



Brief Report

Cannabis Use and the Onset of Cigarette and E-cigarette Use: A Prospective, Longitudinal Study Among Youth in the United States

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Abstract

Introduction: Cigarette use is declining among youth in the United States, whereas cannabis use and e-cigarette use are increasing. Cannabis use has been linked with increased uptake and persistence of cigarette smoking among adults. The goal of this study was to examine whether cannabis use is associated with the prevalence and incidence of cigarette, e-cigarette, and dual product use among U.S. youth.

Methods: Data included U.S. youth ages 12–17 from two waves of the Population Assessment of Tobacco and Health (PATH) Study (Wave 1 youth, $n = 13\ 651$; Wave 1 tobacco-naive youth, $n = 10\ 081$). Weighted logistic regression models were used to examine the association between Wave 1 cannabis use and (1) Wave 1 prevalence of cigarette/e-cigarette use among Wave 1 youth and (2) Wave 2 incidence of cigarette/e-cigarette use among Wave 1 tobacco-naive youth. Analyses were run unadjusted and adjusted for demographics and internalizing/externalizing problem symptoms.

Results: Wave 1 cigarette and e-cigarette use were significantly more common among youth who used versus did not use cannabis. Among Wave 1 tobacco-naive youth, Wave 1 cannabis use was associated with significantly increased incidence of cigarette and e-cigarette use by Wave 2.

Conclusions: Youth who use cannabis are more likely to report cigarette and e-cigarette use, and cannabis use is associated with increased risk of initiation of cigarette and e-cigarette use over 1 year. Continued success in tobacco control—specifically toward reducing smoking among adolescents—may require focusing on cannabis, e-cigarette, and cigarette use in public health education, outreach, and intervention efforts.

Implications: These data extend our knowledge of cigarette and e-cigarette use among youth by showing that cannabis use is associated with increased prevalence and incidence of cigarette and e-cigarette use among youth, relative to youth who do not use cannabis. The increasing popularity of cannabis use among youth and diminished perceptions of risk, coupled with the strong

link between cannabis use and tobacco use, may have unintended consequences for cigarette control efforts among youth.

Introduction

Tobacco use remains the leading cause of premature death and disease in the United States and a major cause of mortality around the world.^{1,2} Cigarette use has decreased over the past several decades¹ whereas, concurrently, cannabis use is increasing rapidly in the United States and other countries.³

Cannabis and tobacco use are intimately intertwined, and use of both may disproportionately affect young people. Among people who use cannabis, current cigarette use is 2–3× more common than among people who do not use cannabis.⁴ In addition, the dual use of some tobacco products (eg, cigarettes and smokeless tobacco⁵) and cannabis has increased over time among youth and adults.⁵ Daily cannabis use and cannabis use disorders have increased among youth ages 12–17 who smoke cigarettes, with ~25% of youth cigarette users in 2015 reporting daily cannabis use.^{4,6} Understanding whether cannabis use is associated with heightened tobacco use and/or increased odds of incident tobacco use among youth is urgent given vulnerability for developing lifelong addiction when exposed early in life.

Like cannabis, the use of noncigarette tobacco products (eg, e-cigarettes) has also increased dramatically, especially among youth. E-cigarettes are currently the most commonly used tobacco product among U.S. high school and middle school students.⁷ The degree to which cannabis use may affect the use of e-cigarettes among youth is not known.

The goal of this study was to use two waves of longitudinal national U.S. data, collected a year apart, to examine the relationship of cannabis use to cigarette, e-cigarette, and dual product (ie, cigarettes and e-cigarettes) use among youth. The first aim was to estimate the prevalence of Wave 1 cigarette and e-cigarette use among youth who did versus who did not report Wave 1 cannabis use. The second aim was to estimate the incidence of Wave 2 cigarette and e-cigarette use among Wave 1 tobacco-naïve youth who did versus did not report Wave 1 cannabis use.

