



HHS Public Access

Author manuscript

J Community Health. Author manuscript; available in PMC 2024 October 01.

Published in final edited form as:

J Community Health. 2023 October ; 48(5): 752–760. doi:10.1007/s10900-023-01214-8.

Investigating Tobacco Product Use Behavior among Students attending High Schools within the Cherokee Nation Reservation

Ashley L. Comiford, Dr.P.H.¹, Sixia Chen, Ph.D.², Andrea Blair, Ph.D.³

¹Cherokee Nation Health Services, 19600 East Ross Road, Tahlequah, OK 74464, USA.

²Department of Biostatistics and Epidemiology, Hudson College of Public Health, University of Oklahoma Health Sciences Center, Oklahoma City, OK 73104, USA.

³Cherokee Nation Public Health, 1325 East Boone Street, Tahlequah, OK 74464, USA.

Abstract

Tobacco use is the leading cause of death in the United States and youth prevention is key to reducing tobacco use. American Indian/Alaska Native (AI/AN) individuals have a higher prevalence of tobacco use compared to other populations. This paper aims to evaluate the prevalence of tobacco products among youth within the Cherokee Nation reservation. Data from the 2019 Cherokee Nation Youth Risk Behavior Survey (YRBS) was used to analyze the prevalence of tobacco use (cigarettes, smokeless tobacco, electronic cigarettes, cigars, and 2 products) among students within Cherokee Nation. Weighted frequency and percentages were obtained for variables and 95% confidence intervals were computed using Taylor linearization variance estimators. Binary associations between variables were examined using the Rao-Scott Chi-square test. There were 1,475 high students who participated in the 2019 Cherokee Nation YRBS. Males were more likely to report the use of smokeless tobacco and 2 products than females. Twelfth graders had a higher prevalence of reported e-cigarette use compared to lower grades. AI/AN students had a higher prevalence of current use of cigarettes and 2 products compared to other groups. The use of marijuana and alcohol was positively associated with the use of all tobacco products. Depression was also positively associated with the use of all products excluding smokeless tobacco. Grade, age, depression, and current use of other tobacco products, marijuana, and alcohol were associated with greater electronic cigarette intensity levels. Using

Corresponding Author Ashley L. Comiford, Phone: 918-453-5000 ext. 7076, ashley-comiford@cherokee.org.

Authors' contributions

All authors contributed to the study conception and design. Ashley Comiford performed material preparation and data collection. Sixia Chen performed data analyses. All authors contributed to the interpretation of data. Ashley Comiford wrote the first draft of the manuscript, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest Competing Interests

The authors declare that they have no conflict of interest.

Ethics Approval

The Cherokee Nation Institutional Review Board approved this project.

Consent to Participate

This was a secondary data analysis of de-identified YRBS surveillance data. Therefore, informed consent was unnecessary.

Availability of data and material (data transparency)

Restrictions apply to the availability of these data, which are owned by the Cherokee Nation, and are not publicly available. Data are, however, available with the explicit permission of the Cherokee Nation.

the results, tribal and local organizations can promote evidence-based interventions that focus on reducing tobacco use among youth.

Keywords

Tobacco Use; Youth; American Indian; Health Disparities

Introduction

Tobacco product use is the leading cause of preventable disease, disability, and death in the United States [1]. American Indian/Alaska Native (AI/AN) individuals have a higher prevalence of tobacco use compared to other populations and are disproportionately affected by tobacco-related morbidity and mortality [2-3]. For example, AI/AN people have a higher prevalence of smoking-related heart disease and stroke deaths than whites.² Youth prevention of tobacco use is critical to reducing overall tobacco-related diseases as almost 90% of adult tobacco users start using tobacco products before the age of 18 years [3].

While cigarette smoking among youth has declined significantly [4-6], electronic cigarette (e-cigarette) use has surged [7]. In 2019, 53.3% of high school students reported ever trying a tobacco product that included e-cigarettes, cigarettes, cigars, smokeless tobacco, hookahs, pipe tobacco, and bidis [8]. Nearly 31% of students reported currently using tobacco, with e-cigarettes being the most common product used at 27.5% [8]. The increase in e-cigarette use among youth is alarming due to the negative effects of nicotine [9-10], unknown long-term effects [11-12], and potential for e-cigarette use leading to utilization of regular tobacco products [13].

AI/AN youth have higher use of tobacco products compared to the general population and other racial/ethnic groups. The 2019 Youth Risk Behavior Survey (YRBS) indicated that 6% of high school students currently use cigarettes [14]. Yet, more than 20% of AI/AN students reported currently smoking cigarettes [14]. While only 32% of all students currently use e-cigarettes, more than 47% of AI/AN students use these products. AI/AN youth also had a higher percentage of current smokeless tobacco and cigar use compared to all students [14].

Another concern relative to adolescent tobacco use is its relationship with other substance abuse and mental health. For example, one study found that ever tobacco use was associated with increased lifetime use of both marijuana and alcohol [15]. Additionally, this study found that tobacco use was associated with poor mental health. These associations held true across other tobacco products including cigarettes, e-cigarettes, smokeless tobacco, and cigars [15]. Other studies have found an association between tobacco products and illicit substances, as well as poor mental health [16-20].

There is often a lack of or incomplete tribal-specific health data for AI/AN populations [21-22]. This hinders tribes and tribal organizations from having data to adequately inform their youth tobacco prevention and cessation initiatives. To combat this, the Cherokee Nation Public Health Department (CNPH) has been building its surveillance infrastructure. This has included the implementation of a biennial youth survey titled, "Cherokee Nation YRBS,"

that has been implemented since 2009 [23]. The YRBS survey monitors six categories of health-related behaviors, including tobacco use [24].

