Original investigation

An Ecological Momentary Assessment of Cigarette and Cigar Dual Use Among African American Young Adults

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Abstract

Introduction: The dual use of cigarettes and cigars among African American young adults is a significant public health issue. Patterns of and reasons for dual use are difficult to capture using traditional self-report methods. This study used ecological momentary assessment (EMA) to characterize patterns of dual smoking and examine the personal and environmental predictors of cigarette and cigar smoking among African American young adult dual users (ages 18–29) in real-time.

Methods: For 14 days, 64 participants smoked *ad libitum* and were prompted four times daily to record their smoking, craving, emotions, social smoking, and environment via text message on their mobile phones. The odds of single product and dual use were examined using adjusted generalized estimating equations.

Results: Participants smoked an average of 7.9 cigarettes and 4.2 cigars per day. Cigarettes and cigars were smoked as frequently during periods of dual use as they were during periods of single product use. Cigarette craving was positively associated with cigarette-only smoking (OR: 1.07), whereas cigar craving was positively associated with cigar-only smoking (OR: 1.43) and dual use (OR: 1.08). Cigars had the greatest odds of dual use when with others (OR: 4.69) and in others' homes (OR: 4.33). Cigarettes had the greatest odds of being smoked while alone (OR: 1.57).

Conclusions: EMA was useful for capturing variable smoking patterns and predictors. In this study population, cigarettes and cigars appeared to be smoked additively, and cigars smoked socially. These findings can inform future interventions addressing dual use in this high priority population.

Implications: This is the first study to use EMA to examine naturalistic patterns and predictors of multiple tobacco use in real-time. African American young adults smoked cigarettes and cigars during periods of dual use as frequently as during periods of single product use. This suggests that most use was additive (one product smoked in addition to another) and less often as substitution (one product smoked instead of another). Social smoking and craving were strongly associated with cigar smoking in single and dual use periods. This study suggests the need for cessation messaging specifically targeted to reduce dual use in this population.

Introduction

The concurrent use of multiple tobacco products (poly use) is a growing problem for US young adults. Nearly 40% of tobacco users are poly users.[1] Poly use has increased among tobacco users under age 26, and young adults are more likely to be poly users than older adults.[2–4] This trend has significant implications for their health and ability to quit. Dual use of cigarettes and cigars is one of the most popular forms of poly use.[3–6] Cigars, including large cigars, cigarillos, and little filtered cigars, are more likely to be smoked by poly users than single product users and are popular among young adults.[1,7] Cigars have unique characteristics that make them a desirable supplement to cigarettes, including flavors, cigarette-like size and shape, slow burn rate, and lower cost due to a lower tax rate and lack of a minimum pack size requirement.[8–11] Cigar smoking is associated with increased risk of morbidity and premature mortality.[12] Dual users inhale cigars more deeply and smoke cigars with a greater intensity than cigar-only smokers, enhancing their health risk and nicotine exposure.[13–15]

African American young adults are at particularly high risk for poly use and, specifically, dual use of cigarettes and cigars. African Americans are more likely to be poly users than non-Hispanic Whites,[16] which puts them at greater risk of tobacco-related diseases and their concomitant mortality. This difference may partially explain the lower rates of cessation and greater risks of tobacco-related diseases among African Americans.[17,18] Cigar smoking is higher among African American youth and young adults than other racial/ethnic groups.[1,7,19] The context for cigar use might also differ by race and ethnicity. A study with youth found that, compared with Whites, African Americans were less likely to smoke cigars in a social situation and more likely to smoke alone.[20]

The US Food and Drug Administration (FDA) has prioritized research on cigars, including use with other products, to assist in its regulatory decision-making. To date, limited work has been done to understand dual use, including patterns of use and antecedents for smoking cigars compared with cigarettes in dual users. Several studies characterize dual users as light or medium, nondaily cigarette smokers.[16,21–23] These studies rely on self-reported recall of smoking over the past 30 days (or without a timeframe) and are subject to recall bias. Moreover, they do not provide information on the personal and environmental factors that predict cigar versus cigarette smoking in dual users. There is a clear need to better understand the patterns of and reasons for dual use to assist in policy-making and developing cessation programs specific for this unique population of smokers.

Ecological Momentary Assessment (EMA) methods collect real-time data repeatedly in participants' natural environments and have been used extensively to study cigarette smoking, cessation, and relapse.[24–26] Prior EMA research has found that affect (eg, craving, mood), social factors (eg, smoking with others), and the environmental context (eg, home, retail) are associated with cigarette smoking.[27–30] However, this work has not extended to the dual use of cigarettes and cigars.

We conducted a study using mobile phone-based EMAs among African American young adult dual users. African Americans were the focus because of their higher risk for use. The study was informed by an earlier phase that used concept mapping to identify reasons for cigarette and cigar smoking among African American young adult dual users.[31] The study aimed to: (1) characterize and describe the naturalistic patterns of dual use of cigarettes and cigars in this population, (2) determine cigarette, cigar, and dual use as a function of cigarette and cigar craving, and (3) identify and contrast other personal and environmental predictors for dual use, cigar smoking, and cigarette smoking.

