



Short communication

Extensive social media use and frequency of current e-cigarette use among US youth

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HIGHLIGHTS

- More than one-third (35.8 %) of youth used social media extensively.
- About 1 in 11 (8.6 %) youth currently used e-cigarettes, with 2.4 % using e-cigarettes daily.
- Extensive social media use was positively associated with daily e-cigarette use.

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ABSTRACT

Introduction: Both electronic cigarette (e-cigarette) and social media use among youth are public health concerns. While the health impacts of extensive social media use and frequent use of e-cigarettes have been discussed independently in the literature, little is known about the relationship between the two. This study aims to examine the potential association between extensive social media use and the frequency of current, e-cigarette use among United States (US) youth.

Methods: Data from the 2022 National Youth Tobacco Survey (NYTS) were analyzed. The sample included 23,655 middle and high school students aged 9–18 years. Frequency of current e-cigarette use was categorized based on past-30 day use (i.e., never/former, 1–9 days, 10–29 days, or 30 days). Social media use was dichotomized into less than 4 hours daily and 4+ hours daily (i.e., extensive use). Multivariable multinomial logistic regression estimated the relationship between social media use and e-cigarette use frequency.

Results: Over one-third (35.8 %) of youth used social media extensively and 8.6 % reported current use of e-cigarettes. Extensive social media use was associated with daily e-cigarette use (OR: 1.94, 95 % CI: 1.48–2.56) but not with other use categories. Older age, female sex, lower grades, current other tobacco use, and family tobacco use were also associated with daily e-cigarette use.

Conclusions: Extensive social media use is associated with daily e-cigarette use among US youth. Public health interventions should consider the influence of social media on tobacco use behaviors and tailor prevention strategies to address this potential modifiable risk factor.

1. Introduction

It is estimated that 82 million people use electronic cigarettes (e-cigarettes) worldwide (Jerzynski & Stimson, 2023). In the United States (US), e-cigarettes are the most prevalent tobacco product used among youth, raising public health concerns (Birdsey et al., 2023; Cooper et al.,

2022; Gentzke et al., 2022; Mattingly & Hart, 2024). While e-cigarettes are believed to be less harmful than combustible tobacco products and may be used as a mitigation tool, they are associated with adverse health outcomes such as impaired neurological development, increased addiction potential, and a decline in mental health, especially among younger populations (Lindson et al., 2024; Lydon et al., 2014; Morean

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and Krishnan-Sarin S, O'Malley, 2018; Smith et al., 2015). Concurrently, the rapid increase in social media use among youth is also an emerging public health challenge as it has been associated with adverse psychological outcomes (Beyari, 2023).

Although there is currently no widely accepted definition of extensive social media use, previous evidence-based research considers daily use for three or more hours as meeting this threshold (American Psychological Association, 2023; Office of the Surgeon General (OSG), 2023). The literature also indicates that 36 % of youth aged 13–17 use social media extensively (Vogels and Gelles-Watnick, 2023), and 51 % of youth aged 13–19 use social media for four or more hours daily (Rothwell, 2023). This level of social media engagement has been linked to various negative outcomes, including depression, anxiety, sleep disruption, and low self-esteem (Zubair et al., 2023) and may differentially expose youth to tobacco products through online advertisements or promotions (Massey et al., 2021; Vassey et al., 2022).

The relationship between extensive social media use and e-cigarette consumption among youth is an area of growing interest, with previous research indicating that both behaviors may reflect underlying psychosocial stressors that have synergistic effects on health outcomes (Cavazos-Rehg et al., 2021; Vassey et al., 2022; Zhang et al., 2023; Zheng et al., 2021). Despite these findings, research examining recent patterns in these behaviors, reflecting shifts in use that may have occurred during the pandemic, is scarce. Furthermore, much remains unexplored regarding how social media use and psychological distress interact to effect e-cigarette use frequency among youth. Therefore, this

study aimed to examine the association between extensive social media use and the frequency of current e-cigarette use among a national sample of US youth. Additionally, we aimed to explore the joint effect of extensive social media use and psychological distress on the relationship between social media use and e-cigarette use frequency.

