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Title

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Permalink

<https://escholarship.org/uc/item/6jg5147v>

Journal

The Journal of the American Dental Association, 150(5)

ISSN

0002-8177

Authors

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Publication Date

2019-05-01

DOI

10.1016/j.adaj.2018.12.004

Peer reviewed



Published in final edited form as:

J Am Dent Assoc. 2019 May ; 150(5): 332–344.e2. doi:10.1016/j.adaj.2018.12.004.

Tobacco-use patterns and self-reported oral health outcomes: A cross-sectional assessment of the Population Assessment of Tobacco and Health study (2013-2014).

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Abstract

Background: Few studies consider simultaneously the oral health implications of non-traditional tobacco products and tobacco use patterns. This study aimed to evaluate self-reported gum disease among cigarette smokers and users of other types of tobacco products.

Methods: Survey-weighted multivariable logistic regression was used to assess associations between different tobacco products, use patterns (e.g. dual/poly use, product switching) and lifetime history of gum disease diagnosis and gum disease treatment, using the nationally representative (USA) Population Assessment of Tobacco and Health study's Wave 1 (2013-2014) adult data (N=32,300).

Results: Overall, 12.1% of participants self-reported gum disease diagnosis and 19.1% reported receiving treatment. Groups with the highest adjusted relative odds for diagnosis (reference: lifetime tobacco never-users) were pipe users (3.1, 95% CI: 1.5-6.4), e-cigarette users (2.6, 95% CI: 1.6-4.3), multiple tobacco product users (2.8, 95% CI: 2.3-3.5), and recent (<12 months) quitters (2.8, 95% CI: 2.1-3.7). Similarly, odds of treatment report were highest among pipe (2.4, 95% CI: 1.3-4.8) and e-cigarette users (2.2, 95% CI: 1.4- 3.4), multiple tobacco product users (1.6, 95% CI: 1.4-1.8), and recent quitters (1.8, 95% CI: 1.4-2.2).

Conclusion: Numerous tobacco use patterns were associated with worse periodontal health compared to tobacco never-users. These findings are consistent with previous biological and epidemiologic evidence linking tobacco use to poor periodontal health.

Practical Implication: Dental clinicians should anticipate various tobacco use patterns among their patients, all of which may impact oral health. Dental professionals should remain informed, screen for and address use of all tobacco products in practice.

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Disclosure. Dr. Vora and Chaffee did not report any disclosures.

Keywords

alternative tobacco products; poly-tobacco use; periodontal health; gingivitis

1. Introduction

Cigarette smoking is a well-known risk factor for several oral diseases [1], including a widely studied and established association with periodontal diseases [2, 3]. Cigars, pipes, and smokeless tobacco products have also garnered attention as potential threats to oral and periodontal health. Studies suggest that cigar and pipe smokers experience more periodontal bone loss compared to non-smokers. [4, 5]. An association between smokeless tobacco use and periodontal diseases has been shown in multiple studies [6, 7].

Fewer studies have examined how new and emerging tobacco products, like hookah (waterpipe, nargile, hubbly bubbly, ghalyun, narguileh, hukka, or a shisha) and electronic cigarettes (e-cigarettes, vaporizers, vapes, JUUL), affect oral health. Dentists will encounter patients using non-cigarette tobacco products in practice and recognizing how these products may be associated with current or past history of oral conditions can inform treatment decisions. Most existing studies of e-cigarettes and oral health outcomes have included fewer than 100 participants. One study identified a statistically significant increase in gingival inflammation when tobacco cigarette smokers switched to e-cigarette use for two weeks [8]. Another study reported no difference in plaque index or probing depths but less gingival bleeding among exclusive e-cigarette users compared to never users [9]. Both studies underscore the need for further research to assess possible associations between non-cigarette tobacco product use and periodontal health.

Greater diversity in tobacco product availability has coincided with evolving tobacco use patterns. While many tobacco users regularly use only one type of product, use of two or more tobacco products (dual or poly use) is increasingly common: 10% of US adults overall report using multiple tobacco products [10]. A small number of studies have considered the oral health implications of multiple tobacco product use; for example, a study in Jordan identified similarly elevated odds of periodontal disease among dual smokers of cigarettes and waterpipe tobacco as was found among users of cigarettes or waterpipe tobacco alone [11]. To our knowledge, no studies have examined oral disease correlates of tobacco dual- or poly-use with new and emerging products among US adults.

The Population Assessment of Tobacco and Health (PATH) study is a national longitudinal study with self-reported tobacco use status and health outcomes. The PATH study sample is representative to the U.S. non-institutionalized population. PATH includes detailed behavioral measures of cigarette and non-cigarette tobacco product use (Figure 1) and, among its health measures (all self-report), includes self-reported gum disease diagnosis, gum disease treatment, and diagnosis of pre-cancerous lesions. Self-reported periodontal measures are known to lack sensitivity compared to clinically verified outcomes [12-14]. Despite this limitation, the PATH wave 1 (baseline) sample provides some of the first population-level information available regarding potential oral health correlates of new and emerging tobacco product use: important hypothesis-generating data to inform future

prospective studies with clinically-verified measures. Using cross-sectional data from PATH wave 1, the present study aims to describe prevalent patterns of tobacco product use and their associations with the oral health measures in PATH at baseline.