The purpose of this paper is to determine the prevalence of ever and current use of tobacco products among high school students within the Cherokee Nation reservation. Further, it aims to explore whether differences in sociodemographic characteristics, illicit substance use, and depression are associated with tobacco use. Finally, it examines the intensity of e-cigarette use among high school students as this is often the most used tobacco product. The overall goal of this study is to provide data for CNPH, tribal, and local leaders so they may make informed decisions about tobacco programs within Cherokee Nation.

Methods

Data Source: YRBS

Data were retrieved from the 2019 Cherokee Nation YRBS. CNPH conducts this survey biennially to better understand how risky health behaviors change over time among students attending regular public high schools located within the Cherokee Nation reservation in Oklahoma. The sampling process consisted of two stages through which 9-12 grade students were approached for participation.

The first-stage sampling frame contained 63 high schools located within the Cherokee Nation reservation. This YRBS sampling frame consisted of all regular public (including charter) schools with students in at least one of grades 9–12 within the boundaries of the Cherokee Nation reservation. Alternative schools, special education schools, schools operated by the U.S. Department of Defense, the Bureau of Indian Education, parochial, nonpublic, and vocational schools serving only students who also attended another school were excluded. Schools with an enrollment of < 40 students across grades 9–12 were also excluded. The sampling frame was based on data sets obtained from the Cherokee Nation Geographic Information System (GIS) department and the Oklahoma Department of Education Statistics. A total of 18 schools were selected using a systematic probability proportional to size sampling design with size variable as the enrollment in grades 9 through 12 in each school.

The second stage of sampling was comprised of systematic equal probability random sampling of about 6 to 8 classrooms in grades 9–12 from either a required subject (e.g., English) or a required period (e.g., homeroom or second period). All students in the sampled classes were eligible to participate. Schools, classes, and students who refused to participate were not replaced in the sampling design. Data collected in 2019 included 1,960 students from 18 schools that were invited to participate in the survey. Of these, 1,476 provided valid data for the final analysis. The overall response rate of this survey was 75%, which was calculated by multiplying the school response rate (100%) by the student response rate (75%). The weighting procedure for the survey included the calculations of the inverse of the probability of selecting the school, the inverse of the probability of selecting the classroom within the school, a student-level nonresponse adjustment factor calculated by class, and a poststratification adjustment factor calculated by using the gender variable within the grade variable and by using race/ethnicity. The final weights were equal to the

product of the previous four terms and were scaled so that the weighted count of students equaled the total frame size, and the weighted proportions of male or female students in each grade as well as of each race/ethnicity category benchmarked with the Oklahoma population proportions within Cherokee Nation reservation. Weighted estimates are representative of all students in grades 9–12 attending Oklahoma public schools within the Cherokee Nation reservation.

Tobacco Products

For ever use of cigarettes, students were asked the question, “Have you ever tried cigarette smoking, even one or two puffs?” Questions about e-cigarettes were prefaced with the following statement, “The next 3 questions ask about electronic vapor products, such as JUUL, Vuse, MarkTen, and blu. Electronic vapor products include e-cigarettes, vapes, vape pens, e-cigars, e-hookahs, hookah pens, and mods.” For ever use of e-cigarettes, students were asked, “Have you ever used an electronic vapor product?” Both the cigarette ever use and e-cigarette ever use variables were dichotomized as yes or no. We also calculated ever use of both products and this variable was dichotomized as yes or no if students indicated they ever used both products.

Students were asked about the current use of cigarettes, e-cigarettes, smokeless tobacco, and cigars. They were asked how many days during the past 30 days did they use the previously mentioned tobacco products. They were given the following options: 0 days, 1 or 2 days, 3 to 5 days, 6 to 9 days, 10 to 19 days, 20 to 29 days, or all 30 days. The current use of cigarettes, e-cigarettes, smokeless tobacco, and cigars variables were dichotomized as yes or no. The yes category was defined as using these products on one or more days during the past 30 days and no was categorized as using these products 0 days during the past 30 days. The intensity of e-cigarette use variable was calculated using the same question as current use. No use was defined as 0 days during the past 30 days, light use was defined as 1 to 5 days, medium use was defined as 6 to 19 days, and heavy use was defined as 20 or more days. Other tobacco use was calculated using the same questions above. If students used cigarettes, smokeless tobacco, or cigars on one or more days during the past 30 days, they were defined as other tobacco users (yes). If they did not use these products in the past 30 days, they were defined as not using other tobacco (no). We also calculated the current use of 2 products and that variable was dichotomized as yes or no if students indicated they currently used 2 or more of the above-mentioned products.

Sociodemographic

Survey participants were asked about age, sex, grade, and race/ethnicity. Sex was categorized as male and female. The grade variable was categorized as 9th grade, 10th grade, 11th grade, and 12th grade. The Race/ethnicity variable was based on the following two questions: “Are you Hispanic or Latino?”; “What is your race? (Select one or more responses).” Individuals who identified as AI/AN either alone or in combination with other racial groups were categorized as AI/AN, regardless of how they answered the Hispanic or Latino question. Individuals who identified solely as White on the racial question and answered no to the Hispanic/Latino question were categorized as non-Hispanic White

(NHW); all other responses were categorized as other. Age was categorized as 15 years of age, 16 to 17 years of age, and 18 years of age.

