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Heterogeneity in Nicotine, Tobacco, and Cannabis Use Among U.S. Adolescents and Adults Aged 12–34 Years

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Abstract

Introduction: Nicotine, tobacco, and cannabis use continues to evolve in the U.S., with new forms of use (e.g., oral nicotine, cannabis edibles) emerging and increasing. It is critical to understand how these substances are being used and co-used. This study identified subgroups of adolescents and younger adults aged 12–34 years on the basis of nicotine, tobacco, and cannabis use using recent nationally representative data.

Methods: Cross-sectional data from the Population Assessment of Tobacco and Health Wave 7 (2022–2023) were used. Analyses focused on those aged 12–34 years who reported any past 30-day nicotine, tobacco, or cannabis use (n=8,722). Latent class analysis was conducted using 8 indicators: combustible tobacco use, nicotine vaping, oral nicotine product use, other noncombustible tobacco use (e.g., snus/chew), blunt use, cannabis smoking, cannabis vaping, and cannabis edibles. Differences were examined by sex, age, race, ethnicity, and region.

Results: On average, individuals reported use of approximately 2 products in the past 30 days (mean=2.08). Six subgroups of nicotine, tobacco, and cannabis use were identified: combustible tobacco (30.77%), multimodal cannabis (26.72%), vaping nicotine (18.37%), multimodal co-use (13.87%), cannabis edibles (5.31%), and multimodal nicotine/tobacco (4.95%). Sociodemographic characteristics were associated with class membership.

Conclusions: There is substantial heterogeneity in nicotine, tobacco, and cannabis use among U.S. adolescents and younger adults. Of particular concern is that most of the sample reported combustible use, including 3 subgroups that reported multiple modes of use. Continued surveillance of nicotine, tobacco, and cannabis use is needed, particularly as the products and their regulation continue to evolve.

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CREDIT AUTHOR STATEMENT

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INTRODUCTION

Nicotine, tobacco, and cannabis is are highly prevalent among U.S. adolescents and younger adults and is associated with many negative physical and mental health consequences.[1,2] Although traditional cigarette smoking continues to decline in prevalence in the U.S.,[3–6] the use of many other forms of nicotine and tobacco remains high, and the use of newly emerging forms of nicotine and tobacco is increasing, particularly among younger age groups.[5,6] Cannabis use is also prevalent, with one quarter (26%) of 12th graders and 50% of adults aged 18–34 years reporting past-year use.[7] Furthermore, 18% of 12th graders and 22% of adults aged 19–30 years report vaping cannabis, a doubling of the prevalence reported in 2017.[5,6] As the landscape of nicotine, tobacco, and cannabis use continues to evolve, it is critical to understand how these substances are being used and co-used (i.e., use of both in the past 30 days).

Prior literature demonstrates strong overlap of tobacco and nicotine use with cannabis use in the U.S. For example, 50%–70% of adolescents and adults who use cannabis also report tobacco or nicotine use.[8–11] The co-use of cannabis with tobacco and nicotine products is particularly prevalent among younger adults, with 42% of adults aged 18–25 years and 26% of adults aged 26–34 years that use tobacco reporting cannabis co-use.[12]

In addition, use of more than 1 nicotine or tobacco product is not uncommon among those who use tobacco and nicotine products, particularly in younger age groups.[13–16] A study on individuals aged 15–23 year in 2016 found that almost half of those who used tobacco reported past 30-day use of more than 1 tobacco product.[17] The few studies that have examined use of different modes of cannabis show that many individuals use multiple forms of cannabis.[8,18,19] In a convenience sample of U.S. adults, almost half of adults who reported cannabis use reported using more than 1 form in the past year.[18] In a sample of university students who used cannabis, 88% reported using more than 1 form in the past month.[19]

Few national studies have examined multiple modes of both tobacco and nicotine use and cannabis use. In 1 study of adolescents from the 2017 International Tobacco Survey, the use of multiple nicotine and tobacco products was associated with a greater likelihood of co-use of nicotine, tobacco, and cannabis.[8] This study also found that those who reported nicotine vaping were more likely to also report cannabis vaping than cannabis smoking.[8] The potential to use different substances with the same mode or even the same device (i.e., vaping device) may facilitate co-use.[20] Existing studies have used latent class analysis (LCA) to identify heterogeneous patterns of use and the overlap of nicotine and tobacco with cannabis use,[21–25] but they do not differentiate the mode of use.

Additional research is needed to examine multimodal (i.e., more than 1 mode of use) patterns of use, accounting for less traditional and emerging forms of use, such as cannabis vaping, cannabis edibles, and nicotine pouch use. Although some recent studies have included edible cannabis[8,26] and oral nicotine pouches alongside more traditional forms of use,[27–29] this work tends to use convenience or geographically restricted samples. Until recently, few nationally representative studies have assessed cannabis edibles or oral nicotine

pouches separately from other modes of use. For instance, the Population Assessment of Tobacco and Health (PATH) Study only began assessing these in the most recent survey wave. Given the increasing availability of these modes,[30,31] it is important to examine how they may or may not be used with other nicotine, tobacco, and cannabis products. A nuanced examination of patterns and modes of nicotine, tobacco, and cannabis co-use, including less traditional and emerging forms, using nationally representative data may shed light on recent patterns of use and whether there is overlap in modes of administration from one substance to the other.