Methods

Study Participants

Participants were recruited from the greater Washington, DC, metropolitan area through Craigslist.com,[32] subject referral, word-of-mouth, and a local newspaper. The online and newspaper ads briefly described the study purpose, eligibility criteria, study procedures, and compensation amount and provided contact information. Initial screening was conducted online, and eligibility was verified by phone. The inclusion criteria were: (1) age 18–29 years; (2) self-identified as African American; (3) current smoker of both cigarettes (≥4 in past 2 weeks) and cigars (≥4 in past 2 weeks, defined as little cigars, cigarillos, or large cigars), which was verified by the researchers through brand names; (4) owned a mobile ("smart") phone with a data plan; and (5) able to read and write in English. Participants were excluded if they were planning to quit smoking cigarettes and/or cigars, or planning an activity (like a vacation) that would take them away from their normal routine in the next 2 weeks. Seventy-nine individuals enrolled in the study. Twelve were dropped due to low compliance (completed ≤50% of the EMA surveys) halfway through the protocol. Another three were dropped from the analysis because it was determined during follow-up interviews that their EMA data were unreliable or they did not meet the age eligibility criterion. A final sample size of 64 participants was used for the analysis.

Participants electronically signed written informed consent. To encourage maximum compliance, financial compensation was tiered such that participants were given more money at higher rates of compliance. Compensation ranged from $40 (50–74% compliance rate) to $95 (≥90% compliance) paid at the end of the study. The University of Maryland School of Public Health Institutional Review Board approved the study.

Data Collection

Data were collected from January 2016 to May 2016. After enrollment, participants completed an online baseline survey that assessed sociodemographics, current and history of tobacco use, and psychosocial perceptions of cigarette and cigar smoking (eg, social acceptability, harm). Next, participants were enrolled in the EMA protocol, which was administered by the NYU mHealth team, in coordination with Survos LLC. For 14 days, participants smoked *ad libitum* and were prompted to complete eight surveys a day via SMS-based messages. Each day of assessment was split into four equal time periods of observation (about 3.5 hours each) based on each participant's waking hours. The EMA surveys consisted of two types: coverage and random. One coverage assessment and one random assessment were pushed during each time period. The purpose of the coverage survey was to capture, as accurately as possible, all the cigarettes and cigars smoked by the participants, including their characteristics and environmental factors. Therefore, it was sent four times a day at the same times every day so that participants could better anticipate and complete it. It asked participants to recall their smoking since the last coverage survey assessment. The random survey was sent at random times but always prior to the coverage survey. It collected information about personal and environmental factors related to smoking. The units of

observation for the analysis are the four time periods per day, which resulted in 56 observations (4 time periods × 14 days) per participant.

The median EMA compliance rate was 86% (range: 50–99%). The analysis examined 3264 observations from the coverage survey (mean: 52, range: 35–56 per participant) and 3000 observations from the random survey (mean: 47, range: 22–56 per participant).

Measures

The baseline survey collected basic demographic and socioeconomic information (eg, sex, age, education, employment status, weekly money to spend or save), lifetime and past 30-day tobacco product use (including cigarettes, cigars, e-cigarettes, hookah, pipes, smokeless, and roll-your-own cigarettes), and cigarette dependence (Fagerström Test for Cigarette Dependence; FTCD).[33,34] For the analysis, the FTCD was scored as follows: very low dependence (0–2), low dependence (3–4), medium dependence (5), high dependence (6–7), and very high dependence (8–10). Participants were also asked, "When you are really craving, do you prefer to smoke a cigarette or do you prefer to smoke a little cigar, cigarillo, or large cigar?" (0=Cigarette, 1=Little cigar, cigarillo, or large cigar, 2=No preference, 3=Don't know). For the analysis, the measure was categorized as cigarette vs. cigar/no preference, because only two participants reported no preference, and none indicated "don't know."

Four random EMAs, which included nine items, were pushed on each day of the study. The following items were collected on the random survey: affect, money for preferred product, craving, location, and social context (described below).

Affect

Participants were asked three affective items about feelings of stress, boredom, and relaxation: "On a scale of 1–10, how [stressed or tense/bored/relaxed] do you feel right now? (1=not at all, 10=extremely)." These three items were rated as the most significant affective reasons for cigarette and/or cigar smoking in an earlier qualitative study phase.[31] The scale was similar to other studies.[35,36]

Money for Preferred Product

Participants were asked: "Right now, do you have enough money to buy the product you want most? (1=yes, 2=no)." This item was included because participants in an earlier study phase identified money as a significant factor when choosing which product to smoke.[31]

Craving

Participants were asked two items about their craving for cigarettes and cigars: "On a scale of 1–10, how much do you want to smoke a [cigarette/cigar (including little cigar, cigarillo, or large cigar)] right now? (1=not at all, 10=Very, very much)." A single-item, rather than a multiple-item, measure was chosen following the recommendation of the Society for Research on Nicotine and Tobacco work group on the assessment of craving[37] and was based on a similar study.[38]