Other Substance Use

The marijuana questions were prefaced with the following: “The next 3 questions ask about marijuana use. Marijuana also is called pot, weed, or cannabis.” Students were asked the question, “During the past 30 days, how many times did you use marijuana?” Students were given the following options: 0 times, 1 or 2 times, 3 to 9 times, 10 to 19 times, 20 to 39 times, or 40 or more times. Current use of marijuana was categorized as yes or no with yes defined as using marijuana one or more times during the past 30 days and no was categorized as using these products 0 times during the past 30 days. The alcohol questions were prefaced with the following: “The next 5 questions ask about drinking alcohol. This includes drinking beer, wine, wine coolers, and liquor such as rum, gin, vodka, or whiskey. For these questions, drinking alcohol does not include drinking a few sips of wine for religious purposes.” Students were asked the question, “During the past 30 days, how many days did you have at least one drink of alcohol?” Students were given the following options: 0 days, 1 or 2 days, 3 to 5 days, 6 to 9 days, 10 to 19 days, 20 to 29 days, or all 30 days. Current use of alcohol was categorized as yes or no with yes defined as using alcohol on one or more days during the past 30 days and no was categorized as using these products 0 times during the past 30 days.

Depression

Students were asked the following question about depression, “During the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing usual activities?” The depression variable was dichotomized as yes or no.

Statistical Analysis Method

The data for this study included 1475 high school students who completed the 2019 Cherokee Nation YRBS. Data were weighted to be representative of public-school students attending grades 9–12 within Cherokee Nation reservation. Weighted frequency and percentages were obtained for all categorical variables. 95% confidence intervals (95% CI) of the percentages were computed by using Taylor linearization variance estimators. Binary associations between categorical variables were examined by using the Rao-Scott Chi-square test. Design features including variance stratification, clustering, and survey final weights were incorporated into the analysis. SAS 9.4 procure “PROC SURVEYFREQ” was used to obtain the above results. Missing values were removed from the data file for statistical analysis.

Results

Table 1 presents the overall population characteristics and ever use of cigarettes, e-cigarettes, and both products. Approximately 51% of the population was male. About 46% of students were NHW and 44% identified as AI/AN. Nearly 50% of participants were 16-17 years of age and 20% were 18 years or older. Among all students, approximately 40% reported depression, 17% currently used marijuana, and more than 28% reported current alcohol use.

Prevalence of ever use of cigarettes, e-cigarettes, and both products was significantly higher among 12th graders when compared to the other grades. AI/AN students had a significantly higher prevalence of ever using cigarettes ($p<0.001$) and both products ($p<0.001$) when compared to NHW, and other racial groups. The prevalence of ever use of cigarettes, e-cigarettes, and both products was significantly higher among students who reported current marijuana use, alcohol use, and depression ($p<0.001$).

Table 2 presents the characteristics of the population by current use of cigarettes, smokeless tobacco, cigars, e-cigarettes, and two or more products. When compared to females, male students were significantly ($p<0.05$) more likely to report currently using smokeless tobacco (11.89% vs. 1.63%), cigars (8.46% vs. 5.21%), and two or more products (15.45% vs. 10.11%). Students in the 12th grade had a significantly higher prevalence of reported e-cigarette use when compared to lower grade levels ($p<0.001$). AI/AN students had a significantly ($p<0.001$) higher prevalence of current cigarette use when compared to both NHW students and students in the other racial/ethnic group (13.20%, 7.19%, and 4.53%, respectively). AI/AN students also had a significantly ($p<0.05$) higher prevalence of the current use of two or more products when compared to students in the other racial/ethnic group (15.24% vs 6.47%). Age group was significantly ($p<0.05$) associated with the current use of every product excluding smokeless tobacco. Individuals 18 years and older had a higher prevalence of using cigarettes, cigars, e-cigarettes, and two or more products when compared to the other age groups. Current use of marijuana was significantly ($p<0.05$) associated with the reported use of cigarettes, smokeless tobacco, cigars, e-cigarettes, and two or more products. For example, nearly 80% of students who currently use marijuana also reported the current use of e-cigarettes. Comparatively, among students who did not use marijuana, only 20% reported the current use of e-cigarettes. Depression was associated with the current use of all products excluding smokeless tobacco ($p<0.05$). Among those who reported being depressed, nearly 16% reported current use of cigarettes, 10% reported cigar use, 41% reported e-cigarette use, and nearly 19% reported use of two or more products. Among those who reported no depression, 6% reported cigarette use, about 5% reported cigar use, 21% reported e-cigarette use, and around 9% reported using two or more products. Current alcohol use was also significantly associated with all tobacco products ($p<0.05$).

Table 3 presents the characteristics of the current use of e-cigarettes by intensity levels. Sex and race/ethnicity were not significantly associated with the intensity of use ($p>0.05$). Grade and age group were significantly associated with the intensity of use. Higher grade levels and age groups had higher intensity of e-cigarette use ($p<0.05$). Current use of other tobacco products and marijuana was also significantly associated with intensity level ($p<0.05$). More than 44% of students who reported other tobacco product use also reported heavy e-cigarette use compared to only 7.01% of those reporting the use of no other tobacco product. Marijuana and alcohol use as well as depression was significantly associated with the intensity of e-cigarette use ($p < 0.001$). Among those who use marijuana, 20% indicated they did not currently use e-cigarettes, 20% were light users, about 17% were medium users, and more than 43% were heavy users. Comparatively, among marijuana non-users, more than 80% reported no use of e-cigarettes, about 7% reported light use, less than 5% reported medium use, and only 7% reported heavy use. Depression was also associated with the intensity of e-cigarette use. Among those who reported depression, more than 22% reported

heavy use compared to only about 9% of those who did not report depression. Among students who reported current alcohol use nearly 36% reported heavy use of e-cigarettes. Comparatively, less than 5% of students reporting no alcohol use were heavy e-cigarette users.