2. Methods

2.1 Study design and participants

The PATH Study is a nationally representative longitudinal study of 32,320 U.S. adults (18 years and older) and 13,651 youth (12–17 years) designed to examine tobacco use and health. This paper reports Wave 1 (September 2013–December 2014) data from adult participants with complete data on variables for the specific associations examined. Participants were recruited via an address-based, area-probability sampling approach, using an in-person household screener to select adults from households, with oversampling for tobacco users, young adults, and African-American adults. Up to two adults were sampled per household. Sample weights adjusted for oversampling and nonresponse, allowing estimates to be representative of the non-institutionalized, civilian U.S. population. The weighted response rate among sampled adults was 74%. Data were collected using Audio-Computer Assisted Self-Interviews administered in English or Spanish.

Detailed methodological information about the study design and protocol is available elsewhere [15]. An institutional review board at the University of California San Francisco reviewed and designated the present study protocol exempt for this analysis of de-identified survey data. The PATH Study protocol received a National Institutes of Health Certificate of Confidentiality and approval from the Westat Institutional Review Board.

2.2 Measures

2.2.1 Tobacco product use—PATH's questionnaire asked participants about use of cigarettes, e-cigarettes, cigar products (traditional cigars, cigarillos, filtered cigars), pipes, hookah, smokeless tobacco products (loose snus, moist snuff, dip, spit, or chewing tobacco, snus pouches and dissolvable tobacco products). For each product, PATH asks about current use and past use. Tobacco product use, in this study, was categorized into 12 groups based on responses regarding product and use patterns (Table 1).

For each tobacco product, 'current use' was defined as now using only one of such products "fairly regularly" either "everyday" or "some days." 'Recent quitters' were defined as respondents who reported using "fairly regularly" in the past (for cigarettes, smoking >100 times) but having stopped use within the past 12 months and no longer using any tobacco product. 'Long-term quitters' had stopped tobacco use 12 months prior. 'Current experimenters' reported currently using at least one tobacco product but smoking fewer than 100 times in their lifetime (cigarettes) and never using other products regularly (the 100 threshold applied only to cigarettes). 'Former experimenters' had tried tobacco but had smoked fewer than 100 cigarettes in their lifetime, never used non-cigarette products regularly, and were not using any tobacco product currently. 'Multiple tobacco product users' were defined as current users of two or more products. 'Non-established switchers'

were defined as recent or long-term quitters of one tobacco product now experimenting with a new product. 'Never users' had never used any tobacco product in their lifetime.

2.2.2 Gum disease diagnosis, treatment for gum disease and pre-cancerous lesion diagnosis—All health outcomes in the PATH study are measured through self-report. Self-reported lifetime diagnosis of gum disease was ascertained through the question: "Have you ever been told by a dentist, hygienist, or other health professional that you have gum disease?" Similarly, treatment of gum disease was determined using the question: "Have you ever had treatment for [gum disease | your gums] such as scaling and root planing, sometimes called deep cleaning?" The PATH questionnaire also queried diagnosis of pre-cancerous lesions: "Have you ever been told by a doctor, dentist, or other health professional that you have pre-cancerous oral lesions?" For all three items, response options were yes, no, or don't know. In other studies, the measure "Have you been told by a dentist or hygienist that you have gum disease?" was shown to have low sensitivity and but excellent specificity to categorize periodontal disease, as defined by any pocket depths >4mm [13,16]. Another study reported 67% sensitivity and 68% specificity for attachment loss >6mm among older adults in Japan [17]. These items allow feasible assessment in a large sample, but low sensitivity may underestimate actual periodontal disease history.

2.2.3 Covariates—Data were collected on socio-demographic characteristics and health history. For this analysis, covariates included were age (18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 and older), sex (male/female), race/ethnicity (White, African American, other, Hispanic), education (less than high school, high school/GED, some college, bachelor's degree or higher), income (less than \$10,000, \$10,000 to \$24,999, \$25,000 to \$49,999, \$50,000 to \$99,999, \$100,000 or more) and employment (working for pay, Yes/No). History of diabetes ('Have you ever been told by a doctor or other health professional that you have diabetes, sugar diabetes, high blood sugar, or borderline diabetes?' Yes/No), visit to the dentist ('In the past 12 months, have you seen a dentist?' Yes/No), and medical health coverage (private insurance, Medicare, Medicaid, other, no insurance) were also collected. Dental benefits coverage was not assessed in the PATH questionnaire.

2.3 Analytic approach

Weighted distribution of the participants' demographic characteristics, health outcomes, healthcare access, overall prevalence of gum disease diagnosis and treatment, and diagnosis of pre-cancerous lesion were calculated according to tobacco use patterns. Simple and multivariable logistic regression was used to evaluate the associations between tobacco use patterns and oral health outcomes. The multivariable logistic regression model controlled for all covariates listed above. Adjusted odds ratios with 95% confidence intervals were estimated using single sample survey weights to be representative of the Wave 1 U.S. non-institutionalized adult population. Replicate weights were not used in multivariable models due to incompatibility with Stata's multiple imputation commands. All analyses were conducted using Stata (StataCorp LP, College Station, TX).

