

E-Hookah Versus E-Cigarettes: Findings From Wave 2 of the PATH Study (2014–2015)



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Introduction: ENDS are evolving quickly with increasing use in the U.S. More recently, e-hookahs have been introduced as healthier alternatives to the traditional hookah-flavored tobacco smoking. To date, virtually all studies of ENDS have focused on e-cigarettes; consequently, little is known about e-hookah use.

Methods: Data were drawn from the 2014–2015 Wave 2 Population Assessment of Tobacco and Health study, a nationally representative sample of adults aged ≥ 18 years ($n=28,362$) and youth aged 12–17 years ($n=12,172$). Weighted analyses, conducted in 2018–2019, estimated the prevalence of e-hookah versus e-cigarette and examined comparisons among users and sociodemographics, patterns of use, and co-use of tobacco products and substances.

Results: Overall, 4.6% of adults reported ever e-hookah use; of these, more than a quarter (26.8%) reported current use. For e-cigarettes, 22.5% reported ever use with 24.8% reporting current use. Among youth, 7.7% reported ever e-hookah use versus 14.3% for e-cigarette use. Comparing e-hookah versus e-cigarette only users, the majority were young adults aged 18–24 years versus ≥ 25 years (60.5% vs 17.3%, $p<0.0001$) with the majority being female (58.8% vs 46.0%, $p<0.0001$). Although alcohol and marijuana were the most common substances used among e-hookah and e-cigarette users, both adult and youth e-hookah only users had a higher prevalence of use than e-cigarette only users.

Conclusions: Although e-hookahs are used less commonly than e-cigarettes, e-hookah use is not rare. Compared with e-cigarette users, e-hookah users have a different profile in terms of user demographics and co-use of substances. Given the rapid uptake of ENDS by young adults, these findings suggest the need to understand e-hookah products' distinct characteristics and users' smoking patterns and behaviors to help inform tobacco regulation specific to hookah.

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INTRODUCTION

ENDS are evolving rapidly with increasing use in the U.S. and around the world.^{1,2} ENDS are rechargeable battery-operated devices consisting of a power source and a heating element that vaporizes a liquid that contains nicotine, propylene glycol, glycerin, and flavorings, mimicking conventional tobacco products but without combustion.³ Although the most widely popular ENDS are e-cigarettes, recent studies suggest that users perceive other ENDS such as e-hookahs as distinct from e-cigarettes.⁴

In 2014, e-hookahs were introduced as healthier alternatives to traditional charcoal-heated hookah (i.e., water

pipe) fruit-flavored tobacco smoking.^{5,6} Currently, there are 2 types of e-hookah products being marketed: e-hookah pens and e-hookah bowls (Appendix Figure 1, available

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online).⁷ Whereas e-hookah pens are used in a same manner as e-cigarettes, e-hookah bowls are used differently. E-hookah bowls are placed on traditional water pipes, allowing the vapor to pass through a water-filled base, cooling the vapor, before being carried through the hose into the user's mouth.

Little is known on how e-hookahs' product characteristics, user demographics, and use patterns are different from those of e-cigarettes. A single pilot study comparing ENDS demonstrated that e-cigarettes and e-hookahs differ by product characteristics.⁶ Although a greater proportion of e-cigarettes were tobacco- or menthol-flavored, a greater proportion of e-hookahs were fruit, candy, and alcoholic drink flavored, the latter of which closely resembles flavored tobacco marketed and sold for traditional hookah. A focus group study with adolescents and young adults aged 13–25 years found that participants discussed flavors only in regard to e-hookahs, not e-cigarettes.⁸ E-cigarette users were described as older in age and addicted to nicotine, whereas e-hookah users were described as cool, fun, and up-to-date with new technology. To date, beyond e-hookah flavors, there is no known additional literature on e-hookahs' product characteristics, toxic contaminants in flavored liquid, aerosol constituents, or health risks.⁹

Virtually all epidemiologic studies of ENDS have focused on e-cigarettes; little information is available on e-hookah use. E-cigarette use is rapidly increasing in popularity among both youth and adults. The U.S. National Youth Tobacco Survey showed that among high school students, current use of e-cigarettes increased from 1.5% in 2011 to 11.3% in 2016 with greater use among male than female students.¹ According to the Wave 1 population assessment of tobacco and health (PATH) study (2013–2014), the prevalence of use among adults in the previous 30 days was 6.7%, whereas the prevalence of current regular use was 2.4%, with most users among those aged 18–24 years than among those aged ≥ 25 years.¹⁰

Use of substances such as alcohol and marijuana strongly correlates with e-cigarette use.^{11,12} By contrast, nothing has been reported about the use of e-hookah at the population level in the U.S. Accordingly, the objective of this study is to estimate the prevalence of e-hookah versus e-cigarette use and examine comparisons among users and sociodemographics, patterns of use, and co-use of tobacco products and substances in a nationally representative sample of youth and adults aged ≥ 12 years in the 2014–2015 PATH study.

METHODS

Study Population

The authors used data from Wave 2 of the PATH study conducted from October 23, 2014 to October 30, 2015. Wave 2 data included

a nationally representative longitudinal cohort of 28,362 U.S. adults aged ≥ 18 years and 12,172 U.S. youth aged 12–17 years. Data were restricted to Wave 2 because Wave 1 did not contain any specific questions pertaining to e-hookah use.

