Disposable E-Cigarette Use and Subsequent Use Patterns in Adolescents and Young Adults

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abstract

BACKGROUND AND OBJECTIVES: Disposable electronic cigarettes (e-cigarettes) are widely used by adolescents and young adults (AYAs). Whether using disposable devices is associated with future e-cigarette use patterns is unknown but important for informing e-cigarette regulation.

METHODS: Prospective longitudinal study combining data from adolescent (14–17 years) and young adult (21–24 years) cohorts from Southern California surveyed at baseline and approximately 8-month follow-up during 2021 to 2022. The analyses included AYAs who used e-cigarettes in the past 30 days at baseline and had exposure and outcome data ($N = 403$; adolescent $n = 124$, young adult $n = 279$).

RESULTS: In the pooled sample of AYAs who used e-cigarettes at baseline (57.2% cis-gender female, 56.2% Hispanic), 278 (69.0%) reported past 30-day disposable e-cigarette use, and 125 (31.0%) used only nondisposable e-cigarettes. Baseline use of disposable (versus only nondisposable) devices was associated with higher odds of continued e-cigarette use (adjusted odds ratio = 1.92; 95% confidence interval = 1.09–3.42) and a greater number of times used e-cigarettes per day at follow-up (adjusted incidence rate ratio = 1.29; 95% confidence interval = 1.02–1.63). In supplemental analyses, disposable e-cigarette use was associated with greater odds of no changes (versus reductions) in e-cigarette use frequency and puffs per episode from baseline to follow-up but was not associated with increases in use frequency and intensity. No differences in e-cigarette use outcomes were found between those with poly-device (disposable and nondisposable) versus only disposable device use.

CONCLUSIONS: Use of disposable e-cigarette devices among AYAs may be associated with higher risks for persistent e-cigarette use patterns, which should be considered in tobacco product regulation designed to protect AYAs.

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WHAT'S KNOWN ON THIS SUBJECT: Disposable e-cigarettes are the most prevalent device type used among adolescent and young adults in the United States. It is unknown whether the use of disposable e-cigarettes increases risk of persistent, frequent, and high intensity e-cigarette use patterns.

WHAT THIS STUDY ADDS: Disposable (versus nondisposable) device use among adolescents and young adults was prospectively associated with higher odds of persistent e-cigarette use.

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There is considerable heterogeneity in the persistence or chronicity (ie, use duration over time), frequency (ie, number of days used per month), and intensity (ie, number of times used per day and puffs per episode) of e-cigarette use behavior among adolescent and young adults (AYAs). Recent estimates from regional and national samples of AYA individuals who use e-cigarettes indicate: (1) over 60% continue e-cigarette use 6 month later,[1,2] (b) 20.8% to 46.0% use e-cigarettes ≥20 days per month,[3] and (2) 16% to 31% have high intensity use patterns involving using e-cigarettes ≥20 times per day on days they use e-cigarettes.[4] Higher chronicity, frequency, and intensity of e-cigarette use in AYAs may increase odds of nicotine addiction,[5,6] combustible tobacco smoking,[6–8] respiratory symptoms,[9] and mental health problems.[10,11]

E-cigarettes are available in various device types, including tank-style or pen-like devices, rechargeable pod-style devices, and disposable products (Supplemental Figs 2 and 3).[12,13] Disposable e-cigarettes – the most prevalent device type used among US AYAs[3,14] – could increase risk of persistent, frequent, and high intensity e-cigarette use. Disposable e-cigarettes come in colorful packaging and designs and various sweet flavors and can be used discreetly and easily concealed, appealing to AYAs.[14] These devices are inexpensive and more convenient than nondisposable devices because they do not require recharging, purchasing e-liquid refills, and/or replacement pods. Most disposable devices contain nicotine in protonated salt formulation.[15,16] In comparison with nonprotonated nicotine solutions often used in refillable devices,[17,18] nicotine salt solutions are less harsh and bitter,[19] which might result in deeper inhalation, increased nicotine extracted per puff, and higher puff intensity patterns. US Food and Drug Administration (FDA), state, and local regulatory agencies can place sales restrictions on e-cigarette devices that, when used by AYAs, may perpetuate or exacerbate e-cigarette use patterns.