2. Materials and methods

2.1. Participants

Our study used data from the 2022 National Youth Tobacco Survey (NYTS). This annual, cross-sectional study offers a comprehensive overview of tobacco use among US middle and high schoolers, ages 9+. The NYTS uses a stratified, multi-stage cluster sampling method to ensure national representation. Of 574 schools invited, 341 participated, yielding a 59.4 % response rate. Among 37,172 recruited students, 28,291 responded, representing a 76.1 % completion rate. The NYTS study design and methodology are detailed online (Office on Smoking and Health, 2022) and were approved by the institutional review board of the Centers for Disease Control and Prevention (CDC). Because the NYTS data are publicly available and deidentified, the current research was deemed exempt from IRB review at the authors' institutions (Office of Research Integrity, 2023).

For this analysis, we excluded students with missing data on social media use, e-cigarette use, and other covariates of interest ($n=4636$). We also excluded respondents aged 19 years or older ($n=154$) to restrict

Table 1

Weighted distributions of participant characteristics overall and by frequency of electronic cigarette (e-cigarette) use.

Participant characteristics, n (%)	Total (n=23,655)	Frequency of e-cigarette use				χ^2	P-value
		Never or Former (n=21637, 91.4 %)	1–9 Days (n=929, 3.8 %)	10–29 Days (n=567, 2.4 %)	30 Days (n=522, 2.4 %)		
Age (years)						1220.3	<0.001
9–12	4426 (19.8)	4325 (21.3)	70 (6.5)	16 (1.4)	15 (2.6)		
13–15	10883 (44.1)	10201 (45.3)	384 (39.5)	196 (31.4)	102 (15.8)		
16–18	8346 (36.2)	7111 (33.4)	475 (54.1)	355 (67.2)	405 (81.6)		
Sex						57.2	<0.01
Male	11872 (50.2)	10980 (50.8)	400 (41.6)	241 (42.9)	251 (45.4)		
Female	11783 (49.8)	10657 (49.2)	529 (58.4)	326 (57.1)	271 (54.6)		
Race and ethnicity						265.6	<0.001
Hispanic	6121 (25.6)	5653 (26.0)	248 (26.1)	134 (22.3)	86 (13.5)		
Non-Hispanic White	10539 (50.4)	9505 (49.5)	409 (51.1)	303 (60.9)	322 (74.7)		
Non-Hispanic Black	2597 (10.9)	2430 (11.2)	103 (12.6)	42 (8.0)	22 (3.7)		
Non-Hispanic multiracial	1740 (6.3)	1570 (6.2)	72 (7.5)	52 (6.5)	46 (6.3)		
Another race/ethnicity ^a	2658 (6.7)	2479 (7.1)	98 (2.6)	36 (2.2)	46 (1.8)		
Sexual orientation						151.59	<0.001
Heterosexual	17564 (74.4)	16151 (74.7)	630 (68.9)	296 (67.0)	387 (78.7)		
Lesbian/gay/bisexual	3798 (16.0)	3313 (15.3)	234 (23.5)	146 (27.5)	105 (16.7)		
Unsure	2293 (9.6)	2173 (9.9)	65 (7.6)	25 (5.5)	30 (4.6)		
Frequency of social media use						140.0	<0.001
Never, weekly, or <4 hours daily	15049 (64.2)	14,006 (65.2)	488 (55.7)	305 (57.0)	250 (47.7)		
4+ hours daily	8606 (35.8)	7631 (34.8)	441 (44.3)	262 (43.0)	272 (52.3)		
Grades						590.2	<0.001
A's	10864 (45.0)	10246 (46.6)	295 (31.8)	167 (26.0)	156 (27.5)		
B's	7055 (30.8)	6409 (30.5)	307 (33.3)	186 (36.7)	153 (33.1)		
C's	2830 (12.3)	2445 (11.6)	165 (18.1)	126 (22.2)	94 (18.0)		
D's/F's	1193 (5.2)	947 (4.5)	93 (9.4)	62 (11.3)	91 (17.2)		
None/Unsure	1713 (6.7)	1590 (6.8)	69 (7.4)	26 (3.8)	28 (4.3)		
Current other tobacco use ^b						4783.7	<0.001
No	22531 (95.5)	21161 (98.1)	701 (74.5)	353 (65.9)	316 (50.9)		
Yes	1124 (4.5)	476 (1.9)	228 (25.5)	214 (34.1)	206 (39.1)		
Family tobacco use ^c						776.8	<0.001
No	18311 (78.2)	17203 (80.2)	562 (64.1)	307 (56.7)	239 (45.3)		
Yes	5344 (21.8)	4434 (19.8)	367 (35.9)	260 (43.3)	283 (53.7)		

Note: Bolded cells indicate statistical significance at $p<0.05$.