Recruitment for the PATH study employed the use of a probability sample that oversampled tobacco users, young adults (aged 18–24 years), and African American adults. The sample was weighted to allow representation of the non-institutionalized, civilian U.S. population. Additional details on the PATH study design and methods are published elsewhere.¹³ The PATH study was approved by Westat's IRB, and the U.S. Office of Management and Budget approved the data collection.

Measures

Demographic data on age, sex (male/female), race/ethnicity, sexual orientation, education level, marital status, health insurance, and annual household income were collected during the Wave 2 interview. Age was categorized as: 12–14, 15–17, 18–24, 25–34, 35–44, 45–54, and ≥ 55 years. Race was classified as: non-Hispanic white, non-Hispanic black, other non-Hispanic, and Hispanic. Sexual orientation was categorized as: heterosexual and lesbian, gay, bisexual, or something else. Education levels were categorized by grade starting from 6th to 11th grade, no college, some college, and other; the latter of which included respondents: not enrolled this year or last, home schooled, school not graded, 12th grade, college, or vocational school. Marital status was categorized as married and nonmarried; the latter of which included widowed, divorced, separated, or never married. Annual household income was categorized into income: $< \$25,000$, $\$25,000$ – $\$49,999$, $\$50,000$ – $\$99,999$, and $> \$100,000$.

Ever (lifetime) use was assessed among adults and youth for e-hookah and e-cigarettes. Current use was defined as currently using the e-product every day or some days. Because youth were not queried about their current e-hookah use, current use was only assessed among adults.

Using survey questions, participants were categorized into 4 groups: e-hookah only users, e-cigarette only users, e-hookah plus e-cigarette users, and neither e-hookah nor e-cigarette users. E-hookah only users were defined as those reporting ever e-hookah but not e-cigarette use, whereas e-cigarette only users were defined as those reporting ever e-cigarette but not e-hookah use. E-hookah plus e-cigarette users were defined as those reporting ever use of both products, and neither e-hookah nor e-cigarette users were defined as those who did not report ever using either product. Study participants were not mutually exclusive to only e-hookah or e-cigarette use.

To characterize the patterns and frequency of use, those who reported current use were asked the following 3 questions: (1) when they last used the e-product, with response options being: *in the past hour*, *sometime today*, *yesterday*, *day before yesterday*, and *3 or more days ago*; (2) time of day when they last used the e-product, with response options being: *between midnight and 6:00AM*, *after 6:00AM but before noon*, *between noon and 6:00PM*, and *after 6:00PM but before midnight*; and (3) to indicate the number of puffs from the e-product used today/yesterday/day before yesterday. Although there were other questions pertaining to patterns of use specific to e-cigarettes (i.e., time to first puff after waking, number of days used in the past 30 days) for a paired comparison, the authors only included questions that also were asked to e-hookah users.

To assess for co-use of other tobacco, alternative tobacco products, nicotine devices, and substances, all participants were asked about their ever use of the following: cigarettes, cigars (traditional and filtered), cigarillos, hookah, smokeless tobacco (i.e., loose snus, moist snuff, dip, spit, or chewing tobacco), pipe tobacco, snus pouches, dissolvable tobacco, bidis (youth only), and kreteks (youth only). Past-year use of the following substances was also asked: alcohol, marijuana, Ritalin/Adderall, painkillers/sedatives, cocaine, methamphetamine, and other drugs (including heroin, inhalants, solvents, or hallucinogens). To separate ever use of ENDS, participants were asked the following: *Which of the following electronic nicotine products have you ever used?* with the following response options: *e-cigarette (including vape pens and personal vaporizers), e-cigar, e-pipe, or e-hookah (including hookah pens).*

Statistical Analysis

Weighted percentages and means along with their corresponding 95% CIs were obtained using SAS, version 9.4 in 2018–2019. To utilize the replicate weights, a balanced repeated replication with Fay's variant were used in all analyses. Comparisons between demographic variables and groups (e-hookah only, e-cigarette only, e-cigarette and e-hookah, or neither) or between only e-cigarette and e-hookah groups were determined with Rao–Scott chi-square tests. Wald F tests were computed to compare continuous variables and groups.

In general, <0.5% of participants had missing, unascertained, or inconsistent values pertaining to e-hookah or e-cigarette use (0.36% for adults and 0.46% for youth). For substance use, 1.26% of adults and 24.31% of youth had missing, unascertained, or inconsistent values for at least 1 substance. In terms of descriptive statistics, the weighted percentage of adult participants with missing data were as follows: 0.55% for age, 0.11% for sex, 1.95% for race, 2.10% for sexual orientation, 0.42% for education level, 0.31% for marital status, 0.53% for health insurance, and 8.79% for household income. Youth participants with missing data were as follows: 0.13% for age, 0.24% for sex, 2.62% for race, and 0.35% for education level. Individuals with missing, unascertained, or inconsistent values were not included in relevant analyses.