Location

Participants were asked, "Where are you right now?" (1=Home, 2=Work, 3=Bar/restaurant, 4=Others' home, 5=Outside, 6=Vehicle, 7=Other). Participants who responded "other" were asked to specify their location. Similar items have been asked in other EMA studies of smoking.[27,29,36] For analysis, we recoded list responses into a set of dichotomous variables indicating endorsement (scored 1) or nonendorsement (scored 0) of each location.[36,39]

Social Context

Participants were asked, "Are you with others?" (1=No, 2=With others, 3=Others in view). Similar items have been asked in other EMA studies of smoking.[27,29,36] As for location, the responses were recoded into a set of dichotomous variables. The dichotomous variable for "others in view" (vs. alone/with others) was excluded from the analysis.

Four coverage EMAs were pushed at the same times on each day of the study. One random survey always preceded each coverage survey. Participants were first asked about the number of cigarettes they smoked since the last assessment. If they smoked at least one cigarette, they were subsequently asked: time since last cigarette smoked, characteristics of last cigarette smoked, and location and social context for last cigarette smoked. If they reported 0 cigarettes, they skipped those follow-up questions. The same procedure was then repeated for cigars (measures described below).

Number of Products Smoked

Participants were asked: "Since the last survey, how many [cigarettes/cigars] have you smoked?" Participants who answered "0" were not asked the subsequent questions about that product. For the analysis, we categorized the observations as nonsmoking (smoked 0 cigarettes and 0 cigars since the last survey), cigarette-only (smoked only cigarettes since the last survey), cigar-only (smoked only cigars since the last survey), and dual use (smoked both products since the last survey).

Time Since Smoked Last Product

Participants were asked, "When did you smoke your last [cigarette/cigar]?" (1=Currently smoking, 2=Within last 15 min, 3=15–60 min ago, 4=1–2 h ago, 5=2–3 h ago, 6=more than 3 h).

Product Characteristics

Participants were asked for the brand of the last cigarette (1=Newport, 2=Marlboro, 3=Other) and cigar (1=Backwoods, 2=Al Capone, 3=Black and Mild, 4=Garcia y Vega, 5=Other) smoked. They were also asked for the flavor of the last cigarette (1=Not flavored/plain tobacco, 2=Menthol) and cigar (1=Not flavored/plain tobacco, 2=Mint or menthol, 3=Cognac-dipped, 4=Wine, 5=Fruit, 6=Other) smoked. Participants who responded "other" were asked to specify the brand or flavor. Open-ended responses for brands were examined and categorized appropriately in the analysis. For cigars, participants were also asked if they put marijuana in their last cigar (1=Yes, 2=No). For the analysis, a protocol developed for classifying e-cigarette flavors was used to classify cigar flavors, including those written in as "other."[40]

Location and Social Context

Similar to the random survey, participants were asked for the location and social context of the last cigarette and cigar smoked. As for the random survey, the responses were recoded into a set of dichotomous variables.

Analysis

The unit of observation for the analysis is the time period that the coverage survey asked participants to recall (ie, smoking behaviors since the last coverage survey). Each time period included one random and one coverage EMA. For descriptive analysis, we contrasted the patterns of smoking behaviors and product characteristics by

single versus dual product use. Next, the data were analyzed using generalized estimating equations (GEE) with a binomial distribution, autoregressive lag 1 covariance structure, and robust standard errors,[41] which has been used in other EMA studies.[39,42] To determine the appropriate covariance structure, we compared GEE models with different covariance structures using lorelogram graphs[43] and Quasi-Likelihood Information Criterion (QIC).[44] We found that the autoregressive lag 1 covariance structure was the best fit for the data. Because there was no *a priori* expectation of a systematic change in behaviors over time, time was not included as a covariate in the model. The GEE models examined the dependent variables of odds of cigarette-only smoking (vs. all other observations, including non-smoking, cigar-only smoking, and dual use), cigar-only smoking (vs. all other observations), and dual use (vs. all other observations) as a function of cigarette and cigar craving (independent variables). To identify other personal and environmental independent variables to include while keeping the models parsimonious, we used purposeful covariate selection as outlined by Hosmer Jr. et al.[45] Univariate GEE models assessed the relationship between the outcomes and each of the following covariates separately: cigarette and cigar craving, affect, money for preferred product, momentary environmental factors, and baseline participant characteristics. Variables that met the recommended initial significance level of $p < .20$ from post-estimation Wald tests were included in the initial multiple regression model.[45] Through an iterative process of examining covariate importance and impact using Wald tests and QIC, we refined and finalized the multiple regression models.[45] The same predictors were used for each multiple regression model to enhance comparability. Additional post hoc analysis examined odds of any tobacco use (cigarette and/or cigar smoking) versus nontobacco use as a function of the same covariates. For the models of cigar-only smoking and any tobacco use, we tested quadratic terms for cigarette craving (cigar-only model), cigar craving (both models), and "feeling relaxed" (both models) because these variables violated the linearity assumption. The quadratic terms significantly improved the models, were included in the final models, and their effects further explored using marginal effects.[46] Analyses were conducted in Stata 15 (Stata Corp., College Station, TX).