Ninety-seven respondents with missing or 'don't know' responses on gum disease diagnosis were excluded from analysis for that outcome. Similarly, 133 respondents for gum disease

treatment and 90 respondents for precancerous lesions were excluded from the analyses related to those outcomes due to missing data. The percent missing for any of the 10 tobacco products was fairly low (e.g., 0.3% for e-cigarettes, 0.5% for cigarettes, and 3.2% for cigarillos), but the percent of respondents with missing information for at least one product was higher (6.2%, or 2004 observations). An additional 3046 observations were missing covariate data. Given systematic differences between observations with and without missing data (i.e., individuals with missing tobacco-use data were more likely to be older, male, non-white, unemployed, low-income, less educated, lack private-payer health insurance, have been diagnosed as diabetic, and not have visited the dentist in the past 12 months), we conducted multiple imputation analysis (15 imputations) using Stata's mi (multiple imputation) suite of commands.

Sensitivity analyses: The PATH study does not have information regarding the current diabetes severity (only self-reported history of ever diagnosed, yes/no). Models excluding all people who responded yes to ever being diagnosed with diabetes were fit to compare with the primary analysis. Second, we fit new models to account for past cigarette use among current e-cigarette users, dividing the current e-cigarette use category between those who had ever smoked ≥ 100 cigarettes and those who had smoked <100 cigarettes in their lifetime. Finally, models fit using imputed data were compared to models fit using complete cases only.

3. Results

3.1 Demographic and other characteristics

Most respondents were classified as tobacco never users (28.1%), former experimenters (24.5%), or long-term quitters (17.0%) (Table 2). Among adults categorized as currently using only one type of tobacco (16.7% of total sample), cigarettes (13.1% of total sample) were the most commonly used product (Table 2), followed by smokeless tobacco (1.6%) and cigars (1.1%). Pipe and smokeless tobacco users were almost exclusively male. About 24.0% of current cigarette users and 27.0% of cigar users were uninsured compared to tobacco never users (14.0%). More than half of current smokeless (51.3%) and cigarette (55.8.0%) users had not seen a dentist in the past 12 months. Current use of e-cigarettes, pipes or hookah was reported by a small percentage of the population (all 0.5%). Among these users, 44.1% of e-cigarette users, 43.7% of cigars users and 93.1% of hookah users were ages 18-34 years (Table 2). On the contrary, pipe use was seen mostly among older male individuals ages 55 and above. Among long-term quitters, 59.8% were age 55 years and older and only 6.5% were uninsured (Table 2).

In total, 6.2% of the population reported current use of more than one tobacco product (multiple product users) (Table 2). Multiple tobacco product users tended to be younger (55.6% age 18-34), lower income (47.8% below \$25,000 annually), and lacking health insurance (26.8% without insurance). Forty-six percent of recent quitters and 50.3% of current experimenters were younger than 35 years. Seventy-five percent of recent switchers were male, 48.6% had some college or higher education, most were employed (73.1%), and the majority (54.0%) reported annual incomes higher than \$50,000 (Table 2).

3.2 Prevalence of oral conditions and treatment

Overall, 12.3% of the study population reported ever being told by a healthcare provider that they have gum disease (Table 3). The highest prevalence of disease diagnosis was reported among current users of pipes (21.3%), e-cigarettes (18.0%) and cigarettes (15.7%). The lowest reported prevalence of gum disease was among current users of hookah (3.8%), smokeless products (7.9%) and never users (7.8%) (Table 3). Ever receiving gum disease treatment was self-reported by 19.1% of the study population (Table 3). Gum disease treatment history was highest among current users of pipes (29.2%) and e-cigarettes (27.0%), long-term quitters (24.5%), product switchers (22.8%), and recent quitters (21.4%). The overall prevalence of having ever been told by a health care provider of having pre-cancerous oral lesions was 0.6% (Table 3). Current smokeless tobacco users (2.2%), recent quitters (1.3%) and long-term quitters (0.9%) reported the highest prevalence of pre-cancerous lesions.

3.3 Tobacco use patterns and oral health outcomes

Both simple and multivariable weighted logistic regression models (N=32,223) indicated that tobacco use (with the exception of hookah and smokeless products), irrespective of whether tobacco use was current or in the past, was associated with higher odds of reporting gum disease diagnosis (Table 4). After controlling for covariates, the highest relative odds of reporting gum disease diagnosis was seen among pipe smokers (2.7, 95% CI: 1.3-5.3), dual/poly tobacco product users (2.8, 95% CI: 2.4-3.4), recent quitters (2.8, 95% CI: 2.0- 3.8) and e-cigarette users (2.9, 95% CI: 1.9-4.5).

When similar models were fit for gum disease treatment (N=32,187), the magnitude of the odds ratios obtained were smaller compared to those for gum disease diagnosis history (Table 4). There was no statistically significant association with gum disease treatment for current use of hookah or smokeless tobacco, or for current or former experimental use. The highest adjusted odds of reporting past treatment for gum disease were among current pipe (2.3, 95% CI: 1.3-4.1) and e-cigarette users (2.3, 95% CI: 1.3-4.1), multiple tobacco product users (1.6, 95% CI: 1.4-1.9) and recent quitters (1.7, 95% CI 1.3-2.2). For the outcome self-reported diagnosis of precancerous oral lesions (N=32,230, Table 4), after controlling for covariates, the association was statistically significant for smokeless tobacco product users (6.8, 95% CI: 2.9-16.1), multiple product users (3.6, 95% CI: 1.7-7.7) and recent quitters (4.0, 95% CI: 1.4-11.2).