However, it is unclear whether use of disposable products leads to persistence of e-cigarette use in young people. This prospective longitudinal study of AYAs from Southern California who used e-cigarettes investigated the association of using disposable e-cigarette devices with continued e-cigarette use and subsequent use frequency and intensity at approximately 8-month follow-up.

METHODS

Participants and Procedures

This study pooled data from 2 consecutive survey waves from 2 ongoing longitudinal cohorts. The Happiness and Health (H&H)[20] Study cohort initially recruited ninth graders from 10 high schools in Los Angeles County in 2013 who completed surveys of health behavior 1 to 2 times per year throughout high school and into young adulthood. After high school, young adult surveys in the H&H study were conducted remotely, wherein participants were sent an online invitation with a link to complete the web-based survey. The ADVANCE Study[21] cohort recruited adolescents in ninth grade from 11 schools across 5 Southern California counties in 2020 and 2021 (Los Angeles, Riverside, San Bernardino, Orange, or Imperial counties). ADVANCE participants completed in-classroom surveys 2 times per year on computers at their respective schools; those absent during data collection days completed web-based surveys remotely outside of their class time. Both cohorts used the same survey measures and digital interfaces.

This study used the 2 recent survey waves: H&H Study (baseline: January 2021–June 2021; follow-up: November 2021–March 2022) and ADVANCE (baseline: September–December 2021; follow-up: February 2022–June 2022), with a median 7.5 (interquartile range: 5.0–9.3; range: 5–14) month intervals between waves. The analytic sample was restricted to participants who reported past 30-day e-cigarette use and had nonmissing data on baseline e-cigarette device type and follow-up e-cigarette use outcomes (N = 403, Fig 1). Before data collection, participants provided informed consent (H&H) or parental consent and student assent (ADVANCE). The study was approved by the University of Southern California Institutional Review Board.

Measures

Baseline Past 30-Day Use of Disposable E-cigarette Devices and Other Device Types

Baseline self-reported past 30-day use of various e-cigarette device types were measured using separate items for each electronic nicotine device. Participants reported past 30-day use (coded ≥1 vs 0 days) for each device: (1) disposable devices without separate cartridges or pods (yes or no), (2) rechargeable devices with prepackaged or refillable cartridges or pods (yes or no), (3) vape pen or pen-like rechargeable device (yes or no), (4) tank-style rechargeable devices, including mod, mech-mod, box mod, or other tank style device with refillable e-liquid (yes or no), and (5) any other type of electronic nicotine device (yes or no). For the primary exposure of disposable device type, responses were dichotomized, separating those who used disposable devices versus those who did not use disposable devices (ie, used only nondisposable devices [ie, rechargeable pod or cartridge, vape pen, tank or mod, and/or another device]). Among those who used disposable devices, we created a binary poly-device exposure variable separating disposable device use only versus using disposable and ≥1 nondisposable device.

Continued E-Cigarette Use and Use Frequency and Intensity at Follow-Up

At baseline and follow-up, participants reported the number of days within the past 30 days that they used e-cigarettes.

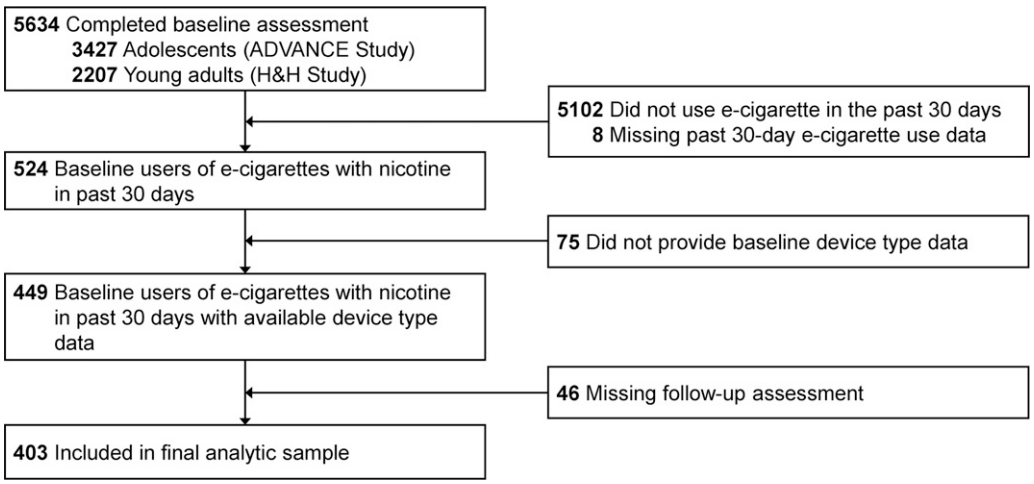

FIGURE 1
Flowchart of study participants.