In addition, identifying sociodemographic differences in patterns of use is important to identify those who may benefit from intervention efforts. For instance, the prevalence of co-use and the modes of administration of nicotine, tobacco, and cannabis may differ by age group and may represent individuals at different stages of a substance use trajectory (e.g., initiation and experimentation versus sustained use). Understanding these differences can be crucial to understanding related disparities and health risks and can help in developing age-appropriate prevention strategies. Yet, most studies focus on either adolescents or younger adults and cannot directly compare different developmental age groups. Although studies have examined sociodemographic differences in product use and mode of use, including differences by sex,[32] race,[33–36] ethnicity,[33,34,36] income,[33,36] and region,[37] no studies have examined sociodemographic differences in nicotine, tobacco, and cannabis patterns using recent nationally representative data.

It is crucial to use the most recent data available to understand these substances patterns. This study identifies heterogeneous patterns of nicotine, tobacco, and cannabis use among U.S. individuals aged 12–34 years using PATH data from 2022 to 2023. Specifically, less traditional forms of use, such as nontobacco oral nicotine products and cannabis edibles, available in the most recent Wave 7 cohort, were included. Sociodemographic associations with use patterns are also examined, including age group, sex, race, ethnicity, and region.

METHODS

Study Population

This study used restricted data from the PATH Study Wave 7 youth and adult cohort (2022–2023). The PATH Study is an ongoing, nationally representative cohort study of U.S. civilian noninstitutionalized youth (aged 12–17 years) and adults (aged ≥18 years). At Wave 7, a new cohort was established that included individuals who entered the study in earlier waves and a probability replenishment sample that was selected to participate beginning at Wave 7. Household screenings were conducted with computer-assisted personal interviewing, and surveys were conducted using audio computer-assisted self-interviews, with the option of being administered in Spanish or English. Individuals were given the option of providing information over the telephone or in person. The weighted response rate ranged from 52.4% to 66.9%, varying by whether they were part of the continuing or replenishment sample of youth and adults.[38] The PATH Study was approved by the Westat IRB, and this secondary data analysis study was determined exempt by the first author's university IRB. Additional details regarding interviewing procedures, sampling, and weighting are available in the PATH Study User Guide.[39] This study focused on PATH Wave 7 cohort youth and

adults aged 12–34 years (N=27,770). Latent class models were restricted to the 31.4% of individuals who reported any past 30-day nicotine, tobacco, or cannabis use (*n*=8,722).

Measures

The following 8 dichotomous indicators of past 30-day use were included: combustible tobacco use (i.e., cigarette, cigar/little cigar/cigarillo, pipe, or hookah), nicotine vaping, oral nicotine product use (e.g., pouches, nonmedicinal gum), other noncombustible tobacco use (i.e., smokeless tobacco, snus), blunt use, cannabis smoking, cannabis vaping, and cannabis edibles. The following sociodemographic characteristics were included as covariates: self-reported sex (male/female), age group (12–17, 18–20, 21–25, or 26–34 years), race (White, Black, Asian, or American Indian or Alaska Native/Native Hawaiian or Pacific Islander/multiracial [those identifying with more than 1 racial group]), Hispanic ethnicity (yes/no), and region (Northeast, Midwest, South, or West).

Statistical Analysis

Weighted prevalence of each of the 8 tobacco and cannabis use indicators was estimated among all individuals aged 12–34 years and among those who reported any past 30-day nicotine, tobacco, or cannabis use. The mean number of indicators of use for those reporting any nicotine, tobacco, or cannabis use was also calculated. Then, LCA was used to characterize individuals on the basis of 8 indicators of use. Models with 2–7 classes were estimated. Information criteria (i.e., Akaike Information Criterion, Bayesian Information Criterion, and adjusted Bayesian Information Criterion) and empirical and theoretical knowledge were used to select the final model.[40] Covariates were included in a multinomial logistic regression model using the Bolck–Croon–Hagenaars method[41] to test the associations between covariates and latent class membership. All models incorporated Wave 7 youth and adult cohort weights[38] to account for sample design and used listwise deletion. Weighted descriptives incorporated balanced repeated replication weights with a 0.3 Fay adjustment, and LCA models employed a pseudomaximum-likelihood weighting approach. PROC LCA macros[42,43] in SAS 9.4 were used for the analyses.