RESULTS

Among surveyed adults, 4.57% were identified as ever e-hookah users and 1.23% current e-hookah users (data not presented). Among those who reported ever e-hookah use, 26.84% were current e-hookah users. E-cigarette use was more prevalent; 22.49% were identified as ever users and 5.58% reported current use. Among those who reported ever e-cigarette use, 24.82% were current e-cigarette users. Among youth, 7.68% were identified as ever e-hookah users and 14.26% were ever e-cigarette users. No PATH data were reported on current e-hookah use among youth. [Appendix Table 1](#) (available online) presents the prevalence breakdown of the 4 groups.

[Table 1](#) presents the demographic characteristics of study participants. The profile of ever users who reported only e-hookah use was qualitatively different than those who reported only e-cigarettes. The majority

(60%) of adult e-hookah only users ($n=823$) were aged 18–24 years compared with 17% e-cigarette only users ($n=9,914$, $p<0.0001$). Although most of e-hookah only users were female (59%), 46% of e-cigarette only users were female ($p<0.0001$). Approximately 35% of e-hookah only users were non-Hispanic white compared with 69% e-cigarette only users ($p<0.0001$). Most of the e-hookah and e-cigarette participants had completed some college (60% and 54%, respectively; $p=0.027$) and were not married (86% and 64%, respectively; $p<0.0001$). Similar to e-hookah only users, the majority (57%) of those who reported e-hookah plus e-cigarettes use were aged 18–24 years. However, similar to e-cigarette only users, most of the dual users were male. Those who used neither e-hookah nor e-cigarettes were older than e-hookah and e-cigarettes users, with 42% aged ≥ 55 years.

Among youth, most of the e-hookah only ($n=401$) and e-cigarette only ($n=1,157$) users were aged 15–17 years (both 74%, $p=0.850$). However, more use was reported among female participants in the e-hookah only user group compared with e-cigarette only users (54% and 44%, respectively; $p=0.002$). Although 40% of e-hookah only users were Hispanic, only 20% of e-cigarette only users were Hispanic. The majority (63%) of e-cigarette only users were non-Hispanic white compared with 31% e-hookah only users ($p<0.0001$). Both the e-hookah and e-cigarette only users reported completing 11th grade and other (including being home schooled, school not graded, 12th grade, college, or vocational school) at similar rates (49% and 48%, respectively; $p<0.0001$).

Three questions addressed patterns of use specific to e-hookah ([Appendix Table 2](#), available online). A much larger percentage of e-hookah compared with e-cigarette users reported infrequent use, with the last time used being ≥ 3 days prior (87% vs 49%, $p<0.0001$). Approximately 23% of e-cigarette users reported last use within the last hour versus 1% e-hookah only users.

Compared with e-hookah only users, e-hookah plus e-cigarette users reported more frequent e-hookah use with respect to use within the past hour (1% vs 5%, $p=0.21$) and the number of puffs today, yesterday, and the day before (6 vs 19, $p=0.004$). By contrast, among e-cigarette users, e-cigarette only users report more frequent use of e-cigarette in the past hour compared with e-hookah plus e-cigarette users (23% vs 14%, $p<0.0001$).

Among adult current e-hookah users, the prevalence of multiple-product use was 65.17% versus 72.79% among current e-cigarette users ([Figure 1](#)). A total of 88 different combinations of products used were reported among e-hookah users and 142 among e-cigarette users. Among e-hookah users, the most common combination was e-hookah plus cigarettes (16.24%) and for e-cigarettes,