Discussion

The current project aimed to identify the prevalence of ever use of cigarettes and e-cigarettes, the current use of these and other tobacco products, and the intensity of e-cigarette use among high school students within the Cherokee Nation reservation. The findings showed that ever and current use of different tobacco products were significantly associated with sociodemographic characteristics including sex, age, race, and grade. Further, tobacco use was associated with the current use of marijuana, and alcohol, and reported depression.

AI/AN students were more likely to report ever use of cigarettes and ever use of both products. Additionally, they were more likely to report the current use of cigarettes compared to NHW students. This is consistent with previous research that has found that AI/AN youth have a higher prevalence of cigarette use [8]. However, in this population, AI/AN students did not significantly differ in ever or current use of e-cigarettes when compared to their NHW peers. These results differ from what other studies have shown and what national survey results indicate [25].

Outside of sociodemographic characteristics of students, current marijuana use was associated with the ever use of cigarettes, e-cigarettes, and both products. Further, current marijuana use was associated with the current use of all tobacco products including cigarettes, smokeless tobacco, cigars, e-cigarettes, and two or more products. Specifically, nearly 80% of current marijuana users also reported current use of e-cigarettes, and more than 40% reported heavy use of e-cigarettes. Other studies have found an association between marijuana and e-cigarette use. For example, one study found that adolescents who use e-cigarettes were also more likely to use marijuana [26]. Another study found that heavier use of e-cigarettes increased the odds of future heavier use of marijuana [27]. Given the increase in e-cigarette use among youth [7] and the increased legalization of marijuana across the United States and Oklahoma [28], the concurrent use of marijuana and tobacco products, particularly e-cigarettes, should be further explored. Interventions and prevention programs should address both e-cigarettes and marijuana, as they seem to be highly associated with each other.

In this population, current alcohol use was significantly associated with all tobacco products. More than 72% of students who currently consume alcohol also reported the current use of e-cigarettes. Additionally, nearly 36% of current alcohol users reported heavy e-cigarette use. Research has shown a strong correlation between e-cigarette and alcohol use [17, 19, 29-30]. A previous study found that adolescents who reported e-cigarette use were 3.5 times more likely to initiate alcohol use in the future compared to non-users of e-cigarettes [17]. E-cigarette users have also been found to have a higher risk of heavy episodic drinking and drunkenness and alcohol-related violence than non-users of e-cigarettes [29-30]. Poly-

substance use or the use of two or more illicit substances, especially alcohol and marijuana, has also been shown to increase e-cigarette use among adolescents [19]. As with marijuana and e-cigarette use, alcohol and e-cigarette use should be further evaluated. Further, this project found that depression was also significantly associated with the use of tobacco products, especially current e-cigarette use. The cross-section of tobacco use, alcohol and marijuana use, and depression should be further explored.

This study has some limitations. First, this was a cross-sectional analysis; therefore, causality and temporal relationship of associations cannot be determined. Second, survey data were self-reported and subject to recall bias. Third, students may be hesitant to report true behaviors as many of these behaviors described in this report are illicit behaviors for this age group, which may lead to under or overreporting of health behaviors. However, the YRBS survey has shown to have good reliability and validity [31-33]. Fourth, this dataset is limited to students who attend public schools within the Cherokee Nation reservation. This limits the generalizability and does not represent high school-aged adolescents not enrolled in public schools. Despite these limitations, this study does have many strengths. First, this is a population-based dataset that represents the health behaviors of high school youth in the Cherokee Nation. Secondly, this data represents tribal-specific data that can be used to inform tribal programs and provide insight into risky health behaviors that are prevalent among youth at the local level. Additionally, at the national level, AI/AN survey participants are often lumped into the “other” racial/ethnic category, and this makes it difficult for public health officials to develop interventions targeting AI/AN youth. These results will provide public health organizations with data that can be utilized to better understand risky behaviors among AI/AN students and to better inform youth tobacco prevention and cessation interventions. Lastly, this study grouped students who identified as AI/AN alone or in combination with other racial/ethnic groups. This may better represent the population that tribal public health programs serve as these programs often provide services to citizens or members of tribes, which may include individuals who identify as AI/AN alone or in combination with other racial/ethnic groups.

In conclusion, the results of this report identified differences in the ever and current use of various tobacco products among sociodemographic characteristics including sex, age, race/ethnicity, and grade. Additionally, this report found that among all high school students within the Cherokee Nation Reservation, current marijuana and alcohol use were associated with the ever and current use of several tobacco products. Using the results of this report, tribal and local organizations can promote evidence-based interventions that focus on reducing tobacco use among youth. This report indicated that while some of the results were similar to national trends, other results differed from those seen at the national level. This highlights the importance of collecting, analyzing, and disseminating information at the local level, particularly among populations that are often excluded or underrepresented in other datasets.

Acknowledgments

The authors acknowledge the public health staff, particularly public health educators, at CNPH for their support and work in collecting the CN YRBS data. Content is solely the responsibility of the authors and does not represent

the official views of the National Institutes of Health, Centers for Disease Control and Prevention, or of Cherokee Nation.

Funding

The funding sponsors for this project were the National Institutes of Health (Grant 1S06GM142119-01), and the Centers for Disease Control and Prevention (Grant NU87PS004302).