Responses were recoded into a binary use continuation outcome variable (≥1 vs 0 days) and a separate count use frequency outcome variable (range: 0–30 days) as in previous research.[1,2,22] Two e-cigarette use intensity survey items were administered at baseline and follow-up: (1) On the days you used your e-cigarette, how many times did you usually pick up your e-cigarette device? (response options: 1, 2, 3–5, 6–9, 10–14, 15–20, 20+ times per day); (2) Each time you picked up your e-cigarette, how many puffs did you usually take before putting it away? (1, 2, 3–5, 6–9, 10–14, 15–20, 20+ puffs). Both e-cigarette use intensity survey item responses were recoded into separate count outcome variables (range: 0–20) by taking the median integer within each response range (eg, 1 [= 1], 3–5 [= 4], 10–14 [= 12], 20+ [= 20]) and coding those who did not use e-cigarettes in the past 30-days as 0 as in previous work.[1,23]

Covariates

Variables that may be associated with exposure to certain devices and/or e-cigarette use patterns and could potentially confound associations were incorporated as a priori covariates based on the literature: self-reported sociodemographic, e-cigarette use, cigarette smoking, and other drug use characteristics.[1,2,14,23–28] Self-reported sociodemographic characteristics included age (continuous), gender (cisgender male, cisgender female, another gender), sexual identity (heterosexual, sexual minority), race and ethnicity (Hispanic or Latino, Non-Hispanic Asian, Non-Hispanic white, or Non-Hispanic another race or ethnicity [American Indian/Alaska Native, Black or African American, Native Hawaiian or Pacific Islander, or multiracial]), and highest parental education level (high school graduate or lower versus some college or higher).[21] E-cigarette use characteristics included baseline e-cigarette use frequency and intensity, nicotine concentration (ie, <5%, 5%, >5%, and "do not know"), and e-cigarette flavor used most often (sweet, menthol or mint, ice-fruit, and another flavor). Other substance use behaviors that may be peripheral to e-cigarette use patterns, including past-month combustible cigarette smoking, smoking or vaporizing cannabis, and binge drinking were assessed.

Statistical Analysis

Preliminary analyses involved calculating descriptive statistics and distributional properties for baseline e-cigarette use patterns and other covariates, stratified by baseline use of disposable devices, using χ^2 and independent samples *t* tests. To assess for potential selection bias, e-cigarette use patterns and covariates were compared between participants included versus excluded from the sample.

In primary analyses, binary logistic regression models estimated associations between use of disposable e-cigarette device type and continued e-cigarette use (yes or no) at follow-up. Given that e-cigarette use frequency and intensity counts were not normally distributed, negative binomial regression modeling was used to test associations between baseline device type and follow-up use frequency and intensity. Likelihood ratio tests confirmed presence of overdispersion for each model (eg, outcome: number of times used e-cigarette per day, $\chi^2 = 735.8$, $P < .001$), supporting negative binomial models over Poisson models.[29] Main analyses included: (1) partially adjusted model adjusting for baseline past 30-day e-cigarette use frequency (number of days used) and intensity (number of times used per day and puffs per episode) and (2) fully adjusted models additionally adjusting for baseline sociodemographic variables, e-cigarette use characteristics (nicotine concentration typically used, flavor used most often), and other substance use (cigarette smoking, smoking or vaporizing cannabis, binge drinking).

A multiple imputation with chained equations approach[30] was employed to account for missing data on covariates (sociodemographic factors: 0.3% to 13.7%; e-cigarette use characteristics: 1.6% to 12.3%; other nicotine or substance use: 0.3% to 12.9%), with 5 imputed data sets generated via 40 iterations for each set. Although we expected disposable device type would be associated with increased e-cigarette use, hypotheses about which of the 4 specific e-cigarette use outcomes would be associated were not proposed. Significance was set to 0.05 (2-tailed) uncorrected across the 4 tests in the primary analysis. All models revealed negligible multicollinearity (variance inflation factor index <2.5). Analyses were performed in R version 4.2.3.