Results

Baseline Characteristics

Baseline characteristics of the 64 participants are presented in Table 1 and Supplementary Table 1. Participants were on average 24.5 (SD: 3.2) years old. Approximately 50% were women. The socioeconomic status of the sample was mixed; almost two-thirds completed at least some education beyond high school, but 41% were not currently working and 36% received public assistance. In addition to cigarettes and cigars, 95% of participants used at least one other nicotine or tobacco product in their lifetime. For most participants, their first nicotine or tobacco product was flavored (83%). In the past 30 days, the prevalence of self-reported use of ≥3 products was high (61%). Usual cigar brand and flavor were highly varied, with Black & Mild brand (31%) and alcohol (39%) and fruit/dessert/sweet (39%) flavors reported by the most participants.

Patterns of Dual Use Captured by the EMA Protocol

Both the frequency (days smoked) and amount (products smoked per day) of cigarette and cigar consumption were higher on the

Table 1. Select Baseline Participant Characteristics and Self-reported Tobacco Use (*N* = 64)

	% or Mean (SD)
Demographic and socioeconomic characteristics	
Age, mean (SD) (*n* = 63)	24.5 (3.2)
Age group, %	
18–24 years	46.0%
25–29 years	54.0%
Women, %	48.4%
Employment status in past 30 days, %	
Full time	23.4%
Part time	35.9%
Not working (unemployed, homemaker, retired/disabled)	40.6%
Weekly amount of money to spend on self or save	
Less than $100	40.6%
≥$100	59.4%
Current tobacco use	
Cigarette flavor smoked most often, %	
Plain/unflavored/other	20.3%
Menthol	79.7%
Cigar flavor smoked most often, %	
Plain/unflavored	14.1%
Alcohol	39.1%
Fruit/dessert/sweet	39.1%
Mint/menthol/other/don't know	7.8%
Preferred product when craving	
Cigarette	67.2%
Cigar	29.7%
No preference	3.1%
Use of another tobacco product in the past 30 days, %[1]	60.9%
Fagerström Test for Cigarette Dependence (FTCD) score	
Very low	42.2%
Low	28.1%
Moderate	15.6%
High or very high	14.1%

[1]Other products used are presented in Supplementary Table 1.

EMAs than what was self-reported at baseline (data not shown). On average, participants reported that they smoked cigarettes on 24.5 days of the past 30 days and 6.9 cigarettes per day (on days they smoked cigarettes) at baseline. They reported lower consumption of cigars: 17.7 days and 3.4 cigars per day (on days they smoked cigars) at baseline. During the 14-day EMA protocol, participants smoked cigarettes on 12.3 days (SD: 2.6) and cigars on 9.4 days (SD: 3.5), which is 26.4 days (SD: 5.6) and 20.1 days (SD: 7.5), respectively, when converted to a 30-day timeframe. On days they smoked, participants smoked an average of 7.9 (SD: 8.6) cigarettes and 4.2 (SD: 5.2) cigars per day.

Dual use during the observed time periods occurred fairly frequently and was highly prevalent (Table 2). Participants reported smoking both cigarettes and cigars in 28.6% of the 3264 observed time periods from the coverage EMA. Nearly all (92.2%) of participants reported periods of dual use at least once during the 14 days. In other words, over 90% of participants smoked both cigarettes and cigars within a 3.5 h window at least once. In nearly 30% of all time periods observed, participants smoked both products. Cigarette-only smoking was the most frequent occurrence (37.8% of observations), and cigar-only smoking occurred the least (8.9%). When participants reported smoking only one product during a time

Table 2. Description of Cigarette-only, Cigar-only, and Dual Use Observations (*I* = 3264 observations, *N* = 64 participants)[1]

	Cigarette-only	Cigar-only	Dual use
Number of observations	1234	292	933
% of total observations	37.8%	8.9%	28.6%
Number of participants	61	46	59
Smoking behaviors			
Number of products smoked since last survey in total, mean (SD)	2.20 (2.25)	1.62 (1.64)	5.77 (5.25)
Number of cigarettes	—	—	3.54 (4.15)
Number of cigars	—	—	2.22 (2.00)
Time since smoked last product, %			
Currently smoking	29.0%	28.8%	43.1%
Within last 15 min	31.9%	21.6%	32.4%
15–60 min ago	26.2%	24.7%	16.1%
More than 1 h	12.9%	25.0%	8.5%
Product characteristics			
Brand of last cigarette smoked, %			
Newport	79.0%	—	88.7%
Other	21.0%	—	11.3%
Brand of last cigar smoked, %			
Backwoods	—	25.5%	37.9%
Al Capone	—	31.0%	19.9%
Black & Mild	—	21.7%	20.7%
Garcia y Vega	—	8.3%	11.3%
Other	—	13.5%	10.2%
Flavor of last cigarette smoked, %			
Plain	29.1%	—	25.6%
Menthol	70.9%	—	74.4%
Flavor of last cigar smoked, %			
Plain	—	35.3%	36.2%
Alcohol	—	37.7%	33.3%
Fruit/dessert/sweet	—	21.5%	24.0%
Mint/menthol/other	—	5.5%	6.5%
Smoked last cigar as a "blunt," %	—	38.9%	44.2%