Methods

Data Source and Study Population

Data were drawn from the first two waves of the Population Assessment of Tobacco and Health (PATH) Study (Wave 1, 2013–2014; Wave 2, 2014–2015), a longitudinal cohort study conducted by Westat that assesses tobacco use and health behavior in a population representative sample of civilian, noninstitutionalized, U.S. persons age 12 years and older (see refs. ^{8,9} for more details). For Aim 1 (ie, Wave 1 prevalence of cigarette/e-cigarette use by Wave 1 cannabis use status), analyses included individuals ages 12–17 who reported data on cannabis, cigarette, and e-cigarette use at Wave 1 ($n = 13\,651$). For Aim 2 (Wave 2 incident cigarette/e-cigarette use by Wave 1 cannabis use status), analyses included individuals ages 12–17 who reported data on cannabis, cigarette, and e-cigarette use at Wave 1 and cigarette and e-cigarette use at Wave 2 ($n = 10\,081$).

Measurements

Cigarette Use

Two cigarette use variables were determined for each wave: “any use” and “exclusive use.” “Cigarette use (any use)” included all

respondents who reported cigarette use (ie, cigarette use with or without e-cigarette use). As the “cigarette use (any use)” category included youth who both did and did not report e-cigarette use, a second variable, “cigarette use (exclusive use),” was created to capture those with exclusive cigarette use and no e-cigarette use. Youth who reported at Wave 1 or Wave 2 that they used cigarettes in the past 30 days were classified as having “Wave 1 cigarette use (any use)” or “Wave 2 cigarette use (any use),” respectively. Youth who reported past 30-day cigarette use and no past 30-day e-cigarette use at Wave 1 or Wave 2 were classified as having “Wave 1 cigarette use (exclusive use)” or “Wave 2 cigarette use (exclusive use),” respectively.

E-cigarette Use

Similar to cigarette use, two e-cigarette use variables were determined for each wave: “any use” and “exclusive use.” “E-cigarette use (any use)” included all respondents who reported e-cigarette use (ie, e-cigarette use with or without cigarette use). As the “e-cigarette use (any use)” category included youth who both did and did not report cigarette use, a second variable, “e-cigarette use (exclusive use),” was created to capture those with exclusive e-cigarette use and no cigarette use. Youth who reported at Wave 1 or Wave 2 that they used e-cigarettes in the past 30 days were classified as having “Wave 1 e-cigarette use (any use)” or “Wave 2 e-cigarette use (any use),” respectively. Youth who reported past 30-day e-cigarette use and no past 30-day cigarette use at Wave 1 or Wave 2 were classified as having “Wave 1 e-cigarette use (exclusive use)” or “Wave 2 e-cigarette use (exclusive use).”

Dual Product Use

Those who reported both past 30-day cigarette use and past 30-day e-cigarette use at Wave 1 (or Wave 2) were classified as having dual product use at Wave 1 (or Wave 2).

Cannabis Use

Among those who reported that they had ever used marijuana, hash, THC, grass, pot, or weed, those who reported any use of these products within the past 30 days were classified as having cannabis use.

Covariates

Wave 1 demographic covariates included race/ethnicity (non-Hispanic [NH] White, NH Black, Hispanic, NH Other [ie, all other races or more than one race]), gender (male, female), and age (12–14 years old, 15–17 years old). Wave 1 mental health covariates, past 30-day internalizing problems (low, moderate, high) and past 30-day externalizing problems (low, moderate, high), were assessed by the Global Appraisal of Individual Needs—Short Screener (GAIN-SS) and scored to be consistent with other studies (eg, ref. ¹⁰).