Sensitivity and Supplement Analysis

We calculated e-values that present the minimum strength of association unmeasured confounders would need to have with the exposure (eg, disposable device use) and outcome (eg, e-cigarette use patterns) to artifactually yield the observed association (ie, lower bound of the confidence interval [CI]) if the true association were null.[31–33] Sensitivity analyses expanded upon significant associations in the primary analysis by comparing outcomes between poly-use of disposable and nondisposable devices versus only disposable devices among those who used disposable devices. To determine if baseline use of another device types may have confounded the primary results, we retested the main models adjusting for use of rechargeables with cartridge or pod, vape pen, tank or mod, and any other device types. In supplemental analyses, we tested: (1) the association of disposable e-cigarette use with changes in e-cigarette use frequency and intensity (decrease or quit, remain the same, or increase) between baseline and follow-up to see if device type is associated with e-cigarette use persistence and/or progression, (2) associations between the use of each of the nondisposable devices (rechargeable pod or cartridge, vape pen, tank or mod) and each outcome, and (3) interactions between disposable e-cigarette use and cohort to examine if the main association would differ between adolescent and young adult cohorts.

RESULTS

Study Sample

Among the 5634 participants who completed baseline surveys pooled across the 2 cohorts, 524 (9.3%) reported e-cigarette use in the past 30 days (Fig 1). Of those with past 30-day e-cigarette use, participants with missing data on e-cigarette device type used (n = 75) or follow-up outcome (n = 46) were excluded, resulting in an analytic sample of 403. In comparison with participants excluded because of missing data, the analytic sample had younger baseline age, more frequent e-cigarette use, less likely to smoke cigarettes, and used e-cigarettes with higher nicotine concentration and different flavors but did not differ in other characteristics (Supplemental Table 3).

Descriptive Analyses

The characteristics of the pooled analytic sample of adolescent (124 [30.8%], mean [SD] age = 15.3 [0.6] years) and young adult (279 young adults [69.2%], mean [SD] age = 21.8 [0.4] years) participants are depicted in Table 1. The pooled sample (n = 403; mean [SD] age = 19.9 [3.0] years) was sociodemographically diverse (57.2% cisgender female, 31.5% sexual minority, 56.2% Hispanic/Latino, 72.3% had parent who attended or graduated college). Participants reported e-cigarette use, on average, on 12.6 (SD = 11.7) of the past 30 days, using e-cigarettes 8.9 (SD = 7.4) times per day, and puffing 4.7(SD = 4.3) times per episode.

Disposable e-cigarette devices were the most frequently used e-cigarettes (69.0%), followed by vape pens (61.8%), rechargeable pod or cartridge (42.2%), tank or mods (24.6%), and another device type (3.7%). Participants using disposable devices (versus nondisposable device users) reported greater number of used days in the past 30 days and of times used per day at baseline (P < .01).

Associations of Disposable Device Use With Continued E-Cigarette Use and Use Frequency and Intensity

Descriptive statistics of study outcomes by disposable device use and results of regression models in primary analyses are depicted in Table 2. Baseline use of disposable e-cigarette devices (versus using only nondisposable devices) was positively associated with continued e-cigarette use in the past 30 days at follow-up (74.2% vs 58.1%) in a fully adjusted model, including all Table 1 covariates (odds ratio [OR] = 1.92, 95% CI = 1.09–3.42). Baseline use of disposable (versus only nondisposable) devices was also associated with greater number of times used per day at follow-up (Mean 9.6 vs 6.0; incident rate ratio [IRR] = 1.29, 95% CI = 1.02–1.63). Disposable (versus nondisposable) device use was not associated with number of days used and puffs per episode.