[1]24.7% of observations (805 observations, 55 people) were nonsmoking.

period, they smoked an average of 2.24 cigarettes (SD: 2.29) and 1.62 cigars (SD: 1.64). The large standard deviations (nearly equal to the averages) indicate substantial variability. In periods of dual use, participants smoked an average of 5.77 products (SD: 5.25) in total (average of 3.54 cigarettes and 2.22 cigars).

Consumption patterns also differed by cigar brand. Compared to cigar-only observations, Backwoods were more likely to be smoked (37.9% vs. 25.5%) and Al Capones less likely to be smoked (19.9% vs. 31.0%) during a dual use time period. Blunts were slightly more prevalent in dual use (44.2%) than cigar-only (38.9%) observations.

Personal and Environmental Factors Associated With Single and Dual Product Use

The results of the univariate GEE models are presented in Table 3. Among baseline characteristics, product preference and FTCD were associated with smoking behaviors captured by EMAs. Among momentary factors measured by EMA, cigarette and cigar craving and "feeling relaxed" were the only personal factors associated with smoking. Physical locations (home, outside, vehicle, work, others' home, and other place) and social context (alone and with others) were associated with single and dual product use. These variables were included in the multiple regression GEE models.

The results of the multiple regression GEE models of the odds of cigarette-only smoking, cigar-only smoking, and dual use are presented in Table 4. Participants who preferred cigars or had no

preference had more than three times the odds of cigar-only smoking than those who preferred cigarettes when craving (OR: 3.27, 95% CI: 1.70, 6.30). However, product preference was not associated with cigarette-only use, and cigarette dependence was not associated with any outcome. For every point increase in cigarette craving, the odds of cigarette-only smoking increased by 7% (OR: 1.07, 95% CI: 1.03, 1.11), but cigarette craving was not associated with dual use. At low and moderate levels of craving, every point increase in cigarette craving was associated with about 40% reduced odds of cigar-only smoking (OR: 0.59, 95% CI: 0.43, 0.82). However, the quadratic term showed that, at high levels of cigarette craving (rated ≥8), the magnitude of the association decreases. For every one point increase in cigar craving, the odds of dual use increased by 8% (OR: 1.08, 95% CI: 1.03, 1.13), and 7% lower odds of cigarette-only smoking (OR: 0.93, 95% CI: 0.88, 0.97). Similar to cigarette craving, at low and moderate levels a 1-point increase in cigar craving was associated with 43% greater odds of cigar-only smoking (OR: 1.43, 95% CI: 1.13, 1.82), but at high levels of craving (rated ≥8), the magnitude of the association decreases. Feeling relaxed was associated with increased odds of dual use (OR: 1.05, 95% CI: 1.00, 1.09), but not cigarette-only use. At lower levels, every point increase in feeling relaxed was associated with 31% increased odds of cigar-only smoking (OR:1.31, 95% CI: 1.13, 1.82). However, higher ratings of feeling relaxed (≥5) were associated with small but statistically significant decreased odds of cigar-only smoking.

Table 3. Odds Ratios (ORs), 95% Confidence Intervals (CIs), and Wald Test *p* Values for Cigarette-only, Cigar-only, and Dual Use Smoking Observations From Univariate GEE Analysis (*N* = 64)