RESULTS

Weighted descriptive characteristics are provided in Table 1. Among those reporting any past 30-day tobacco, nicotine, or cannabis use, 73.15% reported use of any tobacco or nicotine, 61.66% reported use of any cannabis, and 34.79% co-used tobacco or nicotine and cannabis in the past 30 days. Vaping nicotine was the most prevalent mode of use, which was reported at 46.36%. Combustible tobacco use (44.75%) and cannabis smoking (40.52%) were less prevalent. Cannabis edibles (21.71%) and cannabis vaping (24.18%) were less prevalent but were reported by almost one quarter of those using any nicotine, tobacco, or cannabis. Oral nicotine product use (4.45%) had the lowest past 30-day prevalence. On average, individuals reported use of approximately 2 products in the past 30 days (mean=2.08, SE=0.02), and almost three quarters (73.74%) reported use of at least 1 combustible product.

A 6-class model was selected as the optimal model on the basis of model fit, class structure, and interpretation of classes. Although model fit indices continued to improve, as indicated

by a lower value, in the 7-class model, the interpretation of the classes was less clear and did not result in any additional meaningful classes (Appendix Table A, available online, provide the details).

The prevalence of each class and probabilities of each indicator within a given class are shown in Table 2 for the selected 6-class model. Three of the 6 subgroups were characterized primarily by nicotine and tobacco use. The most common subgroup identified was characterized by a high probability of combustible tobacco use as well as a moderate probability of vaping nicotine (combustible tobacco; 30.77%). A second subgroup was characterized by a high probability of vaping nicotine and very low probabilities of any other use (vaping nicotine; 18.37%). A third distinct but less common class was characterized by moderate-to-high probabilities of multiple types of nicotine and tobacco use, including oral nicotine product use, and very low probabilities of cannabis use (multimodal nicotine/tobacco; 4.95%). Two other subgroups were primarily characterized by cannabis use. The most prevalent was a subgroup with a high probability of cannabis smoking; moderate probabilities of other forms of cannabis use, including blunt use; and low probabilities of nicotine and tobacco use (multimodal cannabis; 26.72%). A second, smaller subgroup was characterized by a high probability of cannabis edibles use and low probabilities of any other use (cannabis edibles; 5.31%). Finally, a subgroup characterized by high probabilities of all types of cannabis use, blunt use, combustible tobacco, and nicotine vaping (multimodal co-use; 13.87%) was identified.

Table 3 provides multivariable multinomial regression analysis results examining the associations of sociodemographic covariates with latent class membership; the nicotine vaping class was specified as the reference class. Females were less likely to be in the multimodal nicotine/tobacco class (adjusted RRR [aRRR]=0.09, 95% CI=0.05, 0.17) and combustible tobacco class (aRRR=0.71, 95% CI=0.58, 0.86) and more likely to be in the Cannabis edibles class (aRRR=1.48, 95% CI=1.01, 2.17). Those aged 12–17 years and those aged 18–20 years were less likely to be in all other classes than those aged 21–25 years (aRRR range=0.35–0.71). Those aged 26–34 years were more likely to be in all other classes except the multimodal cannabis class than those aged 21–25 years (aRRR range=1.36–2.51). Black/African American individuals were more likely to be in the multimodal cannabis (aRRR=2.28, 95% CI=1.69, 3.07) and the combustible tobacco (aRRR=3.36, 95% CI=2.56, 4.41) classes than White individuals. Asian individuals were less likely to be in the multimodal cannabis (aRRR=0.40, 95% CI=0.20, 0.81) and the multimodal co-use (aRRR=0.43, 95% CI=0.20, 0.94) classes. Black, Asian, and American Indian or Alaska Native/Native Hawaiian or Pacific Islander/multirace individuals were all less likely to be in the multimodal nicotine/tobacco class than White individuals (aRRR range=0.13–0.46). Hispanic individuals were less likely to be in the multimodal nicotine/tobacco (aRRR=0.26, 95% CI=0.11, 0.64) and multimodal co-use (aRRR=0.60, 95% CI=0.44, 0.82) classes than non-Hispanic individuals. Those living in the Midwest were less likely to be in the multimodal cannabis (aRRR=0.63, 95% CI=0.45, 0.88) and the combustible tobacco (aRRR=0.68, 95% CI=0.50, 0.93) classes than those living in the Northeast. Those living in the South were less likely to be in the multimodal cannabis, cannabis edibles, combustible tobacco, and multimodal co-use classes (aRRR range=0.38–

0.67). Those living in the West were less likely to be in the combustible tobacco class (aRRR=0.59, 95% CI=0.42, 0.83).

DISCUSSION

This study demonstrated that use of nicotine, tobacco, and cannabis is heterogeneous among those aged 12–34 years. Six distinct subgroups of use were identified that varied both by modes of use and whether individuals engaged in co-use of more than 1 substance. Notably, on average, respondents indicated more than 1 substance or mode of use in the past 30 days, and a large majority used at least 1 combustible product. Furthermore, 3 of the 6 subgroups identified, representing 45.5% of the sample, were characterized by high probabilities of more than 1 mode or type of substance used.

