

INTRODUCTION:

- Adolescent electronic cigarette (EC) use has risen dramatically over the past decade.
- Despite extensive established relationships between combustible cigarette (CC) use and mental health problems (1), the mental health comorbidities of EC use remain unclear.
- We systematically reviewed existing literature examining adolescent EC use and mental health comorbidities

METHODS :

Searches and Study Selection:

- PRISMA methodology was employed (2).
- MEDLINE, EMBASE, PsycINFO, Web of Science Core Collection, and Scopus were searched for studies published from 2011 to March 2020 that evaluated psychiatric comorbidities associated with EC use among adolescents.
- Titles and abstracts were reviewed to identify peer-reviewed publications that assessed mental health (excluding substance use disorders), EC use, and had a majority of participants in the adolescent age range (12-18).

Data Extraction:

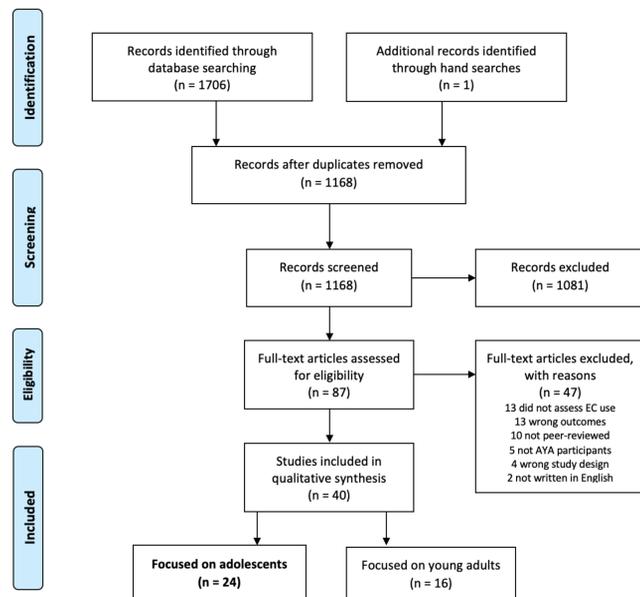
- We used a standardized data extraction tool including first author and year of publication, study aim, participants and setting, study design, response and follow-up rates, EC measurements, mental health measures, prevalence of EC use, findings related to mental health, and covariates adjusted for in analyses

Data Synthesis:

- Findings were synthesized qualitatively by mental illness categories.

RESULTS:

- Results are summarized in the following PRISMA flow diagram:



Study Characteristics:

- Studies were published between 2015-2020, mostly reporting on data collected from 2013-2017.
- 24 studies represented 16 unique cohorts.
- 17 were based in the US, 4 in South Korea, 2 in the UK, and 1 in Taiwan.
- 12 articles analyzed nationally representative samples, one was a clinical population, the rest were school-based.
- Most studies focused on vaping nicotine, while 2 studies focused on vaping cannabis or other illicit substances.
- 15 were cross-sectional analyses, while 9 were longitudinal.



Depression:

- 6 of 7 studies found positive associations between EC use and depressive symptoms.** Most of these were cross-sectional national surveys with limited measures of depression.
- One longitudinal California study suggested a bidirectional relationship between EC use and depression: Sustained EC use was associated with escalation of depressive symptoms over time and past-month use frequency was positively associated with depressive symptoms among sustained users (3).

Anxiety:

- One study assessed anxiety among adolescents using EC (4).**
- Lifetime EC-only users had higher levels of panic disorder than lifetime nicotine abstainers.
- EC-only use was less strongly related with anxiety than CC-only use.

Suicidality:

- Four cross-sectional national studies in the US and Korea found current EC use associated with suicidality.**
- Analysis of US Youth Risk Behavior Survey (2015-2017) showed that current EC only use associated with past year suicidal ideation (5).
- Korean Youth Risk Behavior Surveys (2015, 2016, and 2017) found significant associations between current EC use and past year suicidal ideation, plans, attempts, and serious attempts.