	Cigarette-only use[1]		Cigar-only use[2]		Dual use[3]	
	OR	95% CI	OR	95% CI	OR	95% CI
Baseline factors						
Male	Ref		Ref		Ref	
Female	1.06	0.65,1.73	0.99	0.44, 2.26	1.02	0.54, 1.95
18–24 years	Ref		Ref		Ref	
25–29 years	0.88	0.53, 1.45	1.00	0.44, 2.26	0.96	0.50, 1.84
HS/GED or less	Ref		Ref		Ref	
Higher than HS/GED	1.01	0.61, 1.68	1.77	0.81, 3.90*	0.67	0.34, 1.32
<$100 spending per week	Ref		Ref		Ref	
≥$100	1.01	0.62, 1.67	0.92	0.41, 2.04	1.18	0.63, 2.22
Cigarette preferred	Ref		Ref		Ref	
Cigar/no preference	0.42	0.23, 0.75***	4.77	2.32, 9.84***	0.48	0.22, 1.03*
FTCD: Very low	Ref		Ref		Ref	
Low	1.84	1.01, 3.34	0.52	0.22, 1.27	2.05	0.92, 4.60
Moderate	1.27	0.70, 2.28	0.43	0.13, 1.48	3.51	1.52, 8.11
High or very high	2.11	0.96, 4.61*	0.30	0.07, 1.33	2.74	0.95, 7.90**
Momentary personal factors						
Cigarette craving	1.07	1.03, 1.11***	0.85	0.78, 0.94**	1.03	0.99, 1.07
Cigar craving	0.95	0.91, 0.99**	1.08	1.02, 1.14***	1.07	1.03, 1.12***
Bored	1.02	0.97, 1.07	1.00	0.95, 1.05	1.02	0.97, 1.07
Stressed	1.02	0.98, 1.06	0.99	0.94, 1.05	1.02	0.98, 1.06
Relaxed	0.97	0.94, 1.01	0.96	0.92, 1.01	1.03	1.00, 1.06
Money for pref. product	1.08	0.80, 1.46	1.25	0.74, 2.12	1.18	0.85, 1.63
Momentary environmental factors						
Cigarette location[4]: Home	0.68	0.51, 0.91**	—	—	1.00	0.80, 1.27
Outside	1.78	1.34, 2.35***	—	—	1.07	0.83, 1.37
Vehicle	1.12	0.80, 1.58	—	—	1.03	0.81, 1.32
Work	0.98	0.67, 1.43	—	—	0.80	0.57, 1.11*
Bar or restaurant	1.28	0.82, 1.99	—	—	1.00	0.68, 1.47
Others' home	0.90	0.66, 1.24	—	—	1.29	0.91, 1.82*
Other place	0.68	0.37, 1.27	—	—	0.47	0.25, 0.88**
Cigar location[4]: Home	—	—	0.85	0.57, 1.27	1.09	0.81, 1.47
Outside	—	—	1.25	0.83, 1.88	1.08	0.81, 1.44
Vehicle	—	—	2.17	1.21, 3.87***	0.81	0.57, 1.17
Work	—	—	0.50	0.25, 1.00*	0.63	0.45, 0.90**
Bar or restaurant	—	—	0.67	0.25, 1.78	0.77	0.50, 1.19
Others' home	—	—	0.86	0.56, 1.31	1.68	1.21, 2.34***
Other place	—	—	0.60	0.23, 1.53	0.55	0.29, 1.07*
Cigarette social context[5]						
Alone	1.48	1.19, 1.83***	—	—	0.84	0.67, 1.05*
With others	0.67	0.52, 0.86**	—	—	1.25	0.97, 1.61*
Cigar social context[5]						
Alone	—	—	1.00	0.68, 1.46	0.72	0.55, 0.93**
With others	—	—	0.88	0.57, 1.36	1.67	1.28, 2.19***

***Wald test *p* < .01, **Wald test *p* < .05, *Wald test *p* < .20. For FTCD, test was for variable as a whole. HS: High school; GED: general education diploma; FTCD: Fagerström Test for Cigarette Dependence.
[1]Odds of cigarette-only smoking versus other observations (includes cigar-only smoking, dual use, and nonsmoking).
[2]Odds of cigar-only smoking versus other observations (includes cigarette-only smoking, dual use, and nonsmoking).
[3]Odds of dual use versus other observations (includes cigarette-only smoking, cigar-only smoking and nonsmoking).
[4]Each location versus all other locations.
[5]Each social context versus all other contexts.

The locations and social context for cigarette and cigar smoking differed by single product versus dual use. During time periods in which participants smoked only cigarettes, their odds of smoking at home were reduced by about 50% (OR: 0.48, 95% CI: 0.27, 0.84). In periods of dual use, their odds of smoking cigars at others' homes and socially with others increased by more than fourfold each (OR: 4.33, 95% CI: 1.14, 16.48, and OR: 4.69, 95% CI: 1.76, 12.48, respectively). In contrast, participants had greater odds of smoking cigarettes exclusively when alone (OR: 1.57, 95% CI: 1.19, 2.06) and lower odds of smoking cigarettes with others during periods of dual use (OR: 0.35, 95% CI: 0.15, 0.79). No contextual factors were associated with cigar-only smoking.

The results of the post hoc analysis of any tobacco use (cigarette and/or cigar) versus nonuse is presented in Supplementary Table 2.

Table 4. Odds Ratios (ORs) and 95% Confidence Intervals (CIs) for Cigarette-only, Cigar-only, and Dual Use Smoking Observations From Multiple Regression GEE Analysis