Despite large reductions in the prevalence of cigarette smoking and other combustible tobacco use in the past 2 decades, the subgroup with the highest estimated prevalence was characterized primarily by combustible tobacco use. That this group remains a large proportion of those using nicotine, tobacco, and cannabis suggests that tobacco cessation resources and prevention should remain a top priority, given the well-known harms associated with the use of combustible tobacco.[1] Those in the oldest age group were most likely to be in this group. Whether this is driven by cohort or developmental age differences was not able to be distinguished in this study. Regardless, these findings suggest that interventions focused on combustible tobacco should be directed at those in their 20s and 30s, and adolescent-focused interventions may have more benefit by focusing on other tobacco- and cannabis-use prevention. The authors also found that Black/African American individuals and males were more likely to be in the combustible tobacco subgroup, highlighting the need for greater tobacco cessation services for these populations.

The multimodal nicotine/tobacco subgroup used various forms of nicotine and tobacco, with the greatest probabilities of novel oral nicotine products, including nicotine pouches, and other noncombustible tobacco products. This group was much smaller in size than the combustible tobacco group but may reflect an emerging subgroup. Notably, the sociodemographics of the multimodal nicotine/tobacco subgroup varied from those of the combustible tobacco subgroup. That is, the multimodal nicotine/tobacco subgroup was overwhelmingly male and predominantly White. This is in line with previous findings from U.S. adults that found that individuals using nicotine pouches were more likely to be male and non-Hispanic White and to have sociodemographic characteristics similar to those of people using smokeless tobacco.[44,45] However, that oral nicotine use seems to occur most in a subgroup that reports multiple other forms of nicotine and tobacco does not seem to support oral nicotine pouches being used as a tobacco cessation tool, at least for this younger sample.

Another important and concerning subgroup that was identified, multimodal co-use, comprised over 1 in 8 of those using nicotine, tobacco, or cannabis. This subgroup had high probabilities of both combustible tobacco and combustible cannabis use, which is associated with higher levels of carcinogenic toxicants than the use of either alone.[46–48] In addition, the use of multiple modalities is associated with greater substance use disorder symptoms and

fewer successful cessation attempts.[49–51] Those in the oldest age group were more likely to be in this subgroup, further underscoring the need for targeted intervention strategies for this age group.

This was the first PATH cohort that was able to separately assess cannabis edibles. The finding that a small group used cannabis edibles exclusively suggests that this mode deserves further attention and may be a subgroup that has been overlooked. Future research is needed to determine whether individuals in this subgroup transition to other forms of nicotine, tobacco, and cannabis use or continue to use edibles exclusively. In addition, given the association between being female and membership in this class, a more in-depth examination of sex differences in cannabis use modalities is warranted.

Limitations

The cross-sectional data did not allow for distinguishing age and cohort effects. It is possible that the findings that nicotine vaping is more prevalent for younger age groups and that subgroups with multiple modes of tobacco and nicotine use are more prevalent for older age groups may be due to some younger individuals not yet having the opportunity to transition to multiple forms of use. This study also relied on self-report rather than biological verification of use. Additional sociodemographic variability, such as whether age group differences varied by sex and race, was not able to be examined owing to power limitations. Finally, the PATH survey did not consistently assess past 30-day frequency of use across all indicators, and thus, different levels of frequency of use were not differentiated. Similarly, simultaneous use of multiple products could not be examined in this study. Future work should examine differences in frequency and consider simultaneous use.

CONCLUSIONS

Future directions include examining other physical and mental health outcomes, including respiratory and cardiovascular consequences and subsequent tobacco and cannabis use disorders, among different subgroups. Future work should also make use of longitudinal data to examine transitions between modalities of use and co-use. Study findings underscore the need for research and prevention efforts to consider multiple types of use, including less traditional forms of use. Additional research should examine the role of other factors that may differ between subgroups and inform the development of prevention strategies, such as mental health symptoms, access to cessation and other healthcare services, peer use, alcohol and other substance use, and the tobacco and cannabis policy environment. Finally, continued surveillance of nicotine, tobacco, and cannabis use is needed, particularly as the products and regulatory environment related to these products continue to evolve.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