^a Another race/ethnicity includes respondents who identified as non-Hispanic Asian, American Indian/Alaska Native, or Native Hawaiian/Other Pacific Islander

^b Current other tobacco use includes past 30-day use of at least one of the following products: cigarettes, cigars, hookah, roll-your-own cigarettes, pipe, smokeless tobacco, snus, dissolvables, heated tobacco, nicotine pouches, and bidis

^c Family tobacco use includes past 7-day use of at least one form of tobacco by a household member

our analysis to youth aged 9–18 years. These exclusions resulted in a final analytic sample of 23,655.

2.2. Measures

2.2.1. Social media use frequency

Students were asked, “How often do you use social media?” and provided answers ranging from “no use” to specific use frequencies within a week (i.e., less than one time, about one time, a few times) or daily (i.e., less than 1 hour, 1–2 hours, 3–4 hours, or 4 hours or more). We defined extensive social media use as use 4+ hours per day (the uppermost choice possible) and dichotomized responses into two categories: non-extensive use (i.e., less than 4 hours daily) and extensive use, based on previous research (American Psychological Association, 2023; Office of the Surgeon General (OSG), 2023).

2.2.2. E-cigarette use frequency

Students indicated whether they had ever used e-cigarettes. Respondents who answered “yes” were then asked to identify how many days within the last 30 that they used them. We categorized current frequency of use as never/former (i.e., those who answered “no” on the first question or “0 days” on the second), 1–9 days (infrequent), 10–29 days (frequent), and 30 days (daily).

2.2.3. Covariates

Sociodemographic characteristics included were age (9–12, 13–15, 16–18 years), sex assigned at birth (male, female), race and ethnicity (Hispanic, non-Hispanic [NH] White, NH Black, NH multiracial, another race or ethnicity [NH Asian, NH American Indian/Alaska Native, NH Native Hawaiian/other Pacific Islander]), and sexual orientation (heterosexual, lesbian/gay/bisexual (LGB), not sure). Additional covariates included school grades (mostly A's, B's, C's, D's/F's, none/not sure), past 7-day family tobacco use (yes/no), psychological distress based on the PHQ-4 scale (none, mild, moderate, severe) (Kroenke et al., 2009), and current other tobacco product use (yes/no), which included any past

30-day use of cigarettes, cigars, smokeless tobacco, hookah, roll-your-own cigarettes, pipes, snus, dissolvable tobacco, bidis, heated tobacco products, and nicotine pouches. These sociodemographic covariates were chosen based on their established relevance to e-cigarette use among youth, alignment with previous research, availability in the dataset, and role in underlining health disparities and social determinants of health (Oliver et al., 2023; Viner et al., 2012).

2.3. Statistical analysis

We calculated the weighted distributions of participant characteristics overall and by frequency of e-cigarette use. To estimate the relationship between social media use (referent: non-extensive) and e-cigarette use frequency (referent: never/former), we employed multinomial logistic regression, adjusted for sociodemographic characteristics and other covariates. Additionally, we included a two-way interaction between extensive social media use and psychological distress in the adjusted model and assessed statistical significance using the Wald test. We accounted for the NYTS complex survey design and probability of non-response by using the svy command in Stata 18.0.

3. Results

Overall, the sample was 13–15 years old (44.1 %), male (50.2 %), NH White (50.4 %), and heterosexual (74.4 %) (Table 1). Most youth used social media <4 hours daily, weekly, or never (64.2 %), received A grades (45.0 %), had no other current tobacco use (95.5 %), and did not have family members who used tobacco within the last week (78.2 %). In the past 30 days, most youth did not use e-cigarettes (91.4 %); however, 3.9 % used infrequently (1–9 days), 2.4 % used frequently (10–29 days), and 2.4 % used daily (30 days). Of those who used e-cigarettes daily, 81.6 % were 16–18 years old, 54.6 % were female, 74.7 % were NH White, and 78.7 % were heterosexual. Additionally, of this group, 52.3 % used social media 4+ hours a day, 33.1 % earned B grades, and 39.1 % did not currently use other tobacco products, but

Table 2

Multivariate multinomial logistic regression estimating associations between frequency of social media use and frequency of e-cigarette use.