| | Cigarette-only use[1] | | Cigar-only use[2] | | Dual use[3] | |
| | (N = 64, obs = 2694) | | (N = 64, obs = 2674) | | (N = 64, obs = 2674) | |
	OR	95% CI	OR	95% CI	OR	95% CI
Baseline factors						
Preferred: Cigarette	Ref		Ref		Ref	
Cigar/no preference	0.60	0.28, 1.29	3.27	1.70, 6.30***	0.64	0.24, 1.73
FTCD: Very low	Ref		Ref		Ref	
Low	1.56	0.81, 3.03	1.00	0.45, 2.26	1.91	0.66, 5.53
Moderate	1.02	0.46, 2.28	1.06	0.32, 3.46	2.74	0.96, 7.82
High or very high	1.51	0.56, 4.03	0.56	0.13, 3.24	2.76	0.84, 9.02
Momentary personal factors						
Cigarette craving	1.07	1.03, 1.11***	0.59	0.43, 0.82**	1.01	0.96, 1.05
Cigarette craving^2	—	—	1.04	1.00, 1.07*	—	—
Cigar craving	0.93	0.88, 0.97**	1.43	1.13, 1.82**	1.08	1.03, 1.13**
Cigar craving^2	—	—	0.98	0.96, 1.00*	—	—
Relaxed	0.99	0.95, 1.02	1.31	1.01, 1.70*	1.05	1.00, 1.09*
Relaxed^2	—	—	0.97	0.95, 0.99*	—	—
Momentary environmental factors						
Cigarette location[4]						
Home	0.48	0.27, 0.84*	—	—	0.53	0.17, 1.62
Outside	1.10	0.62, 1.96	—	—	0.48	0.16, 1.44
Vehicle	0.74	0.40, 1.34	—	—	0.88	0.26, 2.92
Work	0.65	0.38, 1.10	—	—	0.88	0.27, 2.91
Others' home	0.81	0.45, 1.46	—	—	0.36	0.11, 1.14
Other place	0.58	0.25, 1.33	—	—	0.07	0.01, 0.75*
Cigar location[4]						
Home	—	—	1.64	0.52, 5.17	2.39	0.64, 8.97
Outside	—	—	2.31	0.54, 9.98	3.31	0.82, 13.35
Vehicle	—	—	3.25	0.76, 13.85	1.34	0.30, 6.07
Work	—	—	1.07	0.30, 3.89	1.19	0.28, 5.08
Others' home	—	—	1.64	0.52, 5.17	4.33	1.14, 16.48*
Other place	—	—	0.75	0.13, 4.38	5.26	0.64, 43.47
Cigarette social context[5]						
Alone	1.57	1.19, 2.06**	—	—	0.53	0.23, 1.26
With others	0.93	0.63, 1.35	—	—	0.35	0.15, 0.79*
Cigar social context[5]						
Alone	—	—	0.84	0.46, 1.52	1.96	0.69, 5.55
With others	—	—	0.69	0.37, 1.28	4.69	1.76, 12.48**

***p < .001, **p < .01, *p < .05.
HS: high school; GED: general education diploma; FTCD: Fagerström Test for Cigarette Dependence.
[1]Odds of cigarette-only smoking versus other observations (includes cigar-only smoking, dual use, and nonsmoking).
[2]Odds of cigar-only smoking versus other observations (includes cigarette-only smoking, dual use, and nonsmoking).
[3]Odds of dual use versus other observations (includes cigarette-only smoking, cigar-only smoking and nonsmoking).
[4]Each location versus all other locations.
[5]Each social context versus all other contexts.

Cigarette dependence was associated with increased odds of tobacco use. Participants with low and moderate levels of dependence had nearly triple the odds of tobacco use (OR: 2.90, 95% CI: 1.55, 5.40, and OR: 2.80, 95% CI: 1.20, 6.54, respectively), and those with high or very high levels of dependence had more than five times the odds of tobacco use (OR: 5.37, 95% CI: 1.94, 14.88). At low and moderate levels (rated <7), every 1-unit increase in cigar craving was associated with 31% greater odds of tobacco use (OR: 1.31, 95% CI: 1.08, 1.61), but was not associated for cravings rated ≥7. Cigarette craving and feeling relaxed were not associated with tobacco use. Several contextual factors were associated with increased odds of tobacco use. Being outside had the largest effect (OR: 12.43, 95% CI: 6.28, 24.59), followed by being in a vehicle (OR: 5.59, 95%

CI: 2.62, 11.94) and others' home (OR: 4.23, 95% CI: 2.04, 8.75). Being alone more than doubled the odds of tobacco use (OR: 2.09, 95% CI: 1.40, 3.12).

Discussion

This study provided real-time data on cigarette and cigar smoking among 64 African American young adult dual users over 14 days. To our knowledge, the study reported here is the first to show that participants from this population smoke as many cigarettes and cigars during periods of dual use compared to periods of single use. That is, cigars and cigarettes appeared to most often be smoked additively, and less often as substitutes, during periods of dual use. For example,

during periods of dual use, participants smoked an average of about six products, which was higher than the number of products smoked during cigarette-only (about 2.2 cigarettes) and cigar-only (about 1.6 cigars) smoking periods. Cigars were also more likely to be smoked in conjunction with cigarettes than alone, further illustrating their appeal for multiple product use. Other studies have shown that dual users of cigarettes and cigars smoke as many or more cigarettes than those who only smoke cigarettes, which also suggests additive smoking.[16,47] Overall, we found that participants smoked an average of about eight cigarettes and about four cigars per day on the days they smoked, which is similar to the estimate of 8.73 cigarettes per day among young adult multiple product users reported by Rath et al.[2]

The additive smoking pattern indicates that cigars may be smoked for reasons other than as substitutes when cigarettes are unavailable. Cravings for cigars might be one such reason. Cigar craving appeared to be distinct from cigarette craving and was associated with different behaviors (cigar-only and dual use) than cigarette craving (cigarette-only smoking). Further research is needed to understand the qualitative difference between cigar and cigarette craving. Given that cigars are popularly used as "blunts," in which some or all of the tobacco is hulled out and replaced with marijuana,[10,48,49] future research is needed to separate the effect of cigar craving on cigar smoking from that of marijuana craving on blunt smoking.