1. HHS. The health consequences of smoking: 50 years of progress. a report of the Surgeon General. Atlanta, GA: HHS, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014. https://www.hhs.gov/sites/default/files/consequences-smoking-exec-summary.pdf. Accessed August 16, 2025.
2. Volkow ND, Swanson JM, Evins AE, et al. Effects of cannabis use on human behavior, including cognition, motivation, and psychosis: a review. JAMA Psychiatry. 2016;73(3):292–297. 10.1001/jamapsychiatry.2015.3278. [PubMed: 26842658]
3. Pierce JP, Luo M, McMenamin SB, et al. Declines in cigarette smoking among U.S. adolescents and young adults: indications of independence from e-cigarette vaping surge. Tob Control. 2025;34(3):286–293. 10.1136/tc-2022-057907. [PubMed: 37940404]
4. Sanford BT, Brownstein NC, Baker NL, et al. Shift from smoking cigarettes to vaping nicotine in young adults. JAMA Intern Med. 2024;184(1):106–108. 10.1001/jamainternmed.2023.5239. [PubMed: 37955869]
5. Miech RA, Johnston LD, Patrick ME, O'Malley PM. Monitoring the Future national survey results on drug use, 1975–2023: Secondary school students. Ann Arbor, MI: Institute for Social Research, University of Michigan; January 2024. https://monitoringthefuture.org/wp-content/uploads/2024/01/mtfoverview2024.pdf. Accessed August 15, 2025.
6. Patrick ME, Miech RA, Johnston LD, O'Malley PM. Monitoring the Future panel study annual report: National data on substance use among adults ages 19 to 65, 1976–2023. Ann Arbor, MI: Institute for Social Research, University of Michigan; July 2024. https://monitoringthefuture.org/wp-content/uploads/2024/07/mtfpanel2024.pdf. Accessed August 15, 2025.
7. Substance Abuse and Mental Health Services Administration, Key substance use and mental health indicators in the United States: results from the 2023 National Survey on Drug Use and Health, 2024, Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration https://www.samhsa.gov/data/report/2023-nsduh-annual-national-report. Accessed August 15, 2025.
8. Smith DM, Miller C, O'Connor RJ, et al. Modes of delivery in concurrent nicotine and cannabis use ("co-use") among youth: findings from the international tobacco control (ITC) survey. Subst Abus. 2021;42(3):339–347. 10.1080/08897077.2019.1709603. [PubMed: 31951806]
9. Chu A, Chaiton M, Kaufman P, et al. Co-use, simultaneous use, and mixing of cannabis and tobacco: a cross-national comparison of Canada and the U.S. by cannabis administration type. Int J Environ Res Public Health. 2023;20(5):4206. 10.3390/ijerph20054206. [PubMed: 36901216]
10. Schauer GL, Berg CJ, Kegler MC, Donovan DM, Windle M. Assessing the overlap between tobacco and marijuana: trends in patterns of co-use of tobacco and marijuana in adults from 2003–2012. Addict Behav. 2015;49:26–32. 10.1016/j.addbeh.2015.05.012. [PubMed: 26036666]
11. NSDUH detailed tables. CBHSQ Data; 2023. https://www.samhsa.gov/data/report/2023-nsduh-detailed-tables. Accessed October 31, 2024.
12. Cohn AM, Chen S. Age groups differences in the prevalence and popularity of individual tobacco product use in young adult and adult marijuana and tobacco co-users and tobacco-only users: findings from Wave 4 of the Population Assessment of Tobacco and Health study. Drug Alcohol Depend. 2022;233:109278. 10.1016/j.drugalcdep.2022.109278. [PubMed: 35151023]