3.4 Sensitivity analyses

In one sensitivity check, all participants that responded "yes" to ever being diagnosed with diabetes were excluded. The results were not meaningfully different from the primary analysis (Supplemental table 1). Second, 45.9% of current e-cigarette users had smoked more than 100 cigarettes in their lifetime. Irrespective of past cigarette use, current e-cigarette use was associated with higher odds of reporting both gum disease treatment and diagnosis. For the outcome gum disease diagnosis, the adjusted odds ratios (reference: tobacco never use) were 2.7 (95% CI: 1.7-3.0) for e-cigarette users who had smoked fewer than 100 cigarettes in their lifetime and 3.1 (95% CI: 1.6-5.7) for those who were former cigarette smokers. Similarly, for gum disease treatment, e-cigarette users who had smoked

fewer than 100 cigarettes had an adjusted odds ratio of 2.1 (95% CI: 1.3-3.5) and those who were former smokers had an adjusted odds ratio of 2.6 (95% CI: 1.6-4.4). Finally, results from models fit on data generated through multiple imputations were not meaningfully different than the models fit using only complete cases (Supplemental table 2).

4. Discussion

The present investigation is one of few studies examining the prevalence of gum or periodontal disease across different tobacco products and use patterns in a nationally representative sample of U.S. adults. In this study, higher odds of self-reported gum disease diagnosis were reported among nearly all tobacco product users. Similarly, higher odds for self-reported gum disease treatment were seen among all groups, with the exception of current experimenters, users of smokeless tobacco and hookah users. Associations were robust, and even strengthened, following adjustment for age, sex, race/ethnicity, education, income, employment, medical insurance coverage, history of diabetes and dental visitation. This implies that all tobacco products, not just cigarettes, could be deleterious to periodontal health. Additionally, higher odds of reporting pre-cancerous lesion diagnosis was seen among smokeless users, multiple tobacco product users and recent quitters. These cross-sectional associations must be interpreted with caution, because the temporal ordering between tobacco use status and oral disease is uncertain, and many current users of non-cigarette products had smoked cigarettes in the past. However, the findings are consistent with previous biological and epidemiologic evidence linking tobacco use to poor oral health.

The epidemiological evidence connecting cigarette smoking to periodontal disease is strong. Longitudinal and cross-sectional studies demonstrate elevated occurrence of periodontitis compared to non-smokers [18-22]. Moreover, cigarette smokers experience greater severity of periodontal diseases, including increased pocket size, more attachment loss, and greater gingival recession [23]. Cigarette smokers also have more alveolar bone loss, more teeth with furcation involvement and experience more tooth loss when compared to non-smokers [19,23]. However, cigarette smokers are less likely to present with overt gingivitis and gingival bleeding than never users, mostly because of the perturbed immune response and nicotine-induced vasoconstriction of local blood flow [24, 25]. In this study, while differentiation between gingivitis and periodontitis was not possible because questionnaire wording, cigarette smokers were much more likely to report both gum disease diagnosis and treatment than never users.

This study found an association between pipe use and self-reported gingival disease. The Veterans Affairs Dental Longitudinal Study, which used clinically validated outcome measures, similarly reported that pipe smoking was associated with greater risk of tooth loss and marginal alveolar bone loss [4]. The Baltimore Longitudinal Study of Aging [5] also found that pipe smokers were at an increased risk of periodontal disease.

Contrary to hypothesis, no association between self-reported periodontal disease diagnosis/treatment and smokeless tobacco use was seen in this study. Periodontal changes in relation to smokeless tobacco use have been reported in some [1, 7, 26-28], but not all [6, 29] previous studies. There are many varieties of smokeless tobacco used worldwide, including

snus, moist and dry snuff, chewing tobacco, and products derived from the areca nut. In the United States, moist snuff is by far the most commonly used smokeless tobacco type; yet, variation exists in toxicity among moist snuff products and brands [30]. Also, unlike combustible tobacco products, smokeless tobacco use produces localized periodontal changes circumscribed to the area of placement of product [27, 28]. Diversity in smokeless tobacco products, localized periodontal effects, or possible differences in dental care utilization or self-report among smokeless tobacco users potentially explain the lack of association between smokeless product use and gum disease in this study. In contrast, we did observe greater report of oral pre-cancerous lesion diagnosis among smokeless tobacco users. Oral moist snuff contains high concentrations of the known oral and esophageal carcinogen N'-nitrosornicotine (NNN) [31], which places smokeless tobacco users at elevated cancer risk.

Among the few studies evaluating oral health effects of e-cigarette use, Javed et al [6] found that exclusive e-cigarette users and tobacco never-users were similar on some periodontal parameters. Wadia et al concluded that switching from smoking cigarettes to e-cigarettes for two weeks led to a statistically significant increase in bleeding on probing [5], potentially indicating increased vascular activity in the gingiva. PATH does not ask specifically about bleeding on probing, attachment loss or bone loss; thus, these outcomes could not be evaluated separately in this study. Nevertheless, the present study observed an increased report of gum disease diagnosis and treatment among current e-cigarette users. Many adult cigarette smokers report switching to e-cigarettes as a strategy to reduce their toxicant exposure compared to cigarettes [32, 33]. It is possible that oral health problems could motivate some cigarette smokers to try e-cigarettes. In this study, 45.9% of current electronic cigarette users report being former cigarette users, which could partly explain the strong association observed between current e-cigarette use and gum disease diagnosis/treatment. In sensitivity analyses, current e-cigarette use, with or without a history of cigarette smoking, was associated with higher odds of reporting both gum disease diagnosis and treatment. This finding should be interpreted cautiously given the limitations of cross-sectional analyses and self-reported measures.