	E-cigarette use frequency ^a		
	1–9 days	10–29 days	30 days
	OR (95 % CI) ^b	OR (95 % CI)	OR (95 % CI)
Frequency of social media use (ref: never, weekly, or <4 hours daily)			
4+ hours	1.25 (1.00–1.57)	1.22 (0.91–1.65)	1.94 (1.48–2.56)
Age (ref: 9–12 years old)			
13–15	2.70 (1.74–4.17)	8.98 (3.83–21.04)	2.30 (0.99–5.36)
16–18	4.75 (2.80–8.04)	24.35 (10.48–56.61)	16.35 (7.08–37.79)
Sex (ref: male)			
Female	1.65 (1.22–2.23)	1.75 (1.048–56.61)	1.86 (1.28–2.72)
Race and ethnicity (ref: non-Hispanic White)			
Hispanic	0.88 (0.67–1.16)	0.63 (0.43–0.92)	0.31 (0.19–0.51)
Non-Hispanic Black	0.81 (0.55–1.20)	0.40 (0.36–1.49)	0.13 (0.06–0.29)
Non-Hispanic multiple races	1.04 (0.67–1.63)	0.73 (0.36–1.49)	0.60 (0.34–1.09)
Another race/ethnicity	0.43 (0.29–0.63)	0.33 (0.10–1.06)	0.27 (0.22–0.64)
Sexual orientation (ref: heterosexual)			
Lesbian/gay/bisexual	1.08 (0.82–1.41)	1.19 (0.86–1.63)	0.50 (0.30–0.83)
Unsure	0.84 (0.55–1.28)	0.68 (0.39–1.30)	0.46 (0.24–0.88)
Grades (ref: A's)			
B's	1.35 (1.07–1.71)	1.74 (1.23–2.45)	1.40 (0.99–1.98)
C's	1.73 (1.23–2.43)	2.51 (1.77–3.57)	1.93 (1.17–3.17)
D's/F's	1.90 (1.30–2.78)	2.52 (1.53–4.13)	3.82 (2.28–6.40)
None/unsure	1.53 (1.03–2.26)	1.11 (0.59–2.07)	1.36 (0.70–2.65)
Current other tobacco use (ref: no)			
Yes	13.18 (9.34–18.61)	18.21 (12.66–26.19)	22.64 (15.75–32.55)
Family tobacco use (ref: no)			
Yes	1.63 (1.24–2.36)	2.10 (1.57–2.80)	3.39 (2.45–4.68)

Note: Bolded text indicates statistical significance ($p < 0.05$).

^a Outcome referent group: never/former use of e-cigarettes

^b Odds ratios (OR) and 95 % confidence intervals adjusted for age, sex, race and ethnicity, sexual orientation, grades, other current tobacco use, and family tobacco use

53.7 % had family members who used tobacco in the last 7 days.

The adjusted regression model revealed that extensive social media use was associated with nearly two-fold increased odds of daily e-cigarette use (OR: 1.94, 95 % CI: 1.48–2.56) (Table 2). Older age (16–18 years) was associated with infrequent (OR: 4.75, 95 % CI: 2.80–8.04), frequent (OR: 24.35, 95 % CI: 10.48–56.61), and daily (OR: 16.35, 95 % CI: 7.08–37.79) e-cigarette use compared to 9–12 years old youth. Female sex (OR: 1.86, 95 % CI: 1.28–2.72) (vs. male sex) and grades of C (OR: 1.93, 95 % CI: 1.17–3.17) and D/F (OR: 3.82, 95 % CI: 2.28–6.40) (vs. A grades) were associated with higher odds of daily e-cigarette use.

