MB. Weight status and cigarette and electronic cigarette use in adolescents. *Am J Prev Med*. 2018;**54**(1):e31-e35.
85. Sun T, Lim CC, Chung J, *et al.* Vaping on TikTok: a systematic thematic analysis. *Tob Control*. 2023;**32**(2):251-254.
86. Landman A, Cortese DK, Glantz S. Tobacco industry sociological programs to influence public beliefs about smoking. *Soc Sci Med*. 2008;**66**(4):970-981.
87. Jha V, Kraguljac A. Assessing the social influences, self-esteem, and stress of high school students who vape. *Yale J Biol Med*. 2021;**94**(1):95-106.
88. Tidey JW, Miller ME. Smoking cessation and reduction in people with chronic mental illness. *BMJ*. 2015;**351**(September):h4065.
89. Cummins SE, Zhu SH, Tedeschi GJ, Gamst AC, Myers MG. Use of e-cigarettes by individuals with mental health conditions. *Tob Control*. 2014;**23**(suppl 3):iii48-iii53.
90. Romm KF, Patterson B, Crawford ND, *et al.* Changes in young adult substance use during COVID-19 as a function of ACEs, depression, prior substance use and resilience. *Subst Abus*. 2022;**43**(1):212-221.
91. Wattick RA, Olfert IM, Olfert MD. Psychosocial factors associated with e-cigarette use among young adults in a 4-year university in Appalachia. *Subst Use Misuse*. 2021;**56**(8):1182-1189.

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