Dual- or poly-users of tobacco products may face health risks equal or exceeding those for users of single products: for example, as seen for cigarette and smokeless tobacco dual-use and myocardial infarction [34]. In our study, multiple tobacco product users were more likely than never users to report a history of oral disease. Recent quitters (less than 12 months ago) were also associated with all three outcomes evaluated. The duration since quitting is highly relevant when discussing effect of periodontal health. Recent quitters of cigarettes are known to exhibit more signs of periodontal inflammation, including increased gingival crevicular fluid flow, bleeding on probing, and other symptoms related to gingivitis [35, 36]. Alternatively, existing oral disease could also motivate this group to quit tobacco use.

Strengths of this study include generalizability to the U.S. population, the large sample size, and the opportunity to evaluate exclusive use of each tobacco product, along with use in combination and after switching or quitting. Studying such tobacco use behavior is essential to effectively regulate tobacco products. While the present study provides insight into the

prevalence of oral disease across a broad range of tobacco use behaviors, at least two important limitations impede causal conclusions. Firstly, the cross-sectional nature of this analysis precludes the establishment of temporality in the study. It is unknown whether these oral health conditions were diagnosed following establishment of tobacco use behavior or whether any pre-existing oral health conditions influenced tobacco use. Most adult cigarette smokers begin smoking in adolescence, but given the relatively recent availability of e-cigarettes, use of this product plausibly occurred in adulthood. Future longitudinal data analysis should clarify the temporal ordering between disease diagnosis and product use.

Secondly, all data were collected through self-report, which may contribute to misclassification in types of tobacco product use and, especially, oral conditions. According to studies assessing the validity of self-reported oral health outcomes in population surveys [12-14], questions related to diagnosis have low sensitivity (29-33%) but acceptable specificity (82-94%). Questions related to treatment have higher sensitivity (48%) but lower specificity (60%). Differential recall accuracy could explain why gum disease treatment (19%) was more common than gum disease diagnosis (12%) in the present study. National Health and Nutrition Examination Survey [37] data indicate that 42% of the adults aged 30 and older in US have at least mild periodontal disease, further suggesting an under-estimate from self-report compared to full mouth examinations. If oral disease experience was underreported differentially by tobacco use status in this study, the true underlying associations between tobacco use and gum disease could be stronger (if tobacco users were less likely to recall gum disease) or weaker (if tobacco users were more likely to recall gum disease) than observed, whereas non-differential underreporting by tobacco status would bias observed association estimates toward the null. Another national study provided estimates of self-reported gum disease prevalence: it reported 15.3% prevalence of gum disease diagnosis and 20.2% prevalence of gum disease treatment [38]. Despite differences in the wording of the questions to ascertain gum disease diagnosis and treatment, these values are similar to this study (12.3% for diagnosis; 19.2% treatment). This study also found greater report of gum disease treatment than gum disease diagnosis. [38] Similarly, other self-reported measures in PATH, like prevalence of diabetes and proportion of people with a past 12-month dental visit, approximate national prevalence data. [39,40]

Results of this study should be considered hypothesis generating. Large longitudinal studies with clinically verifiable measurements are needed to validate the associations observed. Nevertheless, the present findings confirm associations identified in previous studies for cigarettes and conventional tobacco products and demonstrated associations between self-reported gum disease history and current use of non-traditional tobacco products, which merit further examination in prospective, clinical studies.

In summary, dental professionals can expect to encounter patients using a range of tobacco products, including emerging non-traditional products, as well as dual and poly use of products, all of which have potential to contribute to oral diseases. Based on the findings of the present study, nearly all of these tobacco-use behaviors were associated with self-reported oral disease history, although whether those associations are causal in nature awaits further investigation. Given the diversity of tobacco products being used and observed associations with oral health, dental providers should ask about and document use of all

tobacco products, not just cigarettes, at every patient visit. Tobacco cessation interventions in dental settings may increase the chances of quitting smoking [41], including patient counseling, referral to external resources, such as national or state tobacco quit lines, and provision of pharmacological cessation aids. Due to the present uncertainty regarding the causal effects of novel tobacco products on oral health, dental professionals should monitor the literature for additional evidence and convey the most accurate and up-to-date information to their patients.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements:

This work was supported by grants from the US National Cancer Institute, National Health, Lung, and Blood Institute, and Food and Drug Administration Center for Tobacco Products (P50 CA180890 and U54 HL147127). The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or the Food and Drug Administration.

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Figure 1:
Pictures of various tobacco products available in the US market.