References

1. Hu SS, Neff L, Agaku IT, Cox S, Day HR, Holder-Hayes E, & King BA (2016). Tobacco Product Use Among Adults—United States, 2013–2014. *MMWR Morbidity and Mortality Weekly Report*, 65(27), 685–691. 10.15585/mmwr.mm6527a1 [PubMed: 27416365]
2. Mowery PD, Dube SR, Thorne SL, Garrett BE, Homa DM, & Nez Henderson P (2015). Disparities in Smoking-Related Mortality Among American Indians/Alaska Natives. *American Journal of Preventive Medicine*, 49(5), 738–744. 10.1016/j.amepre.2015.05.002 [PubMed: 26163166]
3. National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health. (2014). *The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General*. Centers for Disease Control and Prevention (US). Retrieved August 23, 2022, from <http://www.ncbi.nlm.nih.gov/books/NBK179276/>
4. Warner KE (2015). The remarkable decrease in cigarette smoking by American youth: Further evidence. *Preventive Medicine Reports*, 2, 259–261. 10.1016/j.pmedr.2015.04.001 [PubMed: 26844080]
5. Ziller EC, Lenardson JD, Paluso NC, Talbot JA, & Daley A (2019). Rural-Urban Differences in the Decline of Adolescent Cigarette Smoking. *American Journal of Public Health*, 109(5), 771–773. 10.2105/AJPH.2019.304995 [PubMed: 30897002]
6. Dai H, & Hao J (2019). Temporal Trends of Sources of Cigarettes Among US High School Students: 2001–2015. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*, 21(4), 450–457. 10.1093/ntr/nty001 [PubMed: 29342310]
7. U.S. Department of Health and Human Services. (2016). *E-Cigarette Use Among Youth and Young Adults: A Report of the Surgeon General*. Retrieved January 31, 2023, from https://www.cdc.gov/tobacco/sgr/e-cigarettes/pdfs/2016_sgr_entire_report_508.pdf
8. Wang TW, Gentzke AS, Creamer MR, Cullen KA, Holder-Hayes E, Sawdey MD, Anic GM, Portnoy DB, Hu S, Homa DM, Jamal A, & Neff LJ (2019). Tobacco Product Use and Associated Factors Among Middle and High School Students—United States, 2019. *Morbidity and Mortality Weekly Report. Surveillance Summaries (Washington, D.C.: 2002)*, 68(12), 1–22. 10.15585/mmwr.ss6812a1
9. Goriounova NA, & Mansvelter HD (2012). Short- and long-term consequences of nicotine exposure during adolescence for prefrontal cortex neuronal network function. *Cold Spring Harbor Perspectives in Medicine*, 2(12), a012120. 10.1101/cshperspect.a012120 [PubMed: 22983224]
10. Abreu-Villaça Y, Seidler FJ, Tate CA, & Slotkin TA (2003). Nicotine is a neurotoxin in the adolescent brain: Critical periods, patterns of exposure, regional selectivity, and dose thresholds for macromolecular alterations. *Brain Research*, 979(1–2), 114–128. 10.1016/S0006-8993(03)02885-3 [PubMed: 12850578]
11. Hawk ET, & Colbert Maresso K (2019). E-Cigarettes: Unstandardized, Under-Regulated, Understudied, and Unknown Health and Cancer Risks. *Cancer Research*, 79(24), 6079–6083. 10.1158/0008-5472.CAN-19-2997 [PubMed: 31658978]
12. Bhatt JM, Ramphul M, & Bush A (2020). An update on controversies in e-cigarettes. *Paediatric Respiratory Reviews*, 36, 75–86. 10.1016/j.prpv.2020.09.003 [PubMed: 33071065]
13. Bold KW, Kong G, Camenga DR, Simon P, Cavallo DA, Morean ME, & Krishnan-Sarin S (2018). Trajectories of E-Cigarette and Conventional Cigarette Use Among Youth. *Pediatrics*, 141(1), e20171832. 10.1542/peds.2017-1832 [PubMed: 29203523]
14. Centers for Disease Control and Prevention (CDC). (2019). 1991–2019 High School Youth Risk Behavior Survey Data. Retrieved January 1, 2023, from <http://yrbs-explorer.services.cdc.gov/>.