Table 1. Demographic Characteristics of Ever Use Study Participants^a

Characteristic	Adult (N=28,362)				Youth (N=12,172)			
	E-hookah only, % (CI) (n=823)	E-cigarette only, % (CI) (n=9,914)	E-hookah + e-cigarette, % (CI) (n=2,109)	Neither e-hookah nor e-cigarette, % (CI) (n=15,407)	E-hookah only, % (CI) (n=401)	E-cigarette only, % (CI) (n=1,157)	E-hookah + e-cigarette, % (CI) (n=558)	Neither e-hookah nor e-cigarette, % (CI) (n=9,997)
Age, years ^{b,c,d}								
12–14	—	—	—	—	26.49 (22.51, 30.46)	25.89 (23.65, 28.13)	15.9 (12.56, 19.24)	56.35 (55.82, 56.88)
15–17	—	—	—	—	73.51 (69.54, 77.49)	73.66 (71.41, 75.91)	84.1 (80.76, 87.44)	43.54 (43.02, 44.07)
18–24	60.48 (55.78, 65.18)	17.29 (16.53, 18.04)	57.38 (54.41, 60.35)	8.69 (8.41, 8.97)	—	—	—	—
25–34	25.79 (21.33, 30.25)	28.19 (26.96, 29.43)	25.25 (22.8, 27.70)	14.19 (13.52, 14.87)	—	—	—	—
35–44	8.58 (5.42, 11.75)	19.71 (18.6, 20.82)	9.55 (7.81, 11.29)	15.99 (15.33, 16.65)	—	—	—	—
45–54	2.57 (0.98, 4.16)	15.77 (14.9, 16.63)	4.99 (3.83, 6.16)	18.20 (17.53, 18.86)	—	—	—	—
≥55	2.28 (0.99, 3.57)	18.52 (17.37, 19.67)	1.98 (1.10, 2.85)	42.40 (41.63, 43.17)	—	—	—	—
Sex ^{b,c,d,e}								
Male	41.20 (37.07, 45.34)	53.88 (52.71, 55.06)	54.14 (51.68, 56.59)	46.23 (45.9, 46.56)	45.50 (40.81, 50.19)	55.39 (52.54, 58.23)	53.58 (49.41, 57.75)	50.73 (50.29, 51.17)
Female	58.80 (54.66, 62.93)	46.04 (44.87, 47.21)	45.86 (43.41, 48.32)	53.64 (53.31, 53.98)	53.99 (49.28, 58.7)	44.48 (41.66, 47.3)	46.42 (42.25, 50.59)	49.03 (48.58, 49.48)
Race ^{b,c,d,e}								
White, non-Hispanic	34.61 (29.79, 39.43)	69.27 (68.05, 70.5)	50.29 (47.34, 53.24)	64.51 (64.03, 64.99)	31.08 (25.12, 37.04)	62.55 (59.45, 65.65)	57.22 (53.17, 61.27)	51.92 (51.34, 52.51)
Black, non-Hispanic	28.81 (24.35, 33.27)	9.61 (8.86, 10.37)	14.04 (12.18, 15.9)	10.86 (10.62, 11.11)	19.94 (15.02, 24.86)	8.21 (6.49, 9.94)	9.05 (5.9, 12.2)	13.63 (13.23, 14.03)
Other, non-Hispanic	6.19 (4.18, 8.19)	7.05 (6.41, 7.68)	8.62 (6.92, 10.31)	7.65 (7.42, 7.87)	7.62 (4.38, 10.87)	8.14 (6.47, 9.81)	7.72 (5.66, 9.78)	9.52 (9.17, 9.87)
Hispanic	30.04 (26.43, 33.66)	12.42 (11.68, 13.17)	26.51 (23.73, 29.28)	14.89 (14.62, 15.16)	39.94 (34.97, 44.91)	20.21 (17.51, 22.92)	24.78 (21.1, 28.47)	22.02 (21.54, 22.5)
Sexual orientation								
Heterosexual	92.09 (89.53, 94.65)	91.63 (91.01, 92.26)	86.99 (85.21, 88.77)	93.88 (93.25, 94.5)	—	—	—	—
LGB ^f	7.77 (5.21, 10.33)	7.05 (6.53, 7.56)	12.55 (10.79, 14.3)	3.74 (3.3, 4.19)	—	—	—	—

(continued on next page)

Table 1. Demographic Characteristics of Ever Use Study Participants^a (continued)

Characteristic	Adult (N=28,362)				Youth (N=12,172)			
	E-hookah only, % (CI) (n=823)	E-cigarette only, % (CI) (n=9,914)	E-hookah + e-cigarette, % (CI) (n=2,109)	Neither e-hookah nor e-cigarette, % (CI) (n=15,407)	E-hookah only, % (CI) (n=401)	E-cigarette only, % (CI) (n=1,157)	E-hookah + e-cigarette, % (CI) (n=558)	Neither e-hookah nor e-cigarette, % (CI) (n=9,997)
Education level								
6th grade	—	—	—	—	1.17 (0.10, 2.24)	1.34 (0.70, 1.98)	0.41 (0, 0.87)	6.71 (6.19, 7.24)
7th grade	—	—	—	—	2.21 (0.65, 3.78)	4.43 (3.23, 5.63)	1.99 (0.78, 3.20)	17.46 (16.69, 18.24)
8th grade	—	—	—	—	12.49 (9.01, 15.97)	9.45 (7.66, 11.24)	5.30 (3.02, 7.58)	18.17 (17.52, 18.82)
9th grade	—	—	—	—	13.18 (9.85, 16.51)	14.54 (12.79, 16.28)	14.17 (11.05, 17.28)	16.90 (16.24, 17.55)
10th grade	—	—	—	—	21.34 (17.09, 25.6)	21.79 (19.08, 24.51)	21.26 (18.10, 24.42)	15.43 (14.72, 16.13)
11th grade	—	—	—	—	24.26 (19.12, 29.39)	22.97 (20.34, 25.61)	30.4 (26.20, 34.59)	12.94 (12.32, 13.55)
Other ^g	—	—	—	—	25.19 (20.88, 29.51)	25.18 (22.46, 27.89)	26.37 (22.60, 30.15)	12.03 (11.43, 12.63)
No college	39.54 (34.81, 44.28)	45.17 (43.75, 46.6)	42.43 (39.72, 45.13)	37.55 (36.9, 38.19)	—	—	—	—
Some college	60.24 (55.49, 64.99)	54.23 (52.77, 55.68)	57.05 (54.38, 59.72)	62.10 (61.48, 62.72)	—	—	—	—
Marital status								
Married	14.01 (10.48, 17.55)	35.94 (34.71, 37.17)	18.85 (16.77, 20.93)	58.05 (56.95, 59.15)	—	—	—	—
Not married ^h	85.50 (81.95, 89.06)	63.63 (62.4, 64.85)	80.88 (78.75, 83)	41.68 (40.58, 42.78)	—	—	—	—
Health insurance								
No	15.51 (12.22, 18.81)	19.67 (18.6, 20.73)	22.72 (20.08, 25.36)	9.99 (9.47, 10.51)	—	—	—	—
Yes	83.25 (79.96, 86.53)	79.80 (78.72, 80.89)	76.44 (73.75, 79.12)	89.51 (88.97, 90.05)	—	—	—	—