13. Cho J, Goldenson NI, Kirkpatrick MG, Barrington-Trimis JL, Pang RD, Leventhal AM. Developmental patterns of tobacco product and cannabis use initiation in high school. Addiction. 2021;116(2):382–393. 10.1111/add.15161. [PubMed: 32533801]
14. Harrell PT, Naqvi SMH, Plunk AD, Ji M, Martins SS. Patterns of youth tobacco and polytobacco usage: The shift to alternative tobacco products. Am J Drug Alcohol Abuse. 2017;43(6):694–702. 10.1080/00952990.2016.1225072. [PubMed: 27668320]
15. Osibogun O, Taleb ZB, Bahelah R, Salloum RG, Maziak W. Correlates of poly-tobacco use among youth and young adults: findings from the Population Assessment of Tobacco and Health study, 2013–2014. Drug Alcohol Depend. 2018;187:160–164. 10.1016/j.drugalcdep.2018.02.024. [PubMed: 29674249]
16. Taylor KA, Sharma E, Edwards KC, et al. Longitudinal pathways of exclusive and polytobacco cigarette use among youth, young adults and adults in the USA: Findings from the PATH Study Waves 1–3 (2013–2016). Tob Control. 2020;29(suppl 3):s139–s146. 10.1136/tobaccocontrol-2020-055630. [PubMed: 32321847]
17. Soneji S, Sargent J, Tanski S. Multiple tobacco product use among U.S. adolescents and young adults. Tob Control. 2016;25(2):174–180. 10.1136/tobaccocontrol-2014-051638. [PubMed: 25361744]
18. Steigerwald S, Wong PO, Cohen BE, et al. Smoking, vaping, and use of edibles and other forms of marijuana among U.S. adults. Ann Intern Med. 2018;169(12):890–892. 10.7326/M18-1681. [PubMed: 30167665]
19. Swan C, Ferro MA, Thompson K. Does how you use matter? The link between mode of use and cannabis-related risk. Addict Behav. 2021;112:106620. 10.1016/j.addbeh.2020.106620. [PubMed: 32911353]
20. Nguyen N, Thrul J, Neilands TB, Ling PM. Associations between product type and intensity of tobacco and cannabis co-use on the same day among young adult smokers: Smartphone-based daily-diary study. JMIR MHealth UHealth. 2023;11(1):e40736. 10.2196/40736. [PubMed: 36806440]
21. Cohn AM, Abudayyeh H, Perreras L, Peters EN. Patterns and correlates of the co-use of marijuana with any tobacco and individual tobacco products in young adults from wave 2 of the PATH study. Addict Behav. 2019;92:122–127. 10.1016/j.addbeh.2018.12.025. [PubMed: 30623805]
22. de Jonge MC, Bukman AJ, van Leeuwen L, Onrust SA, Kleinjan M. Latent classes of substance use in young adults – a systematic review. Subst Use Misuse. 2022;57(5):769–785. 10.1080/10826084.2022.2040029. [PubMed: 35188870]
23. Evans-Polce R, Lanza S, Maggs J. Heterogeneity of alcohol, tobacco, and other substance use behaviors in U.S. college students: A latent class analysis. Addict Behav. 2016;53:80–85. 10.1016/j.addbeh.2015.10.010. [PubMed: 26476004]
24. Tomczyk S, Isensee B, Hanewinkel R. Latent classes of polysubstance use among adolescents-a systematic review. Drug Alcohol Depend. 2016;160:12–29. 10.1016/j.drugalcdep.2015.11.035. [PubMed: 26794683]
25. Coulter RWS, Ware D, Fish JN, Plankey MW. Latent classes of poly-substance use among adolescents in the United States: intersections of sexual identity with sex, age, and race/ethnicity. LGBT Health. 2019;6(3):116–125. 10.1089/lgbt.2018.0149. [PubMed: 30822259]
26. Nguyen N, Barrington-Trimis JL, Urman R, et al. Past 30-day co-use of tobacco and marijuana products among adolescents and young adults in California. Addict Behav. 2019;98:106053. 10.1016/j.addbeh.2019.106053. [PubMed: 31357072]
27. Couch ET, Halpern-Felsher B, Werts M, Chaffee BW. Use of emerging and conventional oral tobacco among adolescent and young adult E-cigarette users. Subst Use Misuse. 2023;58(2):283–288. 10.1080/10826084.2022.2161314. [PubMed: 36645845]
28. Harlow AF, Vogel EA, Tackett AP, et al. Adolescent use of flavored non-tobacco oral nicotine products. Pediatrics. 2022;150(3): e2022056586. 10.1542/peds.2022-056586. [PubMed: 35934731]
29. Patel M, Kierstead EC, Kreslake J, Schillo BA. Patterns of oral nicotine pouch use among U.S. adolescents and young adults. Prev Med Rep. 2023;34:102239. 10.1016/j.pmedr.2023.102239. [PubMed: 37228836]

30. Russell C, Rueda S, Room R, Tyndall M, Fischer B. Routes of administration for cannabis use – basic prevalence and related health outcomes: A scoping review and synthesis. Int J Drug Policy. 2018;52:87–96. 10.1016/j.drugpo.2017.11.008. [PubMed: 29277082]

31. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on Population Health and Public Health Practice. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on Population Health and Public Health Practice. Cannabis consumption and markets in the United States. Cannabis Policy Impacts Public Health and Health Equity. Washington, DC: National Academies Press; 2024. 103–139. https://www.ncbi.nlm.nih.gov/sites/books/NBK609482/.

32. Zuckermann AME, Williams G, Battista K, De Groh M, Jiang Y, Leatherdale ST. Trends of poly-substance use among Canadian youth. Addict Behav Rep. 2019;10:100189. 10.1016/j.abrep.2019.100189. [PubMed: 31193263]

33. Ramo DE, Liu H, Prochaska JJ. Tobacco and marijuana use among adolescents and young adults: A systematic review of their co-use. Clin Psychol Rev. 2012;32(2):105–121. 10.1016/j.cpr.2011.12.002. [PubMed: 22245559]

34. Tucker JS, Rodriguez A, Dunbar MS, et al. Cannabis and tobacco use and co-use: Trajectories and correlates from early adolescence to emerging adulthood. Drug Alcohol Depend. 2019;204:107499. 10.1016/j.drugalcdep.2019.06.004. [PubMed: 31479864]

35. Usidame B, Hirschtick JL, Mattingly DT, Patel A, Patrick ME, Fleischer NL. Sociodemographic patterns of exclusive and dual combustible tobacco and E-cigarette use among U.S. adolescents—a nationally representative study (2017–2020). Int J Environ Res Public Health. 2022;19(5):2965. 10.3390/ijerph19052965. [PubMed: 35270656]

36. Evans-Polce RJ, Mongilio JM, Kcomt L, Chen B, McCabe SE. Trends and sociodemographic differences in tobacco/nicotine transitions among U.S. adolescents and young adults using e-cigarettes, 2014–2023. J Adolesc Health. 2025;76(5):920–927. 10.1016/j.jadohealth.2025.01.013. [PubMed: 39969469]

37. Hu SS, Homa DM, Wang T, et al. State-specific patterns of cigarette smoking, smokeless tobacco use, and e-cigarette use among adults — United States, 2016. Prev Chronic Dis. 2019;16:E17. 10.5888/pcd16.180362. [PubMed: 30730828]

38. HHS, National Institutes of Health. National Institute On Drug Abuse. Population Assessment of Tobacco and Health (PATH) Study [United States] restricted-use files: user guide. Ann Arbor, MI: Inter-University Consortium for Political and Social Research; 2016. 10.3886/ICPSR36231.USERGUIDE Published.

39. U.S. Department of Health and Human Services. National Institutes of Health. National Institute on Drug Abuse, U. S. Department of Health and Human Services. Food and Drug Administration. Center for Tobacco Products. Population Assessment of Tobacco and Health (PATH) Study [United States] biomarker restricted-use files, user guide. ICPSR36840-V8. Ann Arbor, MI: Inter-University Consortium for Political and Social Research, 2020 Published. 10.3886/ICPSR36840.v11.

40. Collins LM, Lanza ST. Latent Class and Latent Transition Analysis: With Applications in the Social, Behavioral, and Health Sciences. Hoboken, NJ: John Wiley & Sons, 2010.

41. Bolck A, Croon M, Hagenaars J. Estimating latent structure models with categorical variables: one-step versus three-step estimators. Polit Anal. 2004;12(1):3–27. 10.1093/pan/mph001.

42. Lanza ST, Dziak JJ, Huang L, Wagner A and Collins LM, Proc LCA & Proc LTA Users' Guide (Version 1.3.2), Penn State: The Methodology Center, 2015 http://methodology.psu.edu.

43. Dziak JJ, Bray BC, Wagner AT. %LCA_Covariates_3Step SAS Macro Users' Guide (Version 1.0). https://www.latentclassanalysis.com/wp-content/uploads/2021/01/LCA_Covariates_3Step_UG_1.0.pdf. Accessed August 16, 2025.

44. Dai HD, Leventhal AM. Prevalence of nicotine pouch use among U.S. adults. JAMA. 2024;332(9):755–757. 10.1001/jama.2024.10686. [PubMed: 38985479]

45. Travis N, Warner KE, Goniewicz ML, et al. The potential impact of oral nicotine pouches on public health: a scoping review. Nicotine Tob Res. 2025;27(4):598–610. 10.1093/ntr/ntae131. [PubMed: 38880491]

46. Meier E, Tessier KM, Luo X, et al. Cigarette smokers versus cannabis smokers versus co-users of cigarettes and cannabis: a pilot study examining exposure to toxicants. Nicotine Tob Res. 2022;24(1):125–129. 10.1093/ntr/ntab125. [PubMed: 34120176]

47. Moir D, Rickert WS, Levasseur G, et al. A comparison of mainstream and sidestream marijuana and tobacco cigarette smoke produced under two machine smoking conditions. Chem Res Toxicol. 2008;21(2):494–502. 10.1021/tx700275p. [PubMed: 18062674]

48. Smith DM, O'connor RJ, Wei B, Travers M, Hyland A, Goniewicz ML. Nicotine and toxicant exposure among concurrent users (co-users) of tobacco and cannabis. Nicotine Tob Res. 2020;22(8):1354–1363. 10.1093/ntr/ntz122. [PubMed: 31388679]

49. Boyd CJ, Veliz P, Evans-Polce R, Eisman AB, Esteban McCabe S. Latent class trajectories: U.S. adolescents' nicotine use and its association with nicotine dependence. Addict Behav Rep. 2020;12:100303. 10.1016/j.abrep.2020.100303. [PubMed: 33364312]

50. Sung HY, Wang Y, Yao T, Lightwood J, Max W. Polytobacco use and nicotine dependence symptoms among U.S. adults, 2012–2014. Nicotine Tob Res. 2018;20(suppl 1):S88–S98. 10.1093/ntr/nty050. [PubMed: 30125019]

51. Rostron BL, Schroeder MJ, Ambrose BK. Dependence symptoms and cessation intentions among U.S. adult daily cigarette, cigar, and e-cigarette users, 2012–2013. BMC Public Health. 2016;16(1):814. 10.1186/s12889-016-3510-2. [PubMed: 27538489]

Table 1.

Weighted Characteristics of PATH Wave 7 Cohort Respondents Aged 12–34 Years

Characteristics	All respondents aged 12–34 years (N=27,770), %	Respondents aged 12–34 years reporting any past 30-day nicotine, tobacco, or cannabis use (*n*=8,722), %
Indicators		
Vaping nicotine	15.91	46.36
Combustible tobacco use	15.37	44.75
Oral nicotine product use	1.53	4.45
Other noncombustible tobacco use	1.68	4.88
Blunt use	7.21	20.99
Cannabis vaping	8.30	24.18
Cannabis smoking	13.92	40.52
Cannabis edibles	7.46	21.71
Sociodemographics		
Female	49.61	45.02
Age group, years		
12–17	26.27	6.41
18–20	12.74	13.37
21–25	21.14	27.98
26–34	39.85	52.24
Race		
White	67.26	69.59
Black/African American	14.58	14.50
Asian	7.02	3.86
AIAN/NHPI/multirace	11.14	12.06
Hispanic ethnicity	23.08	19.90
Region		
Northeast	16.31	17.15
Midwest	20.32	21.90
South	38.63	37.53
West	24.74	23.42

AIAN, American Indian or Alaska Native, NHPI, Native Hawaiian or Pacific Islander.