Statistical Analysis

For Aim 1, weighted logistic regression models were conducted to assess the association between Wave 1 past 30-day cannabis use status (cannabis use versus no cannabis use; independent variable) and the Wave

1 tobacco use categories (ie, cigarette use [any use], e-cigarette use [any use], dual product use; dependent variables) among all Wave 1 respondents. Analyses were repeated examining exclusive use in place of any use as the dependent variable. For Aim 2, weighted logistic regression models were conducted to study the association between Wave 1 past 30-day cannabis use (independent variable) and Wave 2 past 30-day incident tobacco use (ie, cigarette use [any use], e-cigarette use [any use], dual product use; dependent variables) among Wave 1 tobacco-naive respondents. Analyses were repeated examining exclusive use in place of any use as the dependent variable. All analyses were run unadjusted and adjusted for baseline demographic covariates (ie, race/ethnicity, gender, age). Mental health covariates (ie, internalizing and externalizing problems) were also included in Aim 1 analyses. Sample sizes are reported in the tables for each analytic group after accounting for missing data. All analyses were performed using SAS-callable SUDAAN Version 11.0.1¹¹ and incorporating the PATH sampling weights to account for the complex clustered sampling and nonresponse bias. We used the balanced repeated replication method with Fay's adjustment and replicate weights (supplied by Westat⁷) in weighted analyses.

Results

Sample Characteristics and Cannabis Use

The Wave 1 analytic sample was approximately half male (51.2%) and NH White (48.5%; Hispanic 28.9%; NH Black 13.4%; NH Other 9.2%). Wave 1 cannabis users were older than noncannabis users (15.9 years vs 14.4 years, $p < .001$). Gender ($p = .69$) and racial/ethnic ($p = .93$) composition did not differ by Wave 1 cannabis use. At both Wave 1 and Wave 2, ~5% of youth reported past 30-day cannabis use. The incidence of cannabis use at Wave 2 was ~3.5%.

Prevalence of Wave 1 Cigarette Use, E-cigarette Use, Dual Product Use, and Exclusive Product Use by Wave 1 Cannabis Use Status

The prevalences of Wave 1 cigarette use (any use), e-cigarette use (any use), and dual product use were significantly higher for youth who reported Wave 1 cannabis use than youth who did not report

Wave 1 cannabis use (see Table 1). Adjusted for demographics and mental health variables, cannabis use was associated with a more than 11-fold increased odds of cigarette use (any use) and dual product use and an over sevenfold increased odds of e-cigarette use (any use). When analyses were repeated examining exclusive cigarette and e-cigarette use, odds ratios were attenuated but still significant (cigarette use [exclusive use], adjusted odds ratio = 8.6, 95% confidence interval = 6.6, 11.2; e-cigarette use [exclusive use], adjusted odds ratio = 3.9, 95% confidence interval = 2.8, 5.5).

Incidence of Wave 2 Cigarette Use, E-cigarette Use, Dual Product Use, and Exclusive Product Use by Wave 1 Cannabis Use Status

Among those who reported Wave 1 cannabis use, Wave 2 incident cigarette use (any use), e-cigarette use (any use), dual product use, and exclusive product use were significantly higher than among those who did not report Wave 1 cannabis use (see Table 2). Adjusted for demographics, Wave 1 cannabis use was associated with an over fivefold increased odds of cigarette (any use) incidence, over fourfold increased odds of e-cigarette (any use) incidence, and over sevenfold increased odds of incident dual product use. When analyses were repeated examining incident exclusive cigarette and e-cigarette use, odds ratios were attenuated but still significant (cigarette [exclusive use] use, adjusted odds ratio = 4.4, 95% confidence interval = 2.5, 7.7; e-cigarette [exclusive use] use, adjusted odds ratio = 3.1, 95% confidence interval = 1.7, 5.7).

Discussion

There are two main findings from this study. First, the prevalences of cigarette use (any use and exclusive use), e-cigarette use (any use and exclusive use), and dual product use were substantially higher among youth with versus without cannabis use at Wave 1. Second, among Wave 1 tobacco-naive youth, Wave 1 cannabis use was associated with increased incidence of cigarette use (any use and exclusive use), e-cigarette use (any use and exclusive use), and dual product use 1 year later at Wave 2.

