Original investigation

Patterns of Nicotine and Tobacco Product Use in Youth and Young Adults in the United States, 2011–2015

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Abstract

Introduction: As cigarette smoking has decreased among youth and young adults (YAs) in the United States, the prevalence of other tobacco and nicotine product use has increased.

Methods: This study identified common past 30-day patterns of tobacco and nicotine product use in youth (grades 6–12) and YAs (aged 18–24). Using data from the 2011–2015 National Youth Tobacco Survey (NYTS) and corresponding years of the Truth Initiative Young Adult Cohort Study (TIYAC), past 30-day use of the following products was assessed: cigarettes, e-cigarettes, any type of cigar, smokeless tobacco, hookah, and other tobacco products (pipe, bidis, kreteks, dissolvable tobacco, and snus). A user-generated program in R was used to assess all possible combinations of product-specific and polytobacco use.

Results: The top five patterns of past 30-day use in youth were exclusive cigarette use (12.0%), exclusive cigar use (10.3%), exclusive e-cigarette use (10.0%), dual use of cigarettes and cigars (6.1%), and exclusive hookah use (5.2%). In YAs, the top five patterns were exclusive cigarette use (46.5%), dual use of cigarettes and cigars (6.4%), exclusive hookah use (5.9%), and dual use of cigarettes and e-cigarettes (3.9%).

Conclusions: As noncigarette tobacco and nicotine products become increasingly popular among tobacco users, further research is needed to identify predictors and correlates of specific tobacco use patterns in youth and YAs. This analysis can inform tobacco prevention efforts focusing on emerging tobacco products such as e-cigarettes and hookah. Educational and other intervention efforts should focus on the diversity of products and use patterns in these age groups.

Implications: This study uses population-based data to provide new information on the most prevalent patterns of past 30-day nicotine and tobacco use over a 5-year period among youth and young adults. Study findings demonstrate that youth and young adults report using tobacco and nicotine products in different combinations, with varying popularity over time. Additionally, by examining young adults as a separate group, this study highlights the unique patterns of use not previously discussed in the adult literature.
Introduction

Although cigarette use among youth and young adults (YAs) has declined in the past decade, use of other combustible products, including little cigars/cigarillos and hookah, remains prevalent among youth and YAs. Past 30-day use of two (dual use) or more (poly use) tobacco and nicotine products is popular in youth and YAs. In 2012, nearly two-thirds (62.4%) of current YA tobacco users reported dual or poly use of cigarettes and other tobacco products. The most common product combination for YAs was cigarettes with little cigars/cigarillos and hookah. Among youth who used tobacco in the past 30 days, 43% reported use of multiple tobacco and nicotine products in 2013, with use of cigarettes and e-cigarettes reported as the most common product combination.

Cross-sectional studies of adolescents have demonstrated an association between past 30-day tobacco use and risk behaviors such as illicit substance use. Evidence suggests that this association is even stronger among adolescents who report use of multiple tobacco and nicotine products. Past 30-day use of multiple tobacco and nicotine products may also lead to greater nicotine dependence among youth and YA users, particularly among cigarette smokers who use other tobacco and nicotine products.

A previous examination of patterns of tobacco and nicotine products identified dual use of cigarettes and e-cigarettes as the most prevalent pattern among adults polytobacco users. However, this prior work did not separate YAs from older adults, who were likely to have established their tobacco and nicotine product use when different products were on the market. National data highlight that YAs (aged 18–24) reported a higher prevalence of any past 30-day tobacco use than adults aged ≥25, and YAs have been shown to be more likely to use multiple products than older adults.

To address these gaps in the literature, this study used data from the National Youth Tobacco Survey (NYTS) and its methodology can be found at http://www.cdc.gov/tobacco/data_statistics/surveys/nyts/index.htm. Protocols were approved by the Centers for Disease Control and Prevention Institutional Review Board-G (IRB00000188, CDC Protocol #4118). The approved IRB protocols included written parental permission and oral consent for all respondents to ensure student anonymity. Student participation was voluntary and anonymous, and subsequent data were analyzed anonymously. This study was exempt from institutional review board approval because it is a secondary data analysis of a publicly available dataset.

Methods

This study leverages data from two large contemporary cohorts. One is a national, self-administered survey of US middle and high school students (NYTS); the other is a national longitudinal online survey of YAs (YA Cohort Study). Both surveys are described in detail elsewhere. Detail on both samples and the measures employed in parallel analyses are described below.