Youth who identified as Hispanic (OR: 0.31, 95 % CI: 0.19–0.51), NH Black (OR: 0.13, 95 % CI: 0.06–0.29), and another race/ethnicity (OR: 0.27, 95 % CI: 0.22–0.64) had lower odds of daily e-cigarette use compared to NH Whites. Current use of other tobacco products (OR: 22.64, 95 % CI: 15.75–32.55) and family tobacco use (OR: 3.39, 95 % CI: 2.45–4.68) were strongest in magnitude for daily e-cigarette use but also associated with increased odds for less frequent use categories. Compared to heterosexual youth, those who identified as LGB (OR: 0.50, 95 % CI: 0.30–0.83) and who were “not sure” about their sexual orientation (OR: 0.46, CI: 0.24–0.88) had lower odds of daily e-cigarette use. Finally, the interaction between psychological distress and social media use was not statistically significant ($p = 0.21$), indicating no joint effect of these factors on e-cigarette use frequency in our model.

4. Discussion

This study examined the association between extensive social media use and the frequency of current e-cigarette use among a nationally representative sample of US youth. Our findings indicate that youth who engage in extensive social media use, defined as using social media four or more hours daily, had higher odds of daily e-cigarette use. However, we found no association involving less frequent e-cigarette use, suggesting that the comorbidity of social media use and e-cigarette use may exist only in forms of excessive use.

Our study builds on previous research that examined the relationship between social media and e-cigarette use, which predominantly relied on pre-pandemic data (Donaldson et al., 2022). For example, a meta-analysis by Donaldson et al. (2022) and a longitudinal study by Pérez et al. (2022) concluded that exposure to tobacco content on social media was associated with higher odds of e-cigarette use. Although our study did not examine social media content exposure specifics, we also found associations using more refined use frequency categories. Another study reported that daily social media use (versus non-daily or never) was associated with higher odds of e-cigarette use (Lee et al., 2023), which our findings also support. In addition, Cavazos-Rehg et al. (2021) showed that active, rather than passive, social media use correlated with a higher likelihood of initial and persistent e-cigarette use one year later. Further research examining longitudinal associations between social media use and e-cigarette use specifically is needed to specify these relationships.

By considering use frequencies of both social media and e-cigarettes and using recent data, we provide a detailed analysis of usage patterns, offering a nuanced understanding of the relationship between extensive social media and daily e-cigarette use in post-pandemic contexts. With the rapid evolution of social media, e-cigarette marketing strategies and product introductions, and the impact of COVID-19, such findings enhance our overall understanding of these public health challenges. Additionally, given that psychological distress is associated with both social media and e-cigarette use (American Psychological Association, 2023; Beyari, 2023; Lindson et al., 2024; Lydon et al., 2014, 2024; Morean and Krishnan-Sarin S, O'Malley, 2018; Smith et al., 2015; Office of the Surgeon General (OSG), 2023), more work is needed to understand the interrelationship among these three factors. We observed no joint effect between extensive social media use and psychological distress on current e-cigarette use. However, our findings highlight the need for future research to examine the timing and impact of social

media on youth e-cigarette uptake and progression into more problematic forms of use, including the ways in which psychological distress, or other mental health problems, may work synergistically to worsen e-cigarette use outcomes.

In the interim, social media is a critical platform for intervention, possibly through clinical and mobile health initiatives. Targeted interventions that address social media use frequency among youth and counteract youth-related, pro-e-cigarette messaging with effective anti-nicotine communication campaigns will potentially reduce the addiction potential of the two behaviors. These campaigns could additionally use social media analytics to identify and mitigate e-cigarette promotions and tailor content to counteract the appeal of e-cigarettes among youth.

4.1. Limitations

The findings of this study should be considered in the context of its limitations. First, the cross-sectional design of the NYTS prohibits temporal inferences between social media and e-cigarette use frequency. Thus, these data cannot be used to determine the timing by which social media use may lead to e-cigarette use. Second, other factors such as neurodevelopmental differences (e.g., ADHD, autism) or environmental influences may have introduced residual confounding in our models. Third, the NYTS relies on self-reported data subject to potential response biases (e.g., social desirability, recall).

5. Conclusion

This study contributes to the understanding of the association between extensive social media use and current e-cigarette use frequency among US youth. Our findings indicate that extensive engagement with social media is associated with daily e-cigarette use but not infrequent and frequent e-cigarette use. Although a joint effect between social media use and psychological distress on current e-cigarette use was not detected in this study, this possibility warrants evaluation in future work. Prevention strategies tailored to address determinants of tobacco use as well as regulatory policies, educational efforts, and family-centered programs to mitigate the influence of social media on risky behaviors are needed.