Sensitivity and Supplementary Analyses

Results of sensitivity analyses to determine the robustness of associations and generalizability of associations with e-cigarette use continuation and use intensity outcome are reported in Supplemental Tables 4–9. The e-value analysis indicate that an unmeasured confounder(s) would need to have a relatively moderate-to-large association[31] (range: 1.81–2.12) with the exposure and outcome to explain the observed associations (Supplemental Table 4). Models that additionally adjusted for other e-cigarette device types used produced similar estimates to those found in

TABLE 1 Participant Characteristics at Baseline

Variables	Overall Sample (n = 403)	Baseline Use of Disposable Devices[a]		
		Yes (n = 278)	No (n = 125)	P
Continued e-cigarette use at follow-up	264 (69.3)	196 (74.2)	68 (58.1)	.002
E-cigarette use frequency and intensity				
Number of days used e-cigarettes in past 30 d, M (SD)	12.6 (11.7)	13.6 (11.7)	10.2 (11.4)	.006
Number of times used per day, M (SD)	8.9 (7.4)	10.0 (7.5)	6.5 (6.6)	<.001
Number of puffs per episode, M (SD)	4.7 (4.3)	4.9 (4.4)	4.3 (4.1)	.231
Demographics				
Age, M (SD)	19.9 (3.0)	19.9 (3.0)	19.8 (3.1)	.655
Gender identity				.274
Cisgender male	145 (37.2)	95 (35.4)	50 (41.0)	
Cisgender female	223 (57.2)	160 (59.7)	63 (51.6)	
Another gender[b]	22 (5.6)	13 (4.9)	9 (7.4)	
Sexual minority identity[c]	123 (31.5)	89 (33.2)	34 (27.6)	.325
Race and ethnicity				.274
Hispanic or Latino	195 (56.2)	128 (53.1)	67 (63.2)	
Non-Hispanic Asian	65 (18.7)	49 (20.3)	16 (15.1)	
Non-Hispanic white	42 (12.1)	29 (12.0)	13 (12.3)	
Non-Hispanic another race and ethnicity[d]	45 (13.0)	35 (14.5)	10 (9.4)	
Parents attended college	245 (72.3)	173 (75.9)	72 (64.9)	.046
E-cigarette and other substance use				
Nicotine concentration typically used in e-cigarette				<.001
Less than 5%	106 (30.2)	60 (23.9)	46 (46.0)	
5%	179 (51.0)	148 (59.0)	31 (31.0)	
Greater than 5%	32 (9.1)	21 (8.4)	11 (11.0)	
Do not know	34 (9.7)	22 (8.8)	12 (12.0)	
E-cigarette flavor used most often				<.001
Fruit, candy, dessert, or buttery flavors	154 (39.0)	92 (33.6)	62 (51.2)	
Menthol or mint	59 (14.9)	35 (12.8)	24 (19.8)	
Fruit-cooling combination	148 (37.5)	129 (47.1)	19 (15.7)	
Another flavor[e]	34 (8.6)	18 (6.6)	16 (13.2)	
Past 30-d use of nondisposable devices[f]				
Rechargeable pod or cartridge	170 (42.2)	119 (42.8)	51 (40.8)	.789
Vape pen	249 (61.8)	148 (53.2)	101 (80.8)	<.001
Tank or mod	99 (24.6)	67 (24.1)	32 (25.6)	.843
Another device type	15 (3.7)	9 (3.2)	6 (4.8)	.630
Any past 30-d cigarette smoking	67 (16.7)	48 (17.3)	19 (15.3)	.735
Any past 30-d smoking or vaporizing cannabis	255 (63.6)	70 (56.0)	185 (67.0)	.044
Any past 30-d binge drinking[g]	221 (62.4)	160 (65.3)	61 (56.0)	.120

Results are n (%) unless otherwise specified. Frequencies may not sum to the total because of different patterns of missing data across variables.

[a] Used disposable e-cigarette device without separate cartridges or pods in past 30 d.

[b] Transgender male or female, gender variant or nonbinary, or another gender identity.

[c] Asexual, bisexual, gay, lesbian, pansexual, queer, questioning or unsure, or another nonheterosexual identity.

[d] American Indian/Alaska Native, Black or African American, Native Hawaiian/Pacific Islander, or multiracial.

[e] Flavorless, tobacco, nonsweet (eg, alcohol, clove, coffee, spice), or mix of flavors.

[f] Rechargable pod or cartridge = rechargeable device that uses prepackaged or refillable cartridges or pods; vape pen = vape pen or pen-like rechargeable device; tank or mod = mod, mech-mod, box mod, tank style rechargeable device. Not mutually exclusive.