(continued on next page)

Table 1. Demographic Characteristics of Ever Use Study Participants^a (continued)

Characteristic	Adult (N=28,362)				Youth (N=12,172)			
	E-hookah only, % (CI) (n=823)	E-cigarette only, % (CI) (n=9,914)	E-hookah + e-cigarette, % (CI) (n=2,109)	Neither e-hookah nor e-cigarette, % (CI) (n=15,407)	E-hookah only, % (CI) (n=401)	E-cigarette only, % (CI) (n=1,157)	E-hookah + e-cigarette, % (CI) (n=558)	Neither e-hookah nor e-cigarette, % (CI) (n=9,997)
Annual household income, \$								
<25,000	37.63 (33.26, 42.01)	39.09 (37.44, 40.73)	44.50 (41.57, 47.42)	26.30 (25.35, 27.25)	—	—	—	—
25,000–49,999	22.00 (17.62, 26.38)	23.30 (22.21, 24.39)	18.54 (16.43, 20.65)	20.26 (19.32, 21.21)	—	—	—	—
50,000–99,999	20.55 (17.16, 23.94)	20.68 (19.57, 21.78)	18.49 (16.33, 20.66)	24.91 (23.98, 25.84)	—	—	—	—
≥100,000	10.96 (8.16, 13.75)	11.04 (10.11, 11.96)	10.99 (9.4, 12.58)	18.98 (17.99, 19.98)	—	—	—	—

^aYoung adults and African American adults were oversampled and percentages were weighted to represent the U.S. adult and youth populations. Data are shown as weighted percent (95% CI).

^bComparing age across groups in adults $p<0.0001$; Comparing sex across groups in adults $p<0.0001$; Comparing race across groups in adults $p<0.0001$.

^cComparing age across groups in youths $p<0.0001$; Comparing sex across groups in youths $p=0.0018$; Comparing race across groups in youths $p<0.0001$.

^dComparing age between e-hookah only and e-cigarette only adults $p<0.0001$; Comparing sex between e-hookah only and e-cigarette only adults $p<0.0001$; Comparing race between e-hookah only and e-cigarette only adults $p<0.0001$.

^eComparing age between e-hookah only and e-cigarette only youths $p=0.85$; Comparing sex between e-hookah only and e-cigarette only youths $p=0.001$; Comparing race between e-hookah only and e-cigarette only youths $p<0.0001$.

^fLesbian, gay, bisexual, or something else. Participants who reported “something else” were asked to provide additional clarifying information (i.e., identifying with other labels such as a “queer,” transgender, in the process of figuring out their sexual orientation, not using such labels, or something else).

^gNot enrolled this year or last, home schooled, school not graded, 12th grade, college, or vocational school.

^hIncluding widowed, divorced, separated, or never married.

LGB, lesbian, gay, bisexual.