Table 1. Prevalence of Wave 1 Past 30-day Cigarette and E-cigarette Use by Wave 1 Past 30-day Cannabis Use Status Among Youth (PATH Wave 1, Ages 12–17)

	Past 30-day cannabis use at Wave 1				Cannabis use versus no cannabis use		
	No cannabis use		Cannabis use		OR (95% CI)	aOR ^d (95% CI)	aOR ^e (95% CI)
Past 30-day tobacco product use at Wave 1 ^a	N ^b = 12 907	% ^c	N ^b = 673	% ^c			
Cigarette use (any use)	369	2.8	255	37.1	20.5 (16.9, 24.8)	13.4 (10.8, 16.6)	11.9 (9.5, 14.9)
E-cigarette use (any use)	262	2.1	152	22.7	13.9 (11.3, 17.2)	9.0 (7.1, 11.4)	7.4 (5.7, 9.6)
Dual product use ^f	101	0.7	92	13.4	21.1 (15.8, 28.2)	14.2 (10.1, 20.1)	11.9 (8.2, 17.3)
Cigarette use (exclusive use)	263	2.0	163	23.5	14.9 (12.0, 18.6)	9.3 (7.2, 11.9)	8.6 (6.6, 11.2)
E-cigarette use (exclusive use)	160	1.3	60	9.3	7.7 (5.8, 10.1)	4.7 (3.4, 6.5)	3.9 (2.8, 5.5)

Subgroup totals may not add up due to missing values (eg, dual product use + cigarette use [exclusive use] vs cigarette use [any use]).

aOR = adjusted odds ratio; CI = confidence interval; OR = odds ratio; PATH = Population Assessment of Tobacco and Health Study.

^a“Cigarette use (any use)” and “e-cigarette use (any use)” included all participants who reported cigarette or e-cigarette use, respectively (regardless of whether they reported use of the other product). “Cigarette use (exclusive use)” and “e-cigarette use (exclusive use)” included only participants who reported cigarette use and no e-cigarette use or participants who reported e-cigarette use and no cigarette use, respectively.

^bUnweighted N.

^cWeighted %.

^dAdjusted for race, gender, and age.

^eAdjusted for race, gender, age, past-month internalizing problems, and past-month externalizing problems.

^fUse of both cigarettes and e-cigarettes in the past month.

Table 2. Incidence of Wave 2 Past 30-day Cigarette and E-cigarette Use by Wave 1 Past 30-day Cannabis Use Status Among Youth Who Were Tobacco Naive at Wave 1 (PATH Waves 1 and 2, Ages 12–17)

Past 30-day tobacco product use at Wave 2 ^a	Past 30-day cannabis use at Wave 1				Cannabis use versus no cannabis use	
	No cannabis use		Cannabis use		OR (95% CI)	aOR ^d (95% CI)
	N ^b	% ^c	N ^b	% ^c		
Cigarette use (any use)	213	2.3	32	16.9	8.7 (5.4, 14.0)	5.7 (3.6, 9.1)
E-cigarette use (any use)	246	2.8	29	16.1	6.8 (4.5, 10.1)	4.5 (2.9, 6.9)
Dual product use ^e	59	0.6	13	7.5	12.5 (6.5, 24.4)	7.6 (4.0, 14.3)
Cigarette use (exclusive use)	149	1.6	19	9.2	6.3 (3.6, 10.9)	4.4 (2.5, 7.7)
E-cigarette use (exclusive use)	187	2.1	16	8.5	4.4 (2.4, 7.9)	3.1 (1.7, 5.7)

Subgroup totals may not add up due to missing values (eg, dual product use + cigarette use [exclusive use] vs cigarette use [any use]).

aOR = adjusted odds ratio; CI = confidence interval; OR = odds ratio; PATH = Population Assessment of Tobacco and Health Study.