National Youth Tobacco Survey

The NYTS provides estimates of past 30-day tobacco use among adolescents. Sample sizes and overall response rates were 18 866 (72.7%) for 2011, 24 658 (73.6%) for 2012, 18 406 (67.8%) for 2013, 22 007 (73.3%) for 2014, and 17 711 (63.4%) for 2015. The current analyses focus on a subset of 17 527 (unweighted) observations from youth who had used at least one tobacco or nicotine product in the past 30 days. Additional information on the NYTS and its methodology can be found at http://www.cdc.gov/tobacco/data_statistics/surveys/nyts/index.htm. The NYTS provides estimates of past 30-day tobacco use among students (NYTS); the other is a national longitudinal online survey of YAs (YA Cohort Study) to assess patterns of past 30-day tobacco and nicotine product use in youth (aged 12–17) and YAs (aged 18–24) and changes in use pattern prevalence over time. Tobacco and nicotine product use in youth (NYTS) and correlates to those who reported past 30-day use and past 30-day frequency of use (if applicable). Due to the surveys not including items for past 30-day frequency for all products, we did not place this restriction on the product-specific denominators in this study. This study uses a subset of participants who reported using at least one tobacco or nicotine product in the past 30 days of survey completion, yielding a total of 16 925 observations (unweighted).

Correlates

Sociodemographic correlates included age (categorized into four groups: 9–11 years old, 12–14 years old, 15–17 years old, and ≥18 years old), sex, race (categorized as White, Black/African American, Asian, and other/multiple races), and education (categorized as 6th–8th grade, 9th–11th grade, 12th grade, and ungraded/other grade). Those who identified as American Indian/Alaskan Native or Native Hawaiian/Other Pacific Islander or selected more than one race were categorized as “other/multiple races.”

Truth Initiative Young Adult Cohort Study

To align with NYTS annual fielding dates, this study uses data from waves 1, 3, 4, 6, and 8 of the Truth Initiative Young Adult Cohort Study (YA Cohort; July 2011–July 2015). The cohort comprised a
nationwide representative sample of YAs aged 18–34 drawn from GfK’s KnowledgePanel that is recruited via address-based sampling to provide statistically valid representation of the US population, including cell phone-only households. African American and Hispanic YAs were oversampled at wave 1 to ensure sufficient sample sizes for subgroup analyses, and the survey was administered online in English and Spanish. The validity of this methodology has been reported previously, and it has been used broadly in the peer-reviewed medical literature.22-24 The cohort is refreshed at each wave to retain the initial sample size.

The panel recruitment rate (RECR) ranged from 13.5% to 14.8% across the seven waves.24 In 64.2% to 65.7% of the households identified for the panel, one member completed a core profile survey in which key demographic information was collected (profile rate—PROR). At each wave, only one panel member per household was selected at random to be part of the study sample, and no members outside of the panel were recruited. The completion rate (COMR) ranged from 46.2% to 65.7%. The cumulative response rate (CUMRR1) (the product of these three rates) ranged from 4.4% to 6.3%, consistent with other published studies.25-27 This study was approved by the Independent Investigational Review Board, Inc, for waves 1 and 3 (Protocol #20036007) and Chesapeake Institutional Review Board, Inc, for waves 4, 6, and 8 (Protocol #20036020). Online consent was collected from participants before survey self-administration. The present analysis focused on a subset of 1170 participants 18–24 years of age who reported using at least one tobacco or nicotine product in the past 30 days of wave completion, yielding a total of 1618 observations (unweighted) and a mean number of 1.4 waves (SD = 0.7) of participation.

Product-Specific Past 30-Day Use
At each wave, participants were asked “Which of the following products have you used in the past 30 days? (select all that apply)” and provided a list of 11 tobacco and nicotine products including cigarettes, cigars, pipe, little cigars/cigarillos, electronic cigarettes (e-cigarettes), chewing tobacco, dip/snuff, snus, dissolvable tobacco products, and hookah/shisha. Participants who selected cigars or little cigars/cigarillos were classified as past 30-day cigar users. Participants who reported using chewing tobacco or dip/snuff in the past 30 days were identified as past 30-day smokeless tobacco users. Past 30-day use of pipe tobacco, snus, and dissolvable tobacco was collapsed into past 30-day use of other tobacco products to align with the NYTS use group. Participants who reported use of any tobacco or nicotine product in the past month were identified as past 30-day tobacco users in that particular wave.

Correlates
Sociodemographic correlates included sex, race/ethnicity (White, non-Hispanic; Black, non-Hispanic; other, non-Hispanic; Hispanic), and highest level of education completed with response options ranging from “Elementary or middle school, but no high school” to “Doctoral or professional degree (PHD, JD, MD)” (categorized as less than high school, high school, and some college or greater).