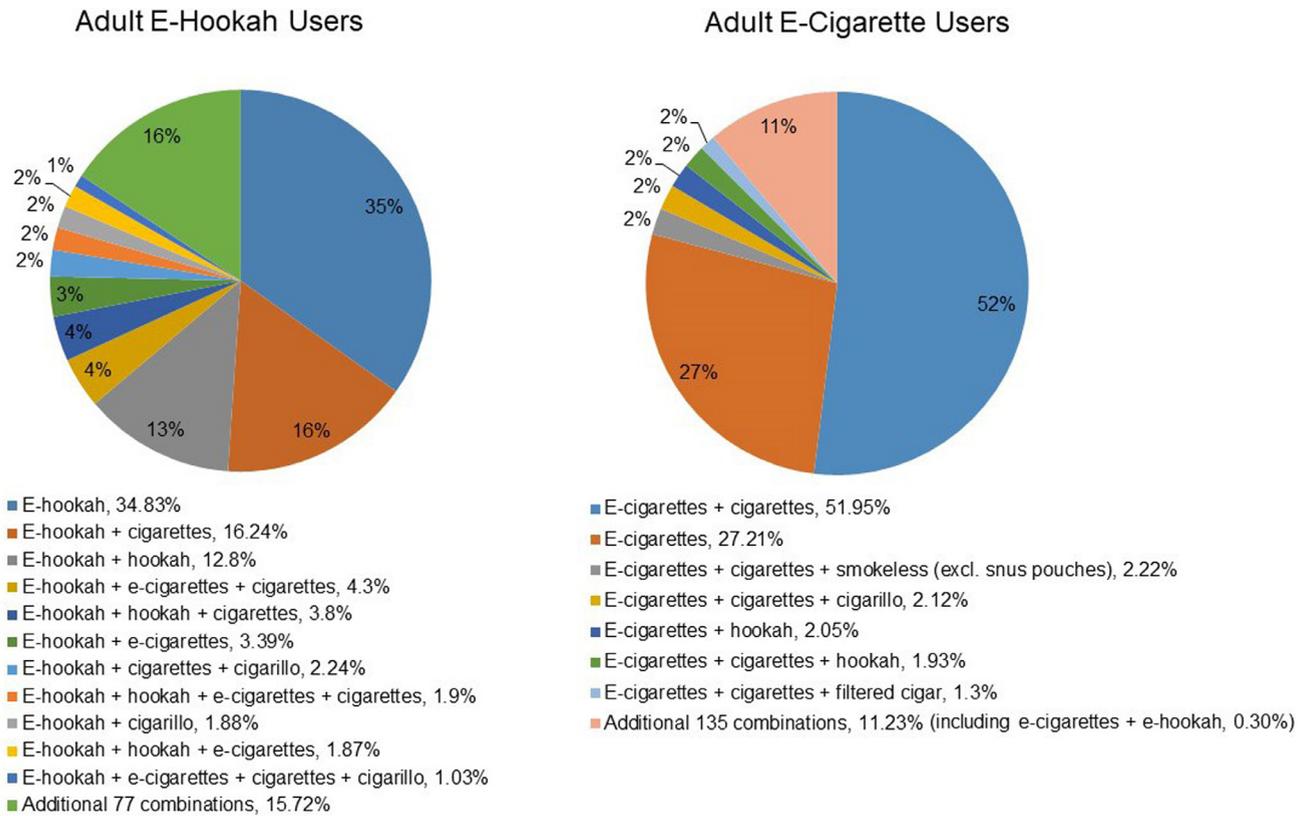


Figure 1. Combinations of tobacco and alternative tobacco products among adult e-hookah versus e-cigarette users. Notes: Current users of e-hookah, other tobacco, and alternative products responded that they now use a product “some days” or “every day.” Current cigarette users responded that they had smoked at least 100 cigarettes in their life and now smoke “some days” or “every day.” Current users of e-cigarette, other tobacco, and alternative products responded that they now use a product “some days” or “every day.” Percentages were weighted to the U.S. adult population.

e-cigarettes plus cigarettes (51.95%). Figure 1 shows the most common combinations of products used among adult current e-hookah versus e-cigarette users.

Because current use of e-hookah versus e-cigarettes was not assessed among youth, this study reported the most common combinations of tobacco products among ever e-hookah versus ever e-cigarette youth users. The prevalence of multiple-product use was 81.68% among e-hookah versus 73.52% among e-cigarette users (Figure 2). A total of 187 different combinations of products used were reported among e-hookah users and 283 among e-cigarette users. Figure 2 shows the most common combinations of tobacco products among youth ever e-hookah versus e-cigarette users. For Figures 1 and 2, the occurrences of multiple-product use <1% were compiled into “additional combinations.”

Among both adult and youth e-hookah and e-cigarette users, alcohol and marijuana were the most common substances used with a slightly higher prevalence of use among e-hookah only users (Table 2). Compared with e-cigarette users, e-hookah users also reported higher use of other substances, including Ritalin/Adderall (adults

only) and pain killers/sedatives (youth), but not cocaine and methamphetamine.

DISCUSSION

The use of ENDS has risen exponentially over the past decade.¹⁴ Virtually all studies of ENDS have focused on e-cigarettes; consequently, little is known about e-hookah use. The present study is the first to examine characteristics between e-hookah and e-cigarette users in a nationally representative sample of U.S. adults and youth. Findings indicate that although the prevalence of e-hookah use is less common than that of e-cigarettes, e-hookah use is not rare. Notably, e-hookah users have a distinctly different profile in terms of user demographics and co-use of other substances than e-cigarette users. These findings have important implications for understanding various types of ENDS use among adults and youth, as well as emphasizing the need for additional understanding on user characteristics, smoking patterns, and behaviors that can help inform tobacco regulation specific to hookah.