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CRediT authorship contribution statement

Joy L. Hart: Conceptualization, Funding acquisition, Writing – review & editing. **Delvon T. Mattingly:** Conceptualization, Data curation, Methodology, Supervision, Writing – review & editing. **Osayande Agbonlahor:** Conceptualization, Writing – review & editing. **Maggie Richardson:** Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

None.

References

- American Psychological Association. Health advisory on social media use in adolescence. Accessed April 24, 2023. (<https://www.apa.org/topics/social-media-internet/health-advisory-adolescent-social-media-use>)
- Beyari, H., 2023. The Relationship between Social Media and the Increase in Mental Health Problems. *Int J. Environ. Res Public Health* 20 (3), 2383. <https://doi.org/10.3390/ijerph20032383>.
- Birdsey, J., Cornelius, M., Jamal, A., et al., 2023. Tobacco product use among U.S. middle and high school students — national youth tobacco survey, 2023. *MMWR Morb. Mortal. Wkly Rep.* 72 (44), 1173–1182. <https://doi.org/10.15585/mmwr.mm7244a1>.
- Cavazos-Rehg, P., Li, X., Kasson, E., et al., 2021. Exploring how social media exposure and interactions are associated with ENDS and tobacco use in adolescents from the PATH study. *Nicotine Tob. Res* 23 (3), 487–494. <https://doi.org/10.1093/ntr/ntaa113>.
- Cooper, M., Park-Lee, E., Ren, C., Cornelius, M., Jamal, A., Cullen, K.A., 2022. Notes from the field: E-cigarette use among middle and high school students — United States, 2022. *MMWR Morb. Mortal. Wkly Rep.* 71 (40), 1283–1285. <https://doi.org/10.15585/mmwr.mm7140a3>.
- Donaldson, S.I., Dormanesh, A., Perez, C., Majmundar, A., Allem, J.-P., 2022. Association between exposure to tobacco content on social media and tobacco use: A systematic review and meta-analysis. *JAMA Pediatr.* 176 (9), 878–885. <https://doi.org/10.1001/jamapediatrics.2022.2223>.
- Gentzke, A.S., Wang, T.W., Cornelius, M., et al., 2022. Tobacco product use and associated factors among middle and high school students — national youth tobacco survey, United States, 2021. *MMWR Surveill. Summ.* 71 (SS-5), 1–29. <https://doi.org/10.15585/mmwr.ss7105a1>.
- Jerzyński, T., Stimson, G.V., 2023. Estimation of the global number of vapers: 82 million worldwide in 2021. *Drugs, Habits Soc. Policy* 24 (2), 91–103. <https://doi.org/10.1108/DHS-07-2022-0028>.
- Kroenke, K., Spitzer, R.L., Williams, J.B., Löwe, B., 2009. An ultra-brief screening scale for anxiety and depression: the PHQ-4. *Psychosomatics* 50 (6), 613–621. <https://doi.org/10.1176/appi.psy.50.6.613>.
- Lee, J., Krishnan-Sarin, S., Kong, G., 2023. Social Media Use and Subsequent E-Cigarette Susceptibility, Initiation, and Continued Use Among US Adolescents. *E78 Prev. Chronic Dis.* 20. <https://doi.org/10.5888/pcd20.220415>.
- Lindson, N., Butler, A.R., McRobbie, H., et al., 2024. Electronic cigarettes for smoking cessation. *Cochrane Database Syst. Rev.* (1), CD010216 <https://doi.org/10.1002/14651858.CD010216.pub8>.
- Lydon, D.M., Wilson, S.J., Child, A., et al., 2014. Adolescent brain maturation and smoking: what we know and where we're headed. *Neurosci. Biobehav. Rev.* 45, 323–342. <https://doi.org/10.1016/j.neubiorev.2014.07.003>.
- Massey, Z.B., Brockenberry, L.O., Harrell, P.T., 2021. Vaping, smartphones, and social media use among young adults: Snapchat is the platform of choice for young adult vapers. *Addict. Behav.* 112, 106576 <https://doi.org/10.1016/j.addbeh.2020.106576>.