Past 30-day alcohol use was determined by two items. The first asked about frequency of alcohol use in the past year (“never,” “monthly or less,” “2–4 times per month,” “2–3 times per week,” and “4 or more times per week”). Those who reported any use of alcohol were then queried about the frequency of use in the past 30 days, with respondents using ≥1 days defined as past 30-day users. Respondents were asked how often they currently use marijuana and other drugs (cocaine, heroin, ecstasy, meth, etc.), with response options of “Not at all,” “Some days,” and “Every day.” Respondents who indicated use “some days” or “every day” were asked how frequently in the past 30 days they used each substance. Current or past 30-day use of each of these substances was categorized as past 30-day use (yes/no). Those who refused to respond reported “not at all” or reported 0 days used in the past 30 days were categorized as non-past 30-day users.

Data Analysis
A user-generated program developed in R was used to identify an exhaustive list of every reported combination of past 30-day use of cigarettes, e-cigarettes, cigars, smokeless tobacco, hookah, and other tobacco separately for youth and YAs. Once the top five patterns were identified in each sample, variables to identify each pattern were generated in Stata/SE 14.2, and pattern prevalence was estimated using survey commands accounting for data weighting by primary sampling unit and sampling stratum in each age group. Weighted prevalence estimates were also estimated for descriptive purposes. In post hoc analyses, bivariate and adjusted log-binomial models were used to identify statistically significant correlates of pattern use prevalence in the top five patterns among past 30-day users in each age group. When adjusted log-binomial models failed to reach convergence, modified Poisson models were used as an approximation and noted in tables.24

Results

Prevalence Estimates
Before evaluating patterns of tobacco and nicotine product use, we present product-specific prevalence estimates in youth and YA past 30-day users from 2011 to 2015 (Table 1). Combustible products (cigarettes, cigars, and hookah) had the greatest prevalence of use, with cigarettes maintaining the highest prevalence in use among YA past 30-day users from 2011 to 2015. Although e-cigarettes were the least prevalent product in both age groups in 2011, e-cigarettes emerged as the most prevalent product in youth past 30-day users and the second most prevalent product (behind cigarettes) in YA past 30-day users in 2015. Prevalence of past 30-day cigar use declined over time in both age groups, with a more rapid decline in 2014 and 2015. Although there appeared to be a consistent prevalence of past 30-day smokeless tobacco use in youth, YAs reported a decline in smokeless tobacco use from 2011 to 2014 with a reemergence in popularity in 2015. Conversely, other tobacco products had a consistent prevalence in YAs and a steady decline in youth. Both youth and YAs reported greater past 30-day hookah use prevalence from 2011 to 2014 with lower prevalence of use in 2015.

Patterns of Use
Among past 30-day tobacco users, youth provided a greater variety of patterns of use compared with YAs throughout all 5 years (youth: 61–64 patterns; YAs: 26–30 patterns). Across 2011–2015, the top five patterns of past 30-day tobacco use among youth were (1) exclusive cigarette use (12.0%), (2) exclusive cigar use (10.3%), (3) exclusive e-cigarette use (10.0%), (4) dual use of cigarettes and cigars (6.1%), and (5) exclusive hookah use (5.2%; Table 2). The top five patterns of past 30-day tobacco use across 2011–2015 among YAs were (1) exclusive cigarette use (46.5%), (2) exclusive cigar use (10.0%), (3) dual use of cigarettes and cigars (6.4%), (4) exclusive
Table 1. Weighted Product-Specific Prevalence Estimates Among Past 30-Day Tobacco Users

|          | 2011 P30D (%) | 2012 P30D (%) | 2013 P30D (%) | 2014 P30D (%) | 2015 P30D (%) |
|----------|---------------|---------------|---------------|---------------|---------------|
| NYTS     |               |               |               |               |               |
| Cigarettes | 57.5          | 55.9          | 49.8          | 35.9          | 35.0          |
| E-cigarettes | 5.7           | 12.3          | 17.7          | 53.2          | 64.0          |
| Cigars    | 43.5          | 49.8          | 48.1          | 30.7          | 31.2          |
| Smokeless | 27.8          | 26.1          | 23.0          | 22.0          | 21.6          |
| Other tobacco | 30.5         | 31.6          | 26.6          | 15.4          | 11.0          |
| Hookah    | 14.4          | 21.1          | 20.0          | 35.9          | 27.0          |
| TIYAC     |               |               |               |               |               |
| Cigarettes | 84.0          | 62.7          | 65.0          | 70.6          | 65.0          |
| E-cigarettes | 5.2           | 8.2           | 7.7           | 18.3          | 21.8          |
| Cigars    | 28.8          | 27.7          | 24.8          | 12.6          | 16.9          |
| Smokeless | 12.3          | 8.4           | 5.8           | 5.9           | 12.7          |
| Other tobacco | 9.2           | 7.7           | 9.6           | 8.8           | 10.1          |
| Hookah    | 8.4           | 13.1          | 14.1          | 15.2          | 9.1           |