^a“Cigarette use (any use)” and “e-cigarette use (any use)” included all participants who reported cigarette or e-cigarette use, respectively (regardless of whether they reported use of the other product). “Cigarette use (exclusive use)” and “e-cigarette use (exclusive use)” included only participants who reported cigarette use and no e-cigarette use or participants who reported e-cigarette use and no cigarette use, respectively.

^bUnweighted N.

^cWeighted %.

^dAdjusted for race, gender, and age.

^eUse of both cigarettes and e-cigarettes in the past month.

Cigarette use declined among high schoolers from ~28% in 1976 to ~4% in 2018;¹² this is tremendous progress as adolescence is the most vulnerable period for developing regular or dependent cigarette smoking.¹³ At the same time, cannabis and e-cigarette use are increasing among youth and associated with cigarette use and nicotine dependence.^{12,14,15} Mechanistic theory supports a potential role for cannabis use in tobacco use onset and maintenance.¹⁶ Specifically, there are overlaps in the neurobiological systems involved with nicotine and cannabis^{17,18} and a number of similar psychological and psychosocial factors associated with the use of cannabis and tobacco.^{19,20} Our analyses of incident e-cigarette and cigarette use included Wave 1 tobacco-naive participants and are consistent with other evidence of a reverse gateway effect where cannabis use occurs first and is followed by use of cigarettes and/or other tobacco products (eg, ref. ²¹). If cannabis use continues to rise and cannabis use is associated with increased cigarette and e-cigarette use, the question arises as to whether this increase could lead to a slowing and/or potential reversal of progress in tobacco control.

Cannabis use has negative consequences on cognition and the brain development,²² and the harms of tobacco use are well documented.¹ The use of both cannabis and cigarettes is associated with greater negative consequences (eg, psychosocial problems, higher toxicant exposure) than either substance alone.^{5,6,22–24} The potential harms of e-cigarettes are still being investigated, but decreasing the use of e-cigarettes by adolescents has been recommended.^{14,25} Public health and clinical efforts to continue reducing tobacco use among youth should consider the potential impact of increasing cannabis use (eg, a larger number of adolescents vulnerable to the harms of cannabis and tobacco use) in the future.

This study included U.S. youth ages 12–17, and the results may not apply to other age groups or other countries. Data were obtained through self-report, which may be subjected to underreporting or reporting biases and errors. Modes of cannabis use are changing (eg, vaping THC), and there was no information available to examine what youth were vaping (eg, nicotine and/or THC). Future research should examine vaping of nicotine versus THC with regard to differences in e-cigarette use and cannabis

use and the relationship of cannabis to other aspects of cigarette and e-cigarette use (eg, frequency of use).²⁶ Options, availability, and popularity of e-cigarette products are perpetually and rapidly changing.^{14,27} Consequently, the assessment of e-cigarettes in more recent waves of the PATH differs from earlier waves, and such assessments are expected to change over time to most accurately assess products in an evolving tobacco marketplace. Therefore, the relationship between cannabis, cigarette, and e-cigarette use among youth demands continuing investigation, so that the changes in types, availability, and other aspects of product use are taken into account to inform clinical and public health implications on an ongoing basis. Finally, due to the cell sizes, we could not include mental health covariates in Aim 2 analyses or include additional covariates (eg, socioeconomic status) in analyses for either aim. Future research should examine these and other psychological and psychosocial variables related to cannabis–tobacco use (eg, parent smoking history, alcohol use) as potential confounders.

Conclusions

Continued success in tobacco control—including reducing the number of adolescents who smoke cigarettes—may require addressing cannabis, e-cigarette, and cigarette use in youth-targeted public health, outreach, and intervention efforts.

Supplementary Material

A Contributorship Form detailing each author's specific involvement with this content, as well as any supplementary data, are available online at <https://academic.oup.com/ntr>.

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Declaration of Interests

None declared.

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