[g] Five or more (for males) or 4 or more (for females) drinks of alcohol in a row within a couple of hours.

the main analyses (Supplemental Table 5). We found no differences in e-cigarette use outcomes between those with baseline disposable device use with poly-device (disposable and nondisposable) versus only disposable device use, indicating that primary results were not driven by the subset who used disposable and nondisposable devices (Supplemental Table 6). Supplemental analyses indicate that (1) disposable e-cigarette use was associated with greater odds of no changes (versus reductions) in the number of days used e-cigarettes and puffs per episode from baseline to follow-up, but was not associated with increases in e-cigarette use frequency and intensity (Supplemental Table 7), (2) there were no significant interactions between use of disposable e-cigarette devices

TABLE 2 Association of Baseline Disposable E-Cigarette Device Type Used With Past 30-d E-cigarette Use Patterns at Follow-up

	N (%) or M (SD)	Partially Adjusted Association[a]		Full Adjusted Association[b]	
		Estimate (95% CI)	*P*	Estimate (95% CI)	*P*
Outcome: continued e-cigarette use (yes or no)					
Disposable device	196 (74.2)[c]	1.68 (1.02–2.76)[e]	.040	1.92 (1.09–3.42)[e]	.025
Only nondisposable devices	68 (58.1)[c]	Reference	—	Reference	—
Outcome: number of days used e-cigarettes					
Disposable device	13.4 (12.6)[d]	1.26 (0.92–1.72)[f]	.153	1.32 (0.95–1.83)[f]	.103
Only nondisposable devices	8.4 (11.9)[d]	Reference	—	Reference	—
Outcome: number of times used e-cigarettes per day[g]					
Disposable device	9.6 (7.7)[d]	1.25 (1.00–1.55)[f]	.045	1.29 (1.02–1.63)[f]	.031
Only nondisposable devices	6.0 (7.0)[d]	Reference	—	Reference	—
Outcome: number of puffs per episode[g]					
Disposable device	3.4 (4.2)[d]	1.06 (0.80–1.39)[f]	.696	1.11 (0.82–1.48)[f]	.501
Only nondisposable devices	3.1 (4.9)[d]	Reference	—	Reference	—

E-values for point estimate and lower 95% confidence limit are reported in Supplemental Table 4.
[a] Adjusting for baseline e-cigarette use frequency and intensity covariates listed in Table 1.
[b] Adjusting for all baseline e-cigarette use frequency and intensity, demographic, e-cigarette and other substance use covariates listed in Table 1.
[c] *N* (%) of respective outcome at follow-up, stratified by based disposable device type use status.
[d] M (SD) of respective outcome at follow-up, stratified by based disposable device type use status.
[e] Odds ratio of association of baseline device type use (disposable versus only nondisposable) with outcome from binary logistic regression models.
[f] Incident rate ratio of association of baseline device type use (disposable versus only nondisposable) with outcome from negative binomial logistic regression models.
[g] Participants who did not use e-cigarettes in the past 30 d were coded 0.

and cohort (Supplemental Table 8), and (3) use of each specific nondisposable e-cigarette device type was not associated with follow-up outcomes (Supplemental Table 9).

DISCUSSION

This study indicates that AYAs who use disposable versus nondisposable e-cigarettes may be more likely to continue e-cigarette use and have greater number of past 30-day e-cigarette use episodes after approximately 8 months of follow-up. In addition, disposable e-cigarette use was associated with greater odds of no changes (versus reductions) in e-cigarette use frequency and intensity (number of puffs per episode) and was not associated with increases in e-cigarette use frequency and intensity from baseline to follow-up. Although prior studies investigated cross-sectional associations of e-cigarette device type used with e-cigarette use behaviors and patterns,[14,24–28] to our knowledge this is the first prospective analysis to assess associations of disposable e-cigarette device type with subsequent persistence of AYA e-cigarette use behavior.