Footnote:

- a. cigarette
- b. electronic cigarette
- c. cigar (large cigar)
- d. pipes
- e. hookah
- f. smokeless tobacco (moist snuff)

Table 1:

Tobacco user groups and their definitions

	Tobacco use groups	Definitions
1	<i>Current Cigarette user:</i>	Someone who has smoked more than 100 cigarettes in their lifetime and is now using only cigarettes, every day or some days
2	<i>Current E-cigarette user:</i>	Someone who is now reporting regular use of only e-cigarettes, every day or some days
3	<i>Current Cigar user:</i>	Someone who is now reporting regular use of only traditional cigars, cigarillos, or filtered cigars, every day or some days
4	<i>Current Pipe user:</i>	Someone who is now reporting regular use of only pipes, every day or some days
5	<i>Current Hookah user:</i>	Someone who is now reporting regular use of only hookah, every day or some days
6	<i>Current Smokeless products user:</i>	Someone who is now reporting regular use of only chewing tobacco, snuff, snus, or dissolvable tobacco, every day or some days
7	<i>Multiple product users</i>	Current users of two or more products listed above
8	<i>Recent quitters</i>	Someone who had been a regular user of one or more tobacco products (in the past) but reports having stopped use in the past 12 months and is no longer using or experimenting with any tobacco product
9	<i>Long term quitters</i>	Former regular user of one or more tobacco products that had stopped tobacco use 12 months or more prior and with no tobacco product use since
10	<i>Current experimenters</i>	Respondents who now reports currently using cigarettes, e-cigarettes, cigar products, pipes, hookah, and/or smokeless tobacco but had smoked fewer than 100 times in their lifetime (cigarettes) or had never used other products regularly
11	<i>Former experimenters</i>	Someone who reports having tried tobacco products but had smoked fewer than 100 cigarettes in their lifetime, never used non-cigarette products regularly, and not currently using any tobacco product
12	<i>Recent switchers</i>	A recent or long-term quitter of one tobacco product who reports now using a different product every day or some days

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Table 2.

Demographic and other characteristic of PATH study Wave-1 adults.

	Current established exclusive user:										Other tobacco use patterns:				
	Never user	Cigarettes	E-Cigarettes	Cigar	Pipe	Hookah	SLT	MTP users	Recent quitters	Long-term quitters	Current experimenters	Former experimenters	Switchers	Total	
	28.1%	13.1%	0.3%	1.1%	0.1%	0.5%	1.5%	6.2%	2.2%	17.0%	4.2%	24.5%	1.1%	100%	
Age															
18-24	15.4	9.6	21.6	22.4	7.9	66.0	10.9	26.5	18.8	1.4	28.0	11.9	15.5	13.0	
25-34	18.9	22.2	22.5	21.3	10.0	27.1	17.7	29.1	25.7	8.1	21.2	16.0	20.8	17.7	
35-44	16.5	19.5	12.1	16.3	11.9	4.3	21.6	17.8	16.5	12.6	13.7	17.9	16.0	16.5	
45-54	16.3	22.4	20.4	14.9	9.2	1.4	24.9	13.3	16.6	18.1	16.6	18.9	15.8	17.9	
55-64	14.8	17.2	15.3	14.7	26.7	0.8	12.0	9.3	13.6	22.6	14.2	17.3	19.4	16.6	
65 and older	18.1	9.1	8.1	10.3	34.2	0.2	12.9	3.9	8.8	37.2	6.2	18.0	12.5	18.2	
Sex															
Male	35.8	49.9	44.8	79.2	97.1	54.9	95.8	70.2	50.7	53.1	57.9	44.2	74.8	48.1	
Female	64.2	50.1	55.2	20.8	2.9	45.1	4.2	29.8	49.3	46.9	42.1	55.8	25.2	51.9	
Race and ethnicity															
Non-Hispanic White	54.0	69.0	68.9	52.5	89.6	47.8	89.4	71.3	70.4	80.5	45.6	68.3	65.6	65.8	
African American	13.9	13.3	8.5	28.4	1.1	10.5	4.0	12.5	11.2	6.0	22.6	9.6	11.0	11.5	
Other	11.8	6.0	10.4	5.1	4.5	12.5	4.0	6.4	5.7	5.0	7.9	6.5	7.2	7.7	
Hispanic/Latino	20.4	11.7	12.1	14.0	4.8	29.2	2.6	9.7	12.6	8.5	24.0	15.6	16.2	15.0	
Education															
High school	13.0	17.0	11.2	11.6	13.1	6.7	13.5	12.7	10.5	8.5	17.5	8.3	7.6	11.6	
High school some college	30.1	39.2	36.6	30.7	22.4	20.8	39.3	36.9	32.9	27.7	32.7	21.9	25.7	29.5	
Bachelors and higher	28.3	32.2	38.8	32.7	31.8	49.7	31.4	38.9	35.5	31.7	28.5	30.4	35.2	31.1	
Employment															
Unemployed	28.6	11.6	13.4	24.9	32.7	22.8	15.8	11.5	21.0	32.1	21.4	39.4	31.4	27.8	
Employed	60.8	60.8	65.6	68.3	54.1	74.6	76.8	66.6	63.8	54.1	67.4	67.6	71.6	62.5	
Income															
<\$10,000	39.2	39.2	34.4	31.7	45.9	25.4	23.2	33.4	36.2	45.9	32.6	32.4	28.4	37.5	
\$10,000-\$24,999	15.6	20.8	21.5	19.5	8.9	20.8	8.7	21.4	17.4	6.2	25.8	9.2	13.4	13.9	
>\$24,999	20.9	27.7	21.4	24.0	19.1	24.4	16.8	26.4	21.1	17.7	24.3	16.1	17.2	20.5	

J Am Dent Assoc. Author manuscript; available in PMC 2020 May 01.