*From 2011 to 2013, past 30-day use of e-cigarettes was assessed using the question: “During the past 30 days, which of the following tobacco products did you use on at least one day?” with participants selecting the response choice “Electronic cigarettes or e-cigarettes, such as Ruyan or NJOY” identified as past 30-day users; there were 10 products presented in this list in 2011, 9 in 2012, and 11 in 2013. In 2014, past 30-day use of e-cigarettes was assessed using the stand-alone question, “During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes such as Blu, 21st Century Smoke, or NJOY?” In 2015, the question was changed to “During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes?” Response categories included “0 days,” “1 or 2 days,” “3–5 days,” “6–9 days,” “10–19 days,” “20–29 days,” and “all 30 days.” Participants who reported using e-cigarettes on at least 1 or 2 days were classified as past 30-day e-cigarette users.

Smokeless tobacco includes chew, dip, and snuff.

Other tobacco includes pipe tobacco, dissolvable tobacco, snus, bids, kreteks, and “some other product not listed here.” Kreteks were either identified as “clove cigars (kreteks)” in 2011 and 2013 or “clove cigarettes (kreteks)” in 2012. Kretek use was not assessed in 2014 or 2015.

Smokeless tobacco includes chew, dip, and snuff. In 2013–2015, a preface was included in the smokeless tobacco section: “Please do not think about using snus when you answer these questions.” Snus users were included in the “other tobacco product user” category below.

Other tobacco includes pipe tobacco, dissolvable tobacco, and snus.

Cigars (2011) and Cigars (2012) are interchangeable terms for the same product, reflecting the use of different tobacco product categories in different years.

Cigarettes (2013) and Cigarettes (2014) are interchangeable terms for the same product, reflecting the use of different tobacco product categories in different years.

Cigarettes (2015) and Cigarettes (2016) are interchangeable terms for the same product, reflecting the use of different tobacco product categories in different years.

Cigarettes (2017) and Cigarettes (2018) are interchangeable terms for the same product, reflecting the use of different tobacco product categories in different years.

Cigarettes (2019) and Cigarettes (2020) are interchangeable terms for the same product, reflecting the use of different tobacco product categories in different years.

Cigarettes (2021) and Cigarettes (2022) are interchangeable terms for the same product, reflecting the use of different tobacco product categories in different years.

Cigarettes (2023) and Cigarettes (2024) are interchangeable terms for the same product, reflecting the use of different tobacco product categories in different years.

Cigarettes (2025) and Cigarettes (2026) are interchangeable terms for the same product, reflecting the use of different tobacco product categories in different years.

Cigarettes (2027) and Cigarettes (2028) are interchangeable terms for the same product, reflecting the use of different tobacco product categories in different years.

Cigarettes (2029) and Cigarettes (2030) are interchangeable terms for the same product, reflecting the use of different tobacco product categories in different years.

While exclusive cigarette use and exclusive cigar use remained in the top five patterns of use across all 5 years in each age group, other patterns of use emerged over time while others declined in popularity. In youth, dual use of cigarettes and cigars maintained a fourth-place ranking from 2011 (8.9%) to 2013 (8.2%), but fell from the top five in later years. In YAs, this pattern was the second most prevalent pattern in 2011 (11.6%), fell to fifth in 2012 (4.4%), fourth in 2013 (7.5%), and dropped from the top five in later years. In both age groups, a similar trend in the prevalence of exclusive hookah use appears over time, emerging in the top five patterns in 2012, maintaining in 2013, and rising to the second most prevalent pattern in 2014. In 2015, exclusive hookah use dropped from the top five most prevalent patterns of use altogether in youth and fell to the fifth most popular pattern in YAs.

A few of the most prevalent patterns of tobacco use were unique to specific age groups. Exclusive use of smokeless tobacco appeared as the fourth most prevalent pattern of use in youth from 2011 (6.8%) to 2013 (5.0%) and the fifth most prevalent pattern in 2015 (5.6%). This pattern was not among the top five most prevalent patterns of past 30-day tobacco use in YAs. Similarly, dual use of e-cigarettes and hookah did not appear in the top five patterns in YAs, but was the fifth most prevalent pattern in youth in 2014 (6.4%) and the second most prevalent pattern in 2015 (8.0%).