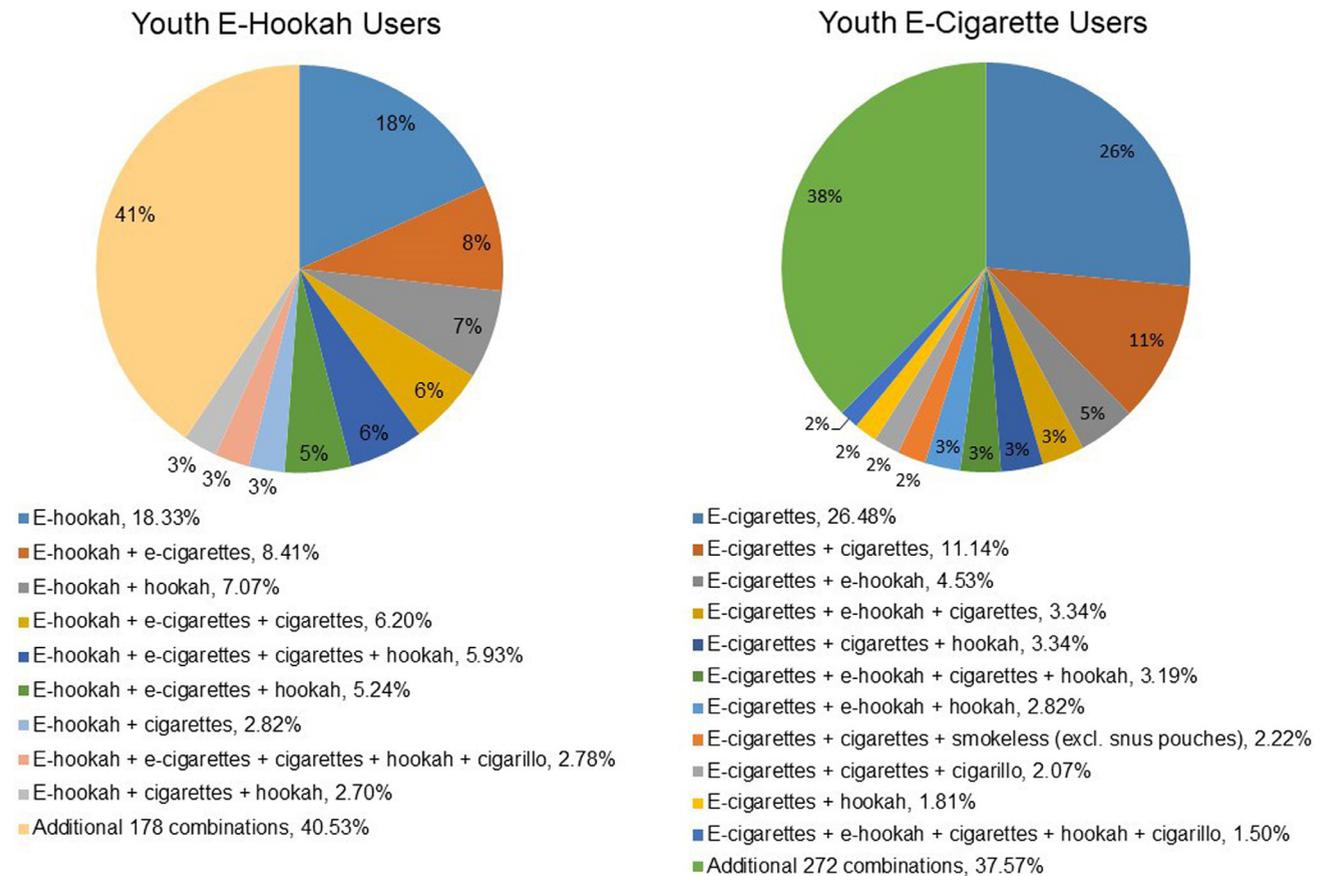


Figure 2. Combinations of tobacco and alternative tobacco products among youth e-hookah versus e-cigarette users.

The present findings advance the literature by showing differences in sociodemographic characteristics according to the type of ENDS used. Compared with e-cigarettes, these data show that adult e-hookah use was inversely related to age, with the highest rates of use among those aged 18–24 years. Whereas most of adult and youth e-cigarette users were male non-Hispanic whites, a large percentage of e-hookah users were Hispanic and non-Hispanic black female users. The authors speculate that these differences may be related to tobacco marketing strategies between both products, where a greater proportion of e-hookahs, commonly marketed as sweet-flavored products (fruit, candy, and alcoholic drinks) compared with tobacco- or menthol-flavored e-cigarette products.⁶ Indeed, research speaks to the appeal of flavored products to young adults and specifically female users, potentially serving as starter products, and studies have previously shown higher use of flavored products among non-Hispanic blacks.^{15–18} Data from Wave 1 of the PATH study show that flavored products are the first kind of tobacco products used with hookah having the highest rate of flavored tobacco use among youth.¹⁹ Flavored hookah tobacco use also has been

recently shown to be a predictor of subsequent initiation of ENDS among young adults.²⁰ Although this study builds upon previous ones by highlighting the need for robust regulation on characterizing flavors in ENDS to reduce appeal to youth, this decision has to be carefully sought because among adult e-cigarette users, flavorings may facilitate smoking cessation.^{21,22}

E-hookah was used less frequently than e-cigarettes. The current findings indicate that 87% of e-hookah users (versus 49% among e-cigarette users) report last use ≥ 3 days ago. Although no additional PATH data has been reported on the frequency of e-hookah use, these findings are similar to traditional hookah only use, where users report intermittent and infrequent use.^{10,23} It is possible that users may be substituting their traditional hookah use with e-hookah, because unlike traditional hookahs that require time for setting up the burning charcoal briquettes, e-hookahs are convenient and ready to use.