Eating Disorders:

- One South Korean national cross-sectional study (6) found that female lifetime and current EC adolescent users had significantly higher rates of all unhealthy weight control behaviors, while male current (but not former) EC users had higher rates.

Conduct Disorder and Delinquency:

- Three longitudinal studies examined and found relationships between conduct disorder symptoms and EC use.**
- In a US national survey, baseline rule-breaking tendency independently predicted EC use in the subsequent year (7).
- In a school-based cohort, past 6-month delinquent behavior was associated with later EC use, and CC use among a cohort of nicotine-naïve US high school students.
- Reports of various delinquent behaviors were significantly higher for lifetime EC only users versus never users.



ADHD:

- Two longitudinal studies** examined relationships between ADHD symptoms and EC use among US high school students over 12-18 months (8-9).
- Both found that ADHD symptoms predicted subsequent EC but not CC use.**
- EC use frequency did not associate with subsequent ADHD symptoms.
- Impulsivity and Executive Function (EF):**
- Five studies found relationships between impulsivity and/or EF and EC use,** as well as earlier initiation and higher frequency use.
- In longitudinal study of British high school students, baseline impulsivity predicted onset of EC use and CC use at 24-months (10).

Perceived Stress:

- One study** assessed perceived stress in adolescents and found that in a four-year longitudinal follow up of California teenagers, **baseline (age 13) perceived stress was associated with lifetime and past-month EC use** and CC use (11).



SUMMARY AND DISCUSSION:

- 24 studies assessed mental health comorbidities of EC use among adolescents.
- EC use was associated with depression, suicidality, disordered eating, ADHD, conduct disorder, impulsivity, and perceived stress, with additional limited evidence for anxiety.
- These findings largely align with prior findings regarding CC use.
- ADHD predicted EC but not CC use onset.
- Anxiety, externalizing symptoms, and conduct problems were more strongly associated with adolescent CC use than EC use.

LIMITATIONS:

- Few studies adjusted for other substance use despite high comorbidity and potential impact of other substance use on mental health.
- Most studies were cross-sectional, or longitudinal studies with short-term follow up.
- Although there are potential theoretical adverse effects of nicotine on adolescent neurodevelopment, impact of EC use on the trajectory of mental health symptoms remains unclear and in need of further study.
- Most studies measured either lifetime use or current use by self-report, leaving factors such as frequency and patterns of use, dose of nicotine, and nicotine dependence relatively uninvestigated.
- Adolescents use EC as a device to consume illicit drugs as well as nicotine, but only a couple studies have investigated mental health comorbidities of illicit drug use in EC.
- We found no studies investigating comorbidity of EC use and psychotic symptoms.

IMPLICATIONS:

- Counseling adolescents with depression and other mental health problems against vaping, warning that vaping and other substance use may exacerbate their mental illness appears indicated.
- Emphasizing vaping cessation in AYA with mental illness may prevent progression to CC and other substance use, although this remains an area of debate.
- Further quality longitudinal data remains needed.

DIRECTIONS FOR FURTHER RESEARCH:

- Future studies should develop more nuanced measures of EC use and establish their validity and reliability.
- No studies assessed psychosis in adolescent EC users and would be an important field of study. This subgroup may be most at risk of long-term adverse effects and need early intervention.
- Given that EC use may alter cognitive and emotional health through multiple pathways, further longitudinal studies remain much needed.
- Further work is needed to develop interventions to mitigate EC use among youth, particularly those with comorbid mental illness

CONCLUSIONS:

- Adolescent EC use is associated with greater mental health problems compared to non-use across several domains.
- Cross-sectional predominance leaves directionality largely uncertain.
- Well-designed longitudinal studies remain needed to investigate long-term mental health sequelae of EC.
- More nuanced, valid, and reliable measures of EC use to identify factors of youth most at risk of adverse outcomes will advance further research.

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