- Mattingly, D.T., Hart, J.L., 2024. Trends in current electronic cigarette use among youths by age, sex, and race and ethnicity. *JAMA Netw. Open* 7 (2), e2354872. <https://doi.org/10.1001/jamanetworkopen.2023.54872>.
- Morean, M.E., Krishnan-Sarin, S., O'Malley, S.S., 2018. Assessing nicotine dependence in adolescent e-cigarette users: the 4-item patient-reported outcomes measurement information system (PROMIS) nicotine dependence item bank for electronic cigarettes. *Drug Alcohol Depend.* 188, 60–63. <https://doi.org/10.1016/j.drugalcdep.2018.03.029>.
- Office of Research Integrity. When do activities need Institutional Review Board (IRB) review and approval? University of Kentucky. Published 2023. Accessed June 21, 2024. (<https://www.research.uky.edu/office-research-integrity>)
- Office of the Surgeon General (OSG). Social Media and Youth Mental Health: The U.S. Surgeon General's Advisory. Washington, DC: US Department of Health and Human Services; 2023.
- Office on Smoking and Health. 2022 National Youth Tobacco Survey: Methodology Report. 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; 2022.
- Oliver, B.E., Jones, S.E., Hops, E.D., Ashley, C.L., Miech, R., Mpofu, J.J., 2023. Electronic vapor product use among high school students — youth risk behavior survey, United States, 2021. *MMWR Suppl.* 72 (Suppl-1), 93–99. <https://doi.org/10.15585/mmwr.su7201a11>.
- Pérez, A., Spells, C.E., Bluestein, M.A., Harrell, M.B., Hébert, E.T., 2022. The longitudinal impact of seeing and posting tobacco-related social media on tobacco use behaviors among youth (aged 12-17): findings from the 2014-2016 Population Assessment of Tobacco and Health (PATH) Study. *Tob. Use Insights* 15, 1–7. <https://doi.org/10.1177/1179173X221087554>.
- Rothwell J. How parenting and self-control mediate the link between social media use and youth mental health. Institute for Family Studies and Gallup; October 11, 2023.
- Smith, R.F., McDonald, C.G., Bergstrom, H.C., et al., 2015. Adolescent nicotine induces persisting changes in development of neural connectivity. *Neurosci. Biobehav. Rev.* 55, 432–443. <https://doi.org/10.1016/j.neubiorev.2015.05.019>.
- Vassey, J., Galimov, A., Kennedy, C.J., et al., 2022. Frequency of social media use and exposure to tobacco or nicotine-related content in association with E-cigarette use among youth: a cross-sectional and longitudinal survey analysis. *Prev. Med Rep.* 30, 102055 <https://doi.org/10.1016/j.pmedr.2022.102055>.
- Viner, R.M., Ozer, E.M., Denny, S., et al., 2012. Adolescence and the social determinants of health. *Lancet* 379 (9826), 1641–1652. [https://doi.org/10.1016/S0140-6736\(12\)60149-4](https://doi.org/10.1016/S0140-6736(12)60149-4).
- Vogels E.A., Gelles-Watnick R. Teens and social media: Key findings from Pew Research Center surveys. Pew Research Center. Published April 24, 2023. (<https://www.pewresearch.org/short-reads/2023/04/24/teens-and-social-media-key-findings-from-pew-research-center-surveys/>)
- Zhang, L., Ao, S.H., Zhao, X., 2023. Longitudinal relationship between social media and e-cigarette use among adolescents: the roles of internalizing problems and academic performance. *BMC Public Health* 23 (1), 2133. <https://doi.org/10.1186/s12889-023-17059-8>.
- Zheng, X., Li, W., Wong, S.-W., et al., 2021. Social media and E-cigarette use among US youth: Longitudinal evidence on the role of online advertisement exposure and risk perception. *Addict. Behav.* 119, 106916 <https://doi.org/10.1016/j.addbeh.2021.106916>.
- Zubair, U., Khan, M.K., Albashari, M., 2023. Link between extensive social media use and psychiatric disorders. *Ann. Med Surg. (Lond.)* 85 (4), 875–878. <https://doi.org/10.1097/MS9.000000000000112>.