15. Conway KP, Green VR, Kasza KA, Silveira ML, Borek N, Kimmel HL, Sargent JD, Stanton CA, Lambert E, Hilmi N, Reissig CJ, Jackson KJ, Tanski SE, Maklan D, Hyland AJ, & Compton WM (2018). Co-occurrence of tobacco product use, substance use, and mental health problems among youth: Findings from wave 1 (2013-2014) of the population assessment of tobacco and health (PATH) study. *Addictive Behaviors*, 76, 208–217. 10.1016/j.addbeh.2017.08.009 [PubMed: 28846942]
16. Watten RG, & Watten VP (2021). Snus and Alcohol: Mutually Rewarding Effects in the Brain? A Matched Controlled Population Study. *Substance Abuse: Research and Treatment*, 15, 11782218211027124. 10.1177/11782218211027124 [PubMed: 34366668]
17. Lozano A, Liu F, Lee TK, Prado G, Schwartz SJ, Leventhal AM, Kelleghan AR, Unger JB, & Barrington-Trimis JL (2021). Bidirectional associations between e-cigarette use and alcohol use across adolescence. *Drug and Alcohol Dependence*, 220, 108496. 10.1016/j.drugalcdep.2020.108496 [PubMed: 33461153]
18. Chadi N, Schroeder R, Jensen JW, & Levy S (2019). Association Between Electronic Cigarette Use and Marijuana Use Among Adolescents and Young Adults: A Systematic Review and Meta-analysis. *JAMA Pediatrics*, 173(10), e192574. 10.1001/jamapediatrics.2019.2574 [PubMed: 31403684]
19. Park E, Livingston JA, Wang W, Kwon M, Eiden RD, & Chang Y-P (2020). Adolescent E-cigarette use trajectories and subsequent alcohol and marijuana use. *Addictive Behaviors*, 103, 106213. 10.1016/j.addbeh.2019.106213 [PubMed: 31862618]
20. Silveira ML, Conway KP, Everard CD, Sim HY, Kimmel HL, & Compton WM (2020). Longitudinal associations between susceptibility to tobacco use and the onset of other substances among U.S. youth. *Preventive Medicine*, 135, 106074. 10.1016/j.ypmed.2020.106074 [PubMed: 32243937]
21. National Congress of American Indians Policy Research Center. (2018). *The State of Tribal Data Capacity In Indian Country: Key Findings from the Survey of Tribal Data Practices..* Retrieved January 18, 2023, from https://www.ncai.org/policy-research-center/research-data/prc-publications/Tribal_Data_Capacity_Survey_FINAL_10_2018.pdf
22. Kukutai T, Taylor J (Eds.). (2016). *Indigenous Data Sovereignty: Toward an agenda* (Vol. 38). ANU Press. <http://www.jstor.org/stable/j.ctt1q1crgf>
23. Centers for Disease Control and Prevention (CDC). (2020, August). *YRBS Participation History, Data Quality, and Data Availability*. Retrieved January 18, 2023 from https://www.cdc.gov/healthyyouth/data/yrbs/pdf/2019/2019_hs_participation_history.pdf
24. Centers for Disease Control and Prevention (CDC). (2022, November 22). *Youth Risk Behavior Surveillance System (YRBSS)*. Retrieved January 18, 2023, from <https://www.cdc.gov/healthyyouth/data/yrbs/index.htm>
25. Seo YS, & Chang Y-P (2022). Racial and Ethnic Differences in E-Cigarette and Cigarette Use Among Adolescents. *Journal of Immigrant and Minority Health*, 24(3), 713–720. 10.1007/s10903-021-01229-0 [PubMed: 34106360]
26. Chadi N, Li G, Cerda N, & Weitzman ER (2019). Depressive Symptoms and Suicidality in Adolescents Using e-Cigarettes and Marijuana: A Secondary Data Analysis From the Youth Risk Behavior Survey. *Journal of Addiction Medicine*, 13(5), 362–365. 10.1097/ADM.0000000000000506 [PubMed: 30688723]
27. Dai H, Catley D, Richter KP, Goggin K, & Ellerbeck EF (2018). Electronic Cigarettes and Future Marijuana Use: A Longitudinal Study. *Pediatrics*, 141(5), e20173787. 10.1542/peds.2017-3787 [PubMed: 29686146]
28. National conference of State Legislatures. (2022, September 12). *State Medical Cannabis Laws*. Retrieved January 18, 2023 from <https://www.ncsl.org/health/state-medical-cannabis-laws>
29. Rothrock AN, Andris H, Swetland SB, Chavez V, Isaak S, Pagane M, Romney J, & Rothrock SG (2020). Association of E-cigarettes with adolescent alcohol use and binge drinking-drunkenness: A systematic review and meta-analysis. *The American Journal of Drug and Alcohol Abuse*, 46(6), 684–698. 10.1080/00952990.2020.1771723 [PubMed: 32795246]
30. Hughes K, Bellis MA, Hardcastle KA, McHale P, Bennett A, Ireland R, & Pike K (2015). Associations between e-cigarette access and smoking and drinking behaviours in teenagers. *BMC Public Health*, 15, 244. 10.1186/s12889-015-1618-4 [PubMed: 25886064]

31. Charles NE, Strong SJ, Floyd PN, Burns LC, Sigurdson L, & Barry CT (2022). Test-Retest Reliability of Self-Reported Substance Use and Sexual Risk Behavior Among at-Risk Adolescents. *Psychological Reports*, 332941221100459. 10.1177/00332941221100459
32. Brener ND, Kann L, McManus T, Kinchen SA, Sundberg EC, & Ross JG (2002). Reliability of the 1999 youth risk behavior survey questionnaire. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, 31(4), 336–342. 10.1016/s1054-139x(02)00339-7 [PubMed: 12359379]
33. Centers for Disease Control and Prevention (CDC), Brener ND, Kann L, Shanklin S, Kinchen S, Eaton DK, Hawkins J, & Flint KH (2013). Methodology of the Youth Risk Behavior Surveillance System—2013. *MMWR. Recommendations and Reports: Morbidity and Mortality Weekly Report. Recommendations and Reports*, 62(RR-1), 1–20.

Table 1.

Ever Use of Cigarettes and E-Cigarettes among High Students in the Cherokee Nation Reservation