Conversely, three dual use patterns appear in the top five patterns of YA tobacco use, but not youth tobacco use. Dual use of cigarettes and smokeless tobacco was the fourth most prevalent pattern in 2011 (4.6%), but fell from the top five in later years. Similarly, dual use of cigarettes and hookah was the fifth most prevalent pattern in 2011 (3.6%), but also did not emerge in the top five patterns in later years. Dual use of cigarettes and e-cigarettes appeared as the fourth most prevalent pattern in 2014 (5.9%) and rose to the second most prevalent pattern in 2015 (8.9%).

Significant pattern-specific correlates existed among the top five patterns in youth and YAs (Supplementary Tables 1A–2B). Bivariate and multivariable log-binomial regressions identified significant relationships between age, sex, race, education, and pattern-specific use in youth. Black/African American respondents (vs. White) had significantly lower prevalence of exclusive e-cigarette use after controlling for age, sex, and education. Female youth respondents had
Table 2. Top Five Patterns of Tobacco Use in NYTS, 2011–2015

| Year | Pattern | 2011 | 2012 | 2013 | 2014 | 2015 |
|------|---------|------|------|------|------|------|
| 2011 | Cigarette exclusive use | 12.0% | 10.3% | 10.0% | 10.0% | 6.1% |
|      | Cigarette and cigar dual use | 6.1% | 5.2% | 5.2% | 4.2% | 3.7% |
|      | Hookah exclusive use | 5.2% | 5.2% | 5.2% | 5.2% | 5.2% |
|      | E-cigarette exclusive use | 4.9% | 4.9% | 4.9% | 4.9% | 4.9% |
|      | Smokeless exclusive use | 5.0% | 4.9% | 4.9% | 4.9% | 4.9% |

Discussion

This study identifies top patterns of past 30-day tobacco use among youth and YAs. When considering the top patterns of tobacco use, exclusive use of a single product was the dominant pattern in both age groups, with exclusive cigarette use having the greatest prevalence from 2011 to 2015. Among YAs, exclusive cigarette use was the dominant pattern of use each year. Previous research on patterns of use among adults found dual use of cigarettes and e-cigarettes to be the most prevalent pattern of use. This discrepancy highlights the need to examine YAs separate from adults. In youth, exclusive cigarette use was the most prevalent pattern of use in 2011 and 2012, but was replaced by exclusive cigar use in 2013 and exclusive e-cigarette use in 2014 and 2015. Although we did not examine the reasons for these changes in patterns among youth, it may be attributed to youth’s reduced risk perceptions of these products and their appealing flavors. Additional research is needed to identify and better understand predictors and correlates of tobacco use patterns in youth and YAs. This analysis can inform tobacco prevention efforts focusing on emerging tobacco products such as e-cigarettes and hookah. Education and other intervention efforts should focus on the diversity of products and use patterns in these age groups.

Despite cigarette use among youth and YAs being at a historic low, study findings underscore the continued and high rate of use of combustible tobacco products across both age groups. Cigarettes were the most prevalent product across all years for YAs. Among youth, cigarettes were the most prevalent product from 2011 to 2013, but surpassed by e-cigarettes from 2014 to 2015. This shift may be due in part to the rising costs of cigarettes and the increased marketing of e-cigarettes. For both age groups, past 30-day hookah use increased from 2011–2014, but declined in 2015. This is consistent with data from the Monitoring the Future study (MTF), which reported a decline of 3.1% points in past 12-month hookah use among 12th graders.

There are several limitations to consider when reviewing these findings. First, the cross-sectional nature of the data does not allow...
for causal interpretations. Second, the low popularity of a pattern does not signify low prevalence of a specific substance. A product may be prevalent, but may be used in a variety of different patterns and therefore does not emerge in the top five patterns listed. This speaks to the complexity of how youth and YAs use tobacco and nicotine products. Additionally, this study is not able to assess whether the dual or poly use occurred at the same event or more distally, such as within the past 30 days.

This study uses population-based data to provide new information on the most prevalent patterns of past 30-day nicotine and tobacco use over a 5-year period among youth and YAs. Study findings demonstrate that youth and YAs report using tobacco and nicotine products in different combinations, with varying popularity over time. Additionally, by examining YAs as a separate group, this study highlights the unique patterns of use not previously discussed in the adult literature. As non-cigarette tobacco and nicotine products become increasingly popular among youth and YAs, knowledge of the relative popularity of dual and poly use of these products is vital to effective prevention efforts.

**Supplementary Material**

Supplementary data are available at *Nicotine & Tobacco Research* online.

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**Declaration of Interests**

None declared.

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