Unique characteristics of disposable e-cigarettes may contribute to the association of using disposable devices with subsequent e-cigarette use patterns. Disposable e-cigarettes previously or currently on the market, such as Puff Bar, Elf Bar, and Flum brands, are uniquely convenient and inexpensive (eg, approximately $17.99 with 5000+ puffs per device). Individuals merely buy the product (given the inexpensive price), unwrap the package and start using e-cigarettes, and dispose of the device when the solution is depleted. These features of disposable devices could make it easier for AYAs to continue using e-cigarettes in comparison with other device types that require purchasing a more expensive starter kit and repeatedly purchasing solution refills. Additionally, disposable device's heating elements and constituents may allow users' exhaled emissions to resemble air instead of cloud-like aerosol when taking short puffs and holding in aerosol according to vaping blogs.[34] These features combined with the small size of disposable devices might allow "stealth" or "zero" vaping wherein individuals use e-cigarettes clandestinely in settings where e-cigarette use may not be socially or legally acceptable (eg, indoors, at work, or at school),[34] which is not possible with larger nondisposable devices that are conspicuous and produce more visible emissions. This feature could explain why disposable device use could be associated with a greater number of use episodes throughout the day as observed in this study. Disposable e-cigarettes also typically contain solutions with high concentrations of nicotine salt formulation,[15–18] which could result in substantial nicotine delivery in the context of palatable aerosol.[19] Presumably, these properties of disposable e-cigarettes could promote the persistence of and higher-intensity e-cigarette use patterns in AYAs. However, high concentrations of nicotine salt solutions are also prominent in pod-style nondisposable e-cigarette devices, which were not also associated with subsequent use patterns in this study's supplementary analyses.

Despite FDA policies to ban cartridge-based e-cigarettes in flavors other than tobacco or menthol in 2020,[35] disposable e-cigarettes continue to be sold in a variety of flavors that may appeal to AYAs, such as menthol, mint, fruit, sweet, and ice (ie, a combination of sweet and fruit and cooling

flavors).[36] Wide availability of flavors may be one explanation for why prevalence of disposable e-cigarette use in young populations continues to be high,[3,14] which aligns with increased sales of disposable e-cigarettes with fruit, sweet, and other flavors in the United States during 2020 to 2022[37] and growth in use prevalence of disposable products, particularly in young people.[38] It is worth commenting that the tobacco product market continually evolves in response to tobacco control policies. For example, when flavors of cartridge-based e-cigarette were restricted by the FDA in 2020, flavored disposable e-cigarettes became the predominant e-cigarette product used by adolescents. More recently, flavored oral nicotine products are increasingly marketed in the United States[39] and used by AYAs.[21,40] Hence, comprehensive policies that restrict youth-appealing flavors in all nicotine and tobacco products merit consideration to protect AYAs.

Study findings should be interpreted in light of the following limitations: reliance on self-report measures, lack of biochemical verification of nicotine use by participants, relatively small sample size, and potentially limited generalizability to other regions of the United States or age groups. There may also be residual confounding by variables not included or not measured in this study. For example, because of different measures between adolescent and young adult surveys, the analysis did not adjust for mental health symptoms. However, relatively moderate-to-large e-values calculated in this study might reduce the concern about unobserved confounding.[31–33] The estimates in this study only changed slightly after adjustment for a number of different covariates, also allaying concerns over residual confounding. Supplemental analyses of the direction of changes in e-cigarette use frequency and intensity outcomes revealed some positive associations between disposable device use and persistent (versus reducing) patterns of frequency and intensity, but the associations with increases in use frequency and intensity were nonsignificant. Although these results may not indicate disposable device use is associated with e-cigarette use progression, smaller cell counts resulting in relatively wide 95% CIs for these analyses suggest that these null findings (for progression) should be interpreted with caution.

CONCLUSIONS

Among AYAs from Southern California who use e-cigarettes, use of disposable e-cigarette devices at baseline was associated with higher risks for persistent e-cigarette use after approximately 8 months of follow-up. Given the AYA rapid migration of the market to disposable e-cigarettes after FDA's regulation aimed at reducing flavored cartridge-based products in 2020, our findings suggest that policies comprehensively regulating the spectrum of nicotine products used by young people, including disposable e-cigarettes, merit consideration in efforts to deter persistent patterns of AYA nicotine use.

ABBREVIATIONS

AYAs: adolescent and young adults
CI: confidence interval
IRR: incidence rate ratio
OR: odds ratio

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