There is increasing concern that ENDS use may increase the risk of subsequent transition to the use of other tobacco products and substances. These data add to the body of literature showing that use of multiple

Table 2. Past-Year Substance Use Among E-Hookah Versus E-Cigarettes Users

Variable	Alcohol, ^{a,b,c,d} % (CI)	Marijuana, ^{a,b,c,d} % (CI)	Ritalin/Adderall, % (CI)	Painkillers/sedatives, % (CI)	Cocaine, % (CI)	Methamphetamine, % (CI)	Other drugs, % (CI)
Adult							
E-hookah only, <i>n</i> =823	78.35 (74.37, 82.33)	36.65 (32.05, 41.25)	4.34 (2.62, 6.05)	5.21 (3.19, 7.23)	1.55 (0.43, 2.68)	0.68 (0.02, 1.33)	0.57 (0.15, 0.99)
E-cigarette only, <i>n</i> =9,914	72.93 (71.64, 74.23)	30.19 (28.7, 31.68)	3.65 (3.17, 4.13)	12.11 (11.3, 12.92)	4.04 (3.51, 4.58)	2.56 (2.2, 2.93)	2.65 (2.26, 3.04)
E-hookah + e-cigarette, <i>n</i> =2,109	82.39 (80.17, 84.6)	54.45 (52.12, 56.79)	8.88 (7.6, 10.15)	13.29 (11.56, 15.03)	7.79 (6.39, 9.2)	2.99 (2.2, 3.78)	5.83 (4.79, 6.87)
Neither e-cigarette nor e-hookah, <i>n</i> =15,407	63.05 (61.05, 65.06)	6.1 (5.56, 6.65)	0.71 (0.57, 0.85)	6.1 (5.55, 6.65)	0.65 (0.5, 0.81)	0.26 (0.17, 0.35)	0.25 (0.18, 0.32)
Youth							
E-hookah only, <i>n</i> =401	56.27 (51.19, 61.36)	14.76 (11.08, 18.44)	4.72 (2.46, 6.98)	12.79 (9.74, 15.85)	0.61 (0, 1.47)	0.55 (0, 1.36)	1.83 (0.43, 3.24)
E-cigarette only, <i>n</i> =1,157	50.02 (46.74, 53.29)	11.0 (9.09, 12.91)	4.82 (3.6, 6.04)	9.83 (7.88, 11.77)	1.96 (1.04, 2.88)	1.24 (0.56, 1.92)	2.56 (1.63, 3.49)
E-hookah + e-cigarette, <i>n</i> =558	66.15 (62.38, 69.93)	13.3 (9.95, 16.66)	10.27 (7.38, 13.17)	14.08 (11.17, 17)	4.53 (2.52, 6.53)	3.21 (1.62, 4.8)	5.53 (3.38, 7.68)
Neither e-cigarette nor e-hookah, <i>n</i> =9,997	16.27 (15.25, 17.29)	1.62 (1.35, 1.89)	0.7 (0.49, 0.91)	4.82 (4.29, 5.34)	0.31 (0.2, 0.42)	0.21 (0.1, 0.31)	0.26 (0.15, 0.37)

Note: Data represent weighted percent (95% CI).

^aComparing alcohol use across groups in adults $p < 0.0001$; Comparing marijuana across groups in adults $p < 0.0001$.

^bComparing alcohol use between e-hookah only and e-cigarette only adults $p = 0.023$; Comparing marijuana use between e-hookah only and e-cigarette only adults $p = 0.009$.

^cComparing alcohol use across groups in youths $p < 0.0001$; Comparing marijuana use between the groups in youths $p < 0.0001$.

^dComparing alcohol use between the e-hookah only and e-cigarette only youths $p = 0.023$; Comparing marijuana use between e-hookah only and e-cigarette only youths $p = 0.045$.

products was common among both e-hookah and e-cigarette adult and youth users alike, with traditional cigarettes as the most common co-product used. E-hookah use, however, was associated with a slightly higher prevalence of use of alcohol, marijuana, and Ritalin than e-cigarette use. Although it is possible that these findings could be a consequence of the younger age of e-hookah users (18–24 years in this study), they highlight the importance of examining product-specific characteristics rather than aggregating across ENDS products.

Limitations

This study has several limitations. Even though an e-hookah pen image was shown to the PATH participants in association with the e-hookah questions, given that e-hookah use is relatively new and more than one product is currently being marketed, it is unclear if participants who use e-hookah bowls were accounted for in the survey responses and thus, could have affected total estimates of prevalence. Similarly, e-cigarette products have become increasingly diversified and are rapidly evolving, and 2015–2016 products may not be the same as those currently available. Neither the frequency (i.e., per day or per week in the last month) nor the quantity of use of e-hookah were available in Wave 2 of the PATH study. Moreover, the type of e-hookah flavoring (e.g., fruit, candy, or alcohol) used was not captured in Wave 2, and participants were not asked about their preferences regarding flavors, limiting the author's ability to establish specific contributions of flavors to e-hookah versus e-cigarette use. Finally, this study used cross-sectional data, thus precluding understanding of temporal associations of e-hookah use prevalence and co-use of other tobacco products and substances.

CONCLUSIONS

This nationally representative study reveals that although the prevalence of e-hookah use is less common than that of e-cigarettes, e-hookah use is not rare. Compared with e-cigarette users, e-hookah users appear to have a different demographic profile and co-use of substances. Given the rapid uptake of ENDS, strong regulatory efforts are needed to prevent further increases in e-hookah use among young adults. Additional understanding of e-hookahs' products distinct characteristics and users' smoking patterns and behaviors will help inform regulatory efforts specific to hookah.

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SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at <https://doi.org/10.1016/j.amepre.2019.05.007>.

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