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tobacco use pattern	Current established exclusive user:										Other tobacco use patterns:					Total
	Never user	Cigarettes	E-Cigarettes	Cigar	Pipe	Hookah	SLT	MTP users	Recent quitters	Long-term quitters	Current experimenters	Former experimenters	Switchers			
	28.1%	13.1%	0.3%	1.1%	0.1%	0.5%	1.5%	6.2%	2.2%	17.0%	4.2%	24.5%	1.1%	100%		
\$25000-\$49999	23.0	25.7	24.5	18.5	27.5	24.5	24.4	24.3	24.2	24.6	20.3	21.3	18.0	23.1		
\$50,000-\$99,999	25.0	18.5	24.6	18.1	24.1	16.1	32.7	18.9	23.6	28.8	16.0	28.2	23.2	24.8		
\$100,000 or more	15.5	7.4	8.1	19.9	20.4	14.2	17.4	9.0	13.7	22.9	13.5	25.2	28.2	17.7		
Health coverage																
Private insurance	69.4	49.5	59.1	61.0	70.1	63.7	72.4	50.5	65.6	74.6	62.1	77.3	70.0	67.9		
Medicaid/Medicare	13.2	23.1	17.8	17.4	16.1	8.5	13.2	18.4	16.1	16.9	14.1	10.2	12.5	14.9		
Other	2.7	3.0	5.8	1.8	2.7	6.0	2.6	4.3	1.9	2.1	2.9	2.2	3.9	2.6		
Uninsured	14.6	24.4	17.3	19.8	11.0	21.8	11.9	26.8	16.3	6.5	20.9	10.2	13.5	14.5		
Last 12 month dental visit																
Yes	62.9	44.2	52.5	54.4	57.5	62.0	48.7	45.2	56.7	67.1	54.8	69.1	63.2	60.8		
No	37.1	55.8	47.5	45.6	42.5	38.0	51.3	54.8	43.3	32.9	45.2	30.9	36.8	39.2		
Diabetes history																
Yes	13.4	12.1	15.9	11.1	15.0	2.0	13.6	10.1	13.1	20.9	10.5	13.3	10.5	14.0		
No	86.6	87.9	84.1	88.9	85.0	98.0	86.4	89.9	86.9	79.1	89.5	86.7	89.5	86.0		

Note: The table presents proportions that are weighted to represent the US adult population. Cell percentages add vertically within covariable categories (e.g., 15.4% of tobacco never users were age 24 years). Findings based on multiply imputed dataset (N=32,320)

Abbreviations: SLT = smokeless tobacco products, MTP = multiple tobacco products, PATH = Population Assessment of Tobacco and Health

Table 3.

Gum disease and treatment report (%) among different defined exposure groups, PATH study, 2013-2014

Tobacco use categories	Gum disease diagnosis^a	Gum disease treatment^b	Oral pre-cancerous lesion diagnosis^c
<i>Lifetime never user</i>	7.8	16.8	0.3
<i>Current user :</i>			
<i>Cigarette</i>	15.7	20.1	0.7
<i>E-cigarette</i>	18.0	27.0	0.8
<i>Cigar^d</i>	12.2	21.5	0.4
<i>Pipe</i>	21.4	29.2	0.0
<i>Hookah</i>	3.8	12.4	0.6
<i>Smokeless products</i>	7.9	12.5	2.2
<i>Multiple product users</i>	14.7	18.2	1.0
<i>Recent quitters</i>	16.9	21.4	1.3
<i>Long term quitters</i>	18.3	24.5	0.9
<i>Current experimenters</i>	9.1	16.7	0.6
<i>Former experimenters</i>	11.1	18.4	0.4
<i>Recent switchers</i>	15.3	22.8	1.2
<i>Total</i>	12.3	19.2	0.6

Footnotes:

*Prevalence weighted to represent US adult non-institutionalized civilian population.

a) Responded yes to “Have you ever been told by a dentist, hygienist, or other health professional that you have gum disease?” (N = 32,223)

b) Responded yes to “Have you ever had treatment for [gum disease | your gums] such as scaling and root planing, sometimes called deep cleaning?” (N = 32,187)

c) Responded yes to “Have you ever been told by a doctor, dentist, or other health professional that you have pre-cancerous oral lesions?” (N = 32,230)

Table 4:

Estimates and 95% confidence intervals (CIs) from multivariable logistic models fit to assess the association between different tobacco products and use patterns with gum disease diagnosis, gum disease treatment and pre-cancerous lesion diagnosis report using PATH Wave-1 adult data, 2013-2014