Affect might be another reason for additive smoking. In the first, qualitative phase, we found that African American young adult dual users rated affect as the most important reason for cigarette and cigar smoking, with no difference by product.[31] In the present study, "feeling relaxed" was the only affect variable associated with smoking, and was predictive of cigar-only and dual use but not cigarette-only smoking. Other research has found that little cigars/cigarillos (LCCs) have a positive influence on users' affect, and that mood regulation is a significant reason for use.[10,50] This finding might be partially due to the presence of sweet and other flavors.[9] Surprisingly, stress and boredom were not associated with the study outcomes, but they have been linked to dual use, LCC, and cigarette smoking in other studies.[9,50,51] Negative affect has a significant effect on smoking cigarettes and relapse after quitting,[27,28,52] but our use of one measure of positive affect ("feeling relaxed") limits our ability to explore the relationship between affect and smoking in greater depth.

The physical and social environments appeared to play a significant role in cigarette and cigar smoking, more so than craving, in the study sample. Being alone was the strongest predictor of cigarette-only smoking. Participants had 57% greater odds of smoking only cigarettes when alone, which is slightly higher than the estimate of 27% greater odds of cigarette smoking reported by Shiffman et al.[27] During periods of single product use, cigarettes were less likely to be smoked at home. One study conducted by Shiffman and colleagues[39] found that cigarettes were more likely to be smoked at home when it is an unrestrictive smoking environment. Interestingly, we found that locations had different effects on cigarette smoking during periods of dual use compared to cigarette-only smoking. Being in others' homes and smoking with others (both indicators of social smoking) were the two strongest predictors of cigar smoking in dual use periods. Another study found high popularity of social cigar smoking among African American youth.[20] The tendency for cigars to be smoked socially might partially explain why cigarettes and cigars were smoked additively during dual use periods.

This study highlights the utility of EMA for capturing the highly variable patterns of dual use among African American young adults. The consumption of cigarettes and cigars was higher in the EMA data than the baseline survey data, suggesting possible underreporting when asked to recall past 30-day consumption. In addition, the data captured the wide variety of cigar brands and flavors smoked. Almost two-thirds of the cigars smoked were flavored. Flavored cigar smoking is highly prevalent among cigar smokers, especially young adults.[53,54] This study found high popularity of alcohol-flavored cigars, which is consistent with the heavy marketing of these flavors by the major tobacco companies (eg, Philip Morris International, British American Tobacco).[55]

Interestingly, we did not find any differences in the odds of cigarette-only, cigar-only, and dual use by sex in our sample of African American young adult dual users. This finding suggests that women were smoking cigarettes and/or cigars at the same frequency as men. Nationally, adult men are more likely to smoke cigarettes and cigars than women.[1] However, a national study found that dual use of cigarettes and cigars decreased among male youth but increased among female youth from 1999 to 2013, suggesting that the gender gap may be closing.[56] Flavorings are used to make LCCs highly appealing to women,[54] and might be one reason for the high rates of smoking of women in the sample.

This study is not without limitations. The EMA survey relied on participants' recall of the cigarettes and cigars smoked since the last survey, and therefore may be subject to recall bias. We believe this bias is minimal because they were asked to recall a short time period (about 3.5 h). Because this study used the coverage approach, we cannot know the exact moment when each product was smoked. Moreover, we were unable to record the characteristics of each product smoked, only the last product smoked. However, we believe the coverage survey was the best approach for capturing all of the products smoked in order to obtain an in-depth examination of dual use patterns. This study focused on 64 African American young adults in the Washington, DC, region, and so the results might not be generalizable to other populations of young adult dual users. Physiologic tests were not used to verify smoking status. The results might differ for cigars smoked with marijuana (as "blunts") and without marijuana, and future analysis should investigate this topic. Nonetheless, the EMA method was well suited to capture detailed information about the patterns of dual use, characteristics of products smoked, and the personal and environmental predictors of cigarette and cigar smoking in dual users.

This EMA study is the first to explore dual use among African American young adults. We provide evidence regarding the popularity of smoking certain brands and flavors, and the influence of environmental factors on cigarette and cigar smoking in this population. Reducing the appeal of cigars through regulatory actions, such as a ban on flavors, could reduce smoking-related health disparities among racial and ethnic minority young adults. Future cessation interventions aimed at this population of dual users should address cigar cravings and the social influences of cigar smoking.

Supplementary Material

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

Funding

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