Characteristic	Total % ^a	Cigarettes ^a	E-Cigarettes ^a	Both Products ^a
		% (95% CI)	% (95% CI)	% (95% CI)
Total (N = 1475) ^b				
Sex		P value = 0.89	P value = 0.66	P value = 0.90
Male	51.16%	35.21% (30.60%-39.83%)	57.55% (53.44%-61.66%)	32.36% (28.64%-36.08%)
Female	48.84%	34.70% (28.23%-41.16%)	58.90% (51.67%-66.13%)	31.94% (25.55%-38.32%)
Grade		P value = 0.01	P value = 0.002	P value = 0.007
9 th	26.43%	26.54% (19.40%-33.68%)	49.91% (44.59%-55.23%)	23.96% (17.70%-30.23%)
10 th	25.51%	37.75% (31.56%-43.94%)	59.00% (47.86%-70.13%)	33.18% (27.39%-38.97%)
11 th	24.30%	36.01% (29.49%-42.52%)	55.61% (49.26%-62.07%)	33.19% (26.43%-39.95%)
12 th	23.75%	40.80% (33.00%-48.59%)	69.00% (61.72%-76.28%)	39.15% (31.28%-47.02%)
Race/Ethnicity		P value < 0.001	P value = 0.06	P value < 0.001
NHW	46.13%	29.46% (24.35%-34.58%)	55.87% (49.07%-62.68%)	27.21% (21.94%-32.49%)
AI/AN	43.79%	42.94% (37.44%-48.45%)	62.50% (55.87%-69.13%)	39.20% (33.79%-44.61%)
Other	10.09%	27.15% (19.66%-34.65%)	52.73% (45.06%-60.39%)	24.59% (17.29%-31.89%)
Age Groups		P value = 0.004	P value < 0.001	P value < 0.001
15 years	29.87%	27.58% (21.76%-33.40%)	51.10% (44.68%-57.52%)	24.60% (19.26%-29.94%)
16-17 years	50.26%	36.01% (30.53%-41.50%)	57.68% (51.47%-63.88%)	32.70% (27.64%-37.75%)
18 years	19.87%	43.52% (34.83%-52.20%)	70.11% (62.98%-77.23%)	41.94% (33.47%-50.41%)
Current Marijuana Use		P value < 0.001	P value < 0.001	P value < 0.001
Yes	16.50%	74.03% (66.26%-81.80%)	95.83% (92.77%-98.89%)	72.05% (65.13%-78.97%)
No	83.50%	27.08% (23.74%-30.42%)	50.39% (45.49%-55.29%)	24.13% (20.99%-27.28%)
Depression		P value < 0.001	P value < 0.001	P value < 0.001
Yes	37.25%	50.34% (42.78%-57.90%)	71.79% (66.24%-77.35%)	46.27% (38.62%-53.93%)
No	62.75%	25.06% (21.53%-28.59%)	49.41% (44.83%-54.34%)	23.11% (20.21%-26.01%)
Current Alcohol Use		P value < 0.001	P value < 0.001	P value < 0.001
Yes	28.85%	63.02% (56.86%-69.19%)	90.73% (87.39%-94.07%)	62.53% (56.22%-68.85%)
No	71.15%	21.08% (17.64%-24.52%)	42.44% (36.77%-48.12%)	17.53% (14.23%-20.83%)

^aWeighted percentages^bUnweighted sample size

Table 2. Current Use of Tobacco Products among High Students in the Cherokee Nation Reservation

Characteristic	Cigarettes ^a	Smokeless Tobacco ^a	Cigars ^a	E-cigarettes ^a	2 Products ^a
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Total (N = 1475) ^b					
Sex					
Male	P value = 0.55 9.24% (7.16%-11.32%)	P value < 0.001 11.89% (9.49%-14.30%)	P value = 0.005 8.46% (6.30%-10.63%)	P value = 0.33 30.58% (27.07%-34.09%)	P value = 0.002 15.45% (12.58%-18.33%)
Female	10.19% (7.26%-13.11%)	1.63% (0.37%-2.89%)	5.21% (3.94%-6.48%)	26.67% (19.42%-33.91%)	10.11% (7.61%-12.62%)
Grade					
9 th	P value = 0.58 7.73% (3.13%-12.32%)	P value = 0.10 6.65% (3.66%-9.63%)	P value = 0.38 5.62% (2.96%-8.27%)	P Value < 0.001 20.79% (15.95%-25.62%)	P value = 0.36 10.70% (6.31%-15.08%)
10 th	8.84% (3.60%-14.08%)	6.84% (4.05%-9.64%)	5.45% (3.17%-7.74%)	31.25% (22.36%-40.15%)	12.49% (7.11%-17.87%)
11 th	10.51% (6.10%-14.92%)	7.07% (3.14%-11.00%)	7.28% (3.10%-11.46%)	25.55% (19.86%-31.23%)	11.73% (6.21%-17.25%)
12 th	12.54% (7.25%-17.84%)	7.03% (4.27%-9.80%)	9.43% (4.87%-14.00%)	39.09% (31.69%-46.50%)	17.19% (11.80%-22.57%)
Race/Ethnicity					
NHW	P value < 0.001 7.19% (5.68%-8.69%)	P value = 0.13 5.84% (3.53%-8.14%)	P value = 0.18 6.62% (4.63%-8.60%)	P value = 0.13 28.25% (23.79%-32.71%)	P value < 0.05 11.71% (9.28%-14.15%)
AI/AN	13.20% (9.4%-17.00%)	8.87% (6.03%-11.71%)	7.95% (5.88%-10.03%)	31.62% (24.07%-39.17%)	15.24% (10.33%-20.16%)
Other	4.53% (1.43%-7.63%)	4.19% (0.49%-7.89%)	3.90% (1.08%-6.72%)	20.48% (13.68%-27.28%)	6.47% (3.10%-9.83%)
Age Groups					
15 years	P value < 0.05 5.90% (2.72%-9.08%)	P value = 0.28 4.99% (2.40%-7.58%)	P value < 0.05 4.39% (2.28%-6.50%)	P value < 0.001 20.75% (16.37%-25.13%)	P value = 0.002 8.55% (5.72%-11.38%)
16-17 years	10.19% (6.92%-13.46%)	7.54% (5.41%-9.66%)	6.93% (5.11%-8.74%)	28.96% (24.03%-33.89%)	12.83% (9.61%-16.05%)
18 years	14.27% (8.09%-20.46%)	7.78% (4.65%-10.91%)	10.53% (5.10%-15.96%)	40.85% (34.17%-47.54%)	19.36% (13.52%-25.21%)
Current Marijuana Use					
Yes	P value < 0.001 33.52% (28.02%-39.02%)	P value < 0.001 16.37% (9.43%-23.31%)	P value < 0.001 26.58% (18.31%-34.85%)	P value < 0.001 79.55% (70.12%-88.99%)	P value < 0.001 42.82% (35.60%-50.04%)
No	4.93% (3.12%-6.75%)	4.67% (3.50%-5.84%)	2.69% (1.91%-3.48%)	19.02% (15.09%-22.95%)	6.73% (4.66%-8.81%)
Depression					
Yes	P value < 0.001 15.95% (11.71%-20.18%)	P value = 0.72 7.45% (3.88%-11.02%)	P value < 0.001 10.00% (7.94%-12.05%)	P value < 0.001 41.06% (35.40%-46.72%)	P value < 0.001 18.68% (13.83%-23.53%)
No	6.03% (4.30%-7.77%)	6.68% (4.93%-8.42%)	4.72% (3.32%-6.13%)	21.08% (17.08%-25.09%)	9.26% (7.732%-11.20%)
Current Alcohol Use					
Yes	P value < 0.001 24.32% (19.71%-28.92%)	P value < 0.001 13.18% (8.67%-17.70%)	P value < 0.001 18.24% (13.05%-23.43%)	P value < 0.001 72.42% (66.86%-77.98%)	P value < 0.001 32.95% (28.39%-37.52%)
No	3.10% (1.43%-4.78%)	3.28% (1.71%-4.85%)	2.09% (0.72%-3.46%)	11.80% (8.66%-14.93%)	3.97% (2.08%-5.86%)