	Gum disease diagnosis (N = 32,223)		Gum disease treatment (N = 32,187)		Pre-cancerous lesion diagnosis (N = 32,230)	
	Adjusted odds ratio ^{a,b}	95% CI	Adjusted odds ratio ^{a,b}	95% CI	Adjusted odds ratio ^{a,b}	95% CI
Tobacco never user	1.0	reference	1.0	reference	1.0	reference
Current cigarette users	2.2	1.9, 2.6	1.5	1.3, 1.7	2.0	0.9, 4.1
Current e-cigarette users	2.9	1.9, 4.5	2.3	1.3, 4.1	2.4	0.5, 12.4
Current cigar users	1.9	1.4, 2.7	1.5	1.2, 2.0	1.2	0.2, 6.2
Current pipe users	2.7	1.3, 5.3	2.3	1.3, 4.1	- ^c	-
Current hookah users	1.3	0.7, 2.3	1.2	0.8, 1.7	3.5	0.5, 27.4
Current smokeless product users	1.0	0.7, 1.4	0.9	0.7, 1.2	6.8	2.9, 16.1
Multiple product users	2.8	2.4, 3.4	1.6	1.4, 1.9	3.6	1.7, 7.7
Recent quitters	2.8	2.0, 3.8	1.7	1.3, 2.2	4.0	1.4, 11.2
Long term quitters	2.0	1.7, 2.4	1.5	1.3, 1.8	2.0	0.9, 4.4
Current experimenters	1.5	1.2, 1.8	1.1	1.0, 1.3	2.1	0.8, 5.1
Former experimenters	1.4	1.2, 1.7	1.1	1.0, 1.3	1.1	0.4, 2.7
Recent switchers	2.2	1.7, 3.0	1.6	1.3, 2.0	3.5	1.0, 11.7
Age: 18 to 25 years old	1.0	reference	1.0	reference	1.0	reference
25 to 34 years old	2.0	1.7, 2.4	1.6	1.4, 1.8	1.0	0.5, 2.2
35 to 44 years old	3.8	3.2, 4.5	2.4	2.1, 2.7	1.6	0.8, 3.0
45 to 54 years old	5.4	4.5, 6.4	2.8	2.5, 3.2	2.1	1.2, 3.7
55 to 64 years old	7.0	5.8, 8.3	3.1	2.7, 3.6	3.2	1.6, 6.2
65 to 74 years old	4.6	3.7, 5.6	2.7	2.3, 3.1	2.9	1.3, 6.4
Sex: Male	1.0	reference	1.0	reference	1.0	reference
Female	1.0	0.9, 1.1	0.9	0.9, 1.0	0.9	0.6, 1.4
Education: Less than high school	1.0	reference	1.0	reference	1.0	reference
High school graduate or GED	1.0	0.9, 1.2	1.0	0.9, 1.2	1.1	0.7, 2.0
Some college or associates degree	1.2	1.0, 1.4	1.2	1.0, 1.4	1.1	0.6, 2.1
Bachelor's degree or above	1.2	1.0, 1.5	1.1	0.9, 1.3	1.0	0.5, 2.2
Income: >\$10,000	1.0	reference	1.0	reference	1.0	reference

	Gum disease diagnosis (N = 32,223)		Gum disease treatment (N = 32,187)		Pre-cancerous lesion diagnosis (N = 32,230)	
	Adjusted odds ratio ^{a,b}	95% CI	Adjusted odds ratio ^{a,b}	95% CI	Adjusted odds ratio ^{a,b}	95% CI
\$10,000 to \$24,999	1.6	0.9, 1.2	1.0	0.9, 1.2	0.6	0.3, 1.0
\$25,000 to \$49,999	1.1	0.9, 1.3	1.1	0.9, 1.3	0.6	0.4, 1.2
\$50,000 to \$99,999	1.0	0.8, 1.2	1.0	0.8, 1.2	0.5	0.3, 1.2
\$100,000 or more	1.0	0.6, 1.0	1.0	0.8, 1.2	0.6	0.2, 1.6
Employment: Employed	1.0	reference	1.0	reference	1.0	reference
Unemployed	1.1	1.0, 1.3	0.9	0.8, 1.0	1.5	0.9, 2.7
Race/Ethnicity: White	1.0	reference	1.0	reference	1.0	reference
African American	1.0	0.8, 1.1	1.8	1.6, 2.0	1.1	0.6, 1.9
Other	1.2	1.0, 1.5	1.9	1.6, 2.2	0.5	0.2, 1.3
Hispanic	0.9	0.8, 1.1	2.0	1.8, 2.2	1.0	0.5, 1.9
Medical Insurance: Private	1.0	reference	1.0	reference	1.0	reference
Medicare/Medicaid	1.2	1.0, 1.4	1.0	0.8, 1.1	0.7	0.4, 1.2
Other	0.9	0.7, 1.2	0.8	0.7, 1.1	1.9	0.8, 4.6
No insurance	1.0	0.8, 1.1	0.9	0.8, 1.0	0.8	0.4, 1.4
Past-Year Dental Visit: No	1.0	reference	1.0	reference	1.0	reference
Yes	1.2	1.1, 1.4	1.7	1.6, 1.9	1.1	0.7, 1.8
Self-Reported Diabetes: No	1.0	reference	1.0	reference	1.0	reference
Yes	1.5	1.3, 1.7	1.3	1.1, 1.4	1.7	1.0, 2.8

Footnotes

^aEstimates weighted to represent US adult non-institutionalized civilian population.

^bThe multivariable model controlled for age at interview, sex, race/ethnicity, education, employment, income, health coverage, access to dentist and history of diabetes.

^cNo outcome occurrence in this category of tobacco use