Table 2.

Probabilities of Nicotine, Tobacco, and Cannabis Use by Latent Class Membership Among Youth and Adults Aged 12–34 Years Reporting any Past 30-Day Use (n=8,722)

Indicators	Vaping nicotine 18.37%	Multimodal cannabis 26.72%	Multimodal nicotine/ tobacco 4.95%	Cannabis edibles 5.31%	Combustible tobacco 30.77%	Multimodal co-use 13.87%
Vaping nicotine	0.99	0.16	0.38	0.14	0.36	0.71
Combustible tobacco use	0.10	0.06	0.36	<0.01	0.99	0.62
Oral nicotine product use	<0.01	<0.01	0.64	<0.01	0.04	0.04
Other noncombustible tobacco use	0.03	<0.01	0.43	0.01	0.02	0.07
Blunt use	0.03	0.29	0.01	0.01	0.15	0.58
Cannabis vaping	0.09	0.39	0.07	0.18	0.03	0.72
Cannabis smoking	0.12	0.69	0.07	0.17	0.21	0.89
Cannabis edibles	<0.01	0.33	0.04	0.99	0.06	0.52

Note: Probabilities provided represent the probability that an individual reported a given substance/mode of use given membership in that substance use class. LCA models employed pseudomaximum-likelihood weighting methods to account for the PATH sample design.

LCA, Latent Class Analysis; PATH, Population Assessment of Tobacco and Health.

Table 3.

Multivariable Multinomial Regression Models of Sociodemographic Covariate Associations With Latent Class Membership

Sociodemographic covariates	Multimodal cannabis aRRR (95% CI)	Multimodal nicotine/tobacco aRRR (95% CI)	Cannabis edibles aRRR (95% CI)	Combustible tobacco aRRR (95% CI)	Multimodal co-use aRRR (95% CI)
Female (ref=male)	1.18 (0.96,1.45)	0.09 (0.05, 0.17)	1.48 (1.01, 2.17)	0.71 (0.58, 0.86)	0.93 (0.74, 1.18)
Age group, years					
12–17	0.52 (0.41, 0.67)	0.34 (0.18, 0.62)	0.35 (0.17, 0.70)	0.10 (0.06, 0.17)	0.35 (0.25, 0.49)
18–20	0.68 (0.54, 0.86)	0.44 (0.26, 0.73)	0.48 (0.27, 0.82)	0.35 (0.27, 0.45)	0.71 (0.54, 0.93)
21–25	ref	ref	ref	ref	ref
26–34	1.27 (0.98, 1.66)	2.20 (1.41, 3.44)	2.40 (1.59, 3.62)	2.51 (1.99, 3.16)	1.36 (1.02, 1.81)
Race					
White	ref	ref	ref	ref	ref
Black	2.28 (1.69, 3.07)	0.13 (0.03, 0.52)	1.05 (0.50, 2.21)	3.36 (2.56, 4.41)	0.87 (0.56, 1.35)
Asian	0.40 (0.20, 0.81)	0.17 (0.05, 0.60)	1.57 (0.72, 3.41)	0.64 (0.33, 1.23)	0.43 (0.20, 0.94)
AIAN/NHPI/multirace	1.27 (0.98, 1.66)	0.46 (0.24, 0.90)	0.68 (0.35, 1.34)	1.23 (0.92, 1.66)	1.16 (0.83, 1.62)
Hispanic (ref=non-Hispanic)	1.20 (0.94, 1.53)	0.26 (0.11, 0.64)	0.53 (0.29, 0.97)	1.06 (0.83, 1.35)	0.60 (0.44, 0.82)
Region					
Northeast	ref	ref	ref	ref	ref
Midwest	0.63 (0.45, 0.88)	1.97 (0.98, 3.96)	0.79 (0.43, 1.45)	0.68 (0.50, 0.93)	0.93 (0.64, 1.36)
South	0.44 (0.32, 0.60)	1.34 (0.66, 2.68)	0.38 (0.20, 0.72)	0.67 (0.50, 0.90)	0.52 (0.36, 0.75)
West	0.85 (0.62, 1.18)	1.45 (0.71, 2.99)	1.36 (0.75, 2.44)	0.59 (0.42, 0.83)	0.89 (0.60, 1.32)

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

LCA models employed pseudomaximum-likelihood weighting methods to account for the PATH sample design.

AIAN, American Indian or Alaska Native; aRRR, adjusted RRR; LCA, Latent Class Analysis; NHPI, Native Hawaiian or Pacific Islander; PATH, Population Assessment of Tobacco and Health.