Unweighted sample size
Weighted percentages

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 3. Intensity of E-Cigarette Use among High School Students within the Cherokee Nation Reservation

Characteristics	No Use ^d	Light Use ^d	Medium Use ^d	Heavy Use ^d	P value
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	
Total (N = 1475) ^b					
Sex					0.30
Male	69.42% (65.91%-72.93%)	9.01% (5.85%-12.18%)	5.89% (3.73%-8.06%)	15.68% (12.63%-18.72%)	
Female	73.33% (66.09%-80.58%)	8.84% (6.68%-11.00%)	6.92% (3.36%-10.48%)	10.91% (6.68%-15.13%)	
Grade					< 0.001
9 th	79.21% (74.38%-84.05%)	9.41% (5.10%-13.72%)	5.88% (3.32%-8.43%)	5.49% (3.70%-7.29%)	
10 th	68.75% (59.85%-77.64%)	8.65% (5.62%-11.69%)	8.94% (6.83%-11.05%)	13.66% (7.78%-19.54%)	
11 th	74.45% (68.77%-80.14%)	8.54% (5.98%-11.11%)	3.97% (2.28%-5.66%)	13.03% (9.00%-17.07%)	
12 th	60.91% (53.50%-68.31%)	8.85% (4.13%-13.57%)	7.02% (2.54%-11.50%)	23.22% (16.46%-29.99%)	
Race/Ethnicity					0.14
NHW	71.75% (67.29%-76.21%)	9.32% (6.75%-11.89%)	5.25% (3.37%-7.12%)	13.68% (9.63%-17.73%)	
AI/AN	68.38% (60.83%-75.93%)	8.79% (4.87%-12.71%)	8.48% (5.97%-10.98%)	14.35% (9.70%-19.00%)	
Other	79.52% (72.72%-86.32%)	7.92% (4.43%-11.42%)	5.49% (1.63%-9.36%)	7.07% (3.1%-11.03%)	
Age Groups					< 0.001
15 years	79.25% (74.87%-83.63%)	8.66% (5.40%-11.92%)	6.25% (2.29%-10.22%)	5.83% (4.00%-7.65%)	
16-17 years	71.04% (66.11%-75.97%)	8.40% (5.94%-10.86%)	6.41% (4.55%-8.26%)	14.15% (10.17%-18.14%)	
18 years	59.15% (52.46%-65.83%)	10.69% (5.84%-15.55%)	6.71% (1.56%-11.87%)	23.45% (17.48%-29.42%)	
Other Tobacco Use					< 0.001
Yes	16.65% (9.55%-23.76%)	21.75% (14.18%-29.32%)	17.71% (12.70%-22.73%)	43.88% (34.44%-53.31%)	
No	82.55% (78.44%-86.66%)	6.13% (4.67%-7.59%)	4.24% (3.05%-5.45%)	7.07% (4.22%-9.91%)	
Current Marijuana Use					< 0.001
Yes	20.45% (11.01%-29.88%)	20.06% (10.66%-29.47%)	16.52% (9.10%-23.95%)	42.98% (27.39%-58.86%)	
No	80.98% (77.05%-84.91%)	6.73% (4.83%-8.64%)	4.71% (3.52%-5.90%)	7.58% (4.89%-10.27%)	
Depression					< 0.001
Yes	58.94% (53.28%-64.60%)	9.89% (7.08%-12.70%)	9.05% (7.08%-12.70%)	22.12% (17.75%-26.49%)	
No	78.92% (74.91%-82.92%)	8.21% (5.44%-10.98%)	4.12% (2.52%-5.72%)	8.75% (4.63%-12.88%)	

Characteristics	No Use ^a	Light Use ^a	Medium Use ^a	Heavy Use ^a	P value
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	
Current Alcohol Use					
Yes	27.57% (22.01%-33.13%)	19.84% (12.98%-26.49%)	16.73% (12.64%-20.81%)	35.95% (29.89%-42.00%)	< 0.001
No	88.19% (85.06%-91.33%)	4.70% (3.35%-6.06%)	2.44% (1.23%-3.65%)	4.64% (2.91%-6.37%)	

^aWeighted percentages

^bUnweighted sample size

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript