Nicotine & Tobacco Research, 2018, 183–191
doi:10.1093/ntr/ntw289
Original investigation
Received June 14, 2016; Editorial Decision October 6, 2016; Accepted October 19, 2016

Original investigation

Large Cigars: Smoking Topography and Toxicant Exposure

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Abstract

Background: Cigar smoking in the United States continues despite decreases in cigarette smoking and increased tobacco control efforts. We compared large cigar and cigarette smoking for use patterns, smoking topography, and toxicant exposure.
Methods: Dual users ($n = 17$, 94% men, 77% African American) smoked *ad libitum* either their usual cigarette brand or a study large cigar (Phillies Blunt) in two laboratory sessions. Plasma nicotine and exhaled carbon monoxide were collected before and after smoking. Smoking topography measures of puff volume, puff duration, puff velocity, and interpuff interval were also collected.
Results: Both cigarettes and large cigars significantly increased plasma nicotine and carbon monoxide and significantly decreased the urge to smoke. Cigarettes delivered more nicotine per gram of tobacco smoked and per 1000 mL of puff volume. Number of puffs, time to smoke, puff volume, and puff velocity were significantly larger and interpuff interval was significantly shorter in large cigar smoking. The temporal pattern of puffing more intensely at the beginning of smoking was similar for both large cigars and cigarettes.
Conclusions: People who regularly use both large cigars and cigarettes adapt their smoking pattern such that they are exposed to similar levels of nicotine from each product. The immediate increase in plasma nicotine and carbon monoxide suggest significant inhalation of large cigar smoke. These data call to question the assumption that cigar smoking is less toxic than cigarette smoking. By smoking large cigars, dual users expose themselves to toxic components that have been linked with the addiction risk, morbidity, and mortality of cigarette smoking.
Implications: This study found that dual users of large cigars and cigarettes inhale significant quantities of carbon monoxide, nicotine, and presumably other components of mainstream smoke. Large cigar smoke exposure may lead to or sustain nicotine addiction as wells as subject large cigar consumers to similar risks associated with cigarette smoking such as lung cancer and cardiovascular disease.

Introduction

Although cigar sales are much less than those of cigarettes, their use is still evident in adult and youth populations.[1,2] Cigar use in the United States has historically been linked to cigarette smoking. Before the advent of the automatic cigarette rolling machine in 1875, two-thirds of the tobacco produced was used in cigar production.[3] The use of cigars diminished with the increasing popularity of machine-made cigarettes, but when the United States Surgeon General reported the health consequences of cigarettes in 1964, cigar use increased because of the perceptions that they were less harmful than cigarettes.[4] Cigar use subsequently declined to historic low levels from the 1970s through early 1980s, until *Cigar Aficionado* magazine was launched and there was a steady increase in sales.[4] Although the Master Settlement Agreement and the Family Smoking Prevention and Tobacco Control Act, which made cigars less expensive than cigarettes,[5] there has been

an increase in large cigars sales from 4.7 billion large cigars in 2008 to 9.5 billion large cigars in 2012.[6]

The increase in cigar popularity over the past several years may be an unintended consequence of tobacco regulation and taxation. In addition to product cost, their availability in various flavors, which are now prohibited from cigarettes following legislation enforced by Family Smoking Prevention and Tobacco Control Act in 2009, is another reason that cigar products may appeal to consumers, especially youth.[7,8] In April 2014, the Food and Drug Administration (FDA) proposed to extend their authority to regulate products that meet the statutory definition of a tobacco product, including cigars.[9] In May 2016, the FDA announced the adoption of the "Deeming Rule" putting cigar products under their direct regulatory authority.[10]

Despite significant progress in reducing cigarette smoking over the past five decades,[11] cigar smoking has become more popular. For example, large cigar consumption increased by 126.3% between 2008 and 2011.[12] Prevalence of cigar use tends to be highest among young adults and adolescents. In 2012, about 5.4% of US adults reported being cigar users whereas 10.7% of individuals aged 18–25 years reported current cigar use.[13] The 2010 National Survey on Drug Use and Health (NSDUH) reported that among young adults, 34.2% have used cigarettes and 11.2% have used cigars in the past month.[14] In 2012, 23.3% of high school students reported using any type of tobacco product and 12.6% specifically reported using cigars.[15] Some current and former users of cigars and cigarettes as well as the nonsmoking public misperceive cigar smoking to be less harmful than cigarette smoking[16–18] despite the associations of cigar smoking with heart disease, pulmonary disease, and many types of cancer including oral, esophageal, laryngeal, and lung cancer.[19–21] Though studies have found little cigar and cigarillo use rates are influenced by flavoring and affordability,[22] few studies have aimed to determine why individuals may choose to initiate as well as continue to use large cigars.

Recent studies suggest that smokers tend to use multiple tobacco products. Richardson et al.[23] reported that approximately 12.5% of current cigarette smokers are dual users of cigarettes and cigars. In this nationally representative sample, dual users were most likely to be African American males between the ages of 18 and 29 and of low socioeconomic status.[23] Additionally, results from the 2012 National Adult Tobacco Survey showed that the greatest proportion of dual users smoked both cigarettes and cigars (37.0%), and the use of multiple products was most prevalent among young adults aged 18–24 (62.4%).[24] The use of multiple tobacco products has also been evident among US middle and high school students as multiple product use was associated with being male, using flavored products, nicotine dependence, perceived prevalence of peer use, and marketing receptivity.[25]

The increase in cigar popularity, higher consumption, and the implications for FDA regulation emphasizes the importance of a better understanding of these products, their toxicant delivery, and addiction potential. Physical characteristics of cigarettes are fairly consistent compared to large cigars which vary greatly in size. Puff topography is used as a marker for toxicant exposure in cigarette smoking,[26] making it important to measure in order to understand the use behaviors and subsequent toxicant exposure resulting from large cigar smoking.

The objectives of this within-subject study of cigarette and large cigar dual users were to examine toxicant delivery and addiction potential by evaluating smoking topography, biomarkers of acute exposure, and subjective responses from smoking cigarettes compared to a popular unflavored factory-made large cigar (Phillies Blunt). This study also aimed to provide preliminary evidence regarding reasons for initiating and continuing the use of large cigars. The study was part of a series that investigated smoking behavior and toxicant exposure from little cigars[27] and cigarillos.[28]

Methods

Participants

Seventeen adult dual users of large cigars and cigarettes were recruited through newspapers, Craigslist, word of mouth, and from our database of former research participants. Dual users of large cigars and cigarettes were recruited to control for issues with lack of familiarity with a novel tobacco product. Eligibility was determined through a telephone interview. An experienced recruiting specialist gathered basic demographic, health, and product use information to determine if inclusion criteria were met. Eligibility criteria described elsewhere[27,28] included healthy adults not trying to quit tobacco use and current smoking of any brand of large cigar (≥1 per week) and cigarettes (≥10/day). The study was approved by Battelle's Institutional Review Board. Data from this study were collected between March 2014 and January 2015.

Procedure

Participants read and signed a Battelle Institutional Review Board-approved consent form at the first visit. They answered questions on their personal smoking history and a urine sample was collected. Participants were randomized to smoke either an unflavored Phillies Blunt large cigar or their own brand of cigarette at this first session. At their next visit, they smoked the other tobacco product. The two laboratory sessions were separated by at least 24 hours.

Prior to smoking, exhaled carbon monoxide (COex) was measured and blood was drawn from a forearm vein. Participants were then instructed to smoke "as much as you normally do": either the provided large cigar or their own brand of cigarette through the mouthpiece of a smoking puff analyzer. Heart rate and blood pressure were measured within 2 minutes after smoking and COex was measured within 5 minutes after smoking. Plasma samples, which were collected 5 and 10 minutes after smoking, were analyzed for plasma nicotine concentration. The large cigar and cigarettes (filter attached) were weighed before and after smoking to determine the amount of tobacco smoked. The amount of tobacco smoked and total puff volume (TPV) were used to adjust biomarkers of acute exposure (COex and plasma nicotine) per gram of tobacco smoked and per 1000 mL of TPV. The procedures at the second visit were identical but the participant smoked the other product.

Dependent Measures

Demographic and Tobacco Use Characteristics

In order to understand and describe this sample of dual using participants, a tobacco use history questionnaire was administered at baseline which evaluated the participants' demographics, current and past smoking history, and types of tobacco products used. Information was also collected regarding age of initiation, brand and flavor preference, and use of other nicotine and tobacco products.

Nicotine Dependence

Nicotine dependence was assessed using the Fagerström Test for Nicotine Dependence (FTND)[29] based on cigarette consumption at the initial visit.

Toxicant Exposure (Tobacco Smoke Biomarkers): Plasma Nicotine

The blood samples were centrifuged and the plasma was separated and stored frozen until analysis for nicotine concentration by the Bioanalytical Laboratory at Virginia Commonwealth University (VCU) School of Pharmacy. The lower limit of quantification for the assay was 2.5 ng/mL. The change in plasma nicotine was calculated as the difference between baseline and 5 minutes after smoking.

Toxicant Exposure: Exhaled Carbon Monoxide

COex is a biomarker of recent tobacco smoke exposure and smoke inhalation.[27,28,30,31] COex was collected at baseline and within 5 minutes after smoking using a BreathCO Monitor (Vitalograph Inc., Lenexa, KS). The change in COex was calculated as the difference between the post- and pre-smoking COex measurement in parts per million (ppm).

Toxicant Exposure: Urinary Cotinine

Cotinine, the primary metabolite of nicotine, was analyzed from urine samples taken at baseline. Cotinine has a longer half-life than nicotine (approximately 16 hours vs. 90 minutes) and provides a more stable assessment of chronic nicotine exposure.[32] Urine samples were analyzed by Labstat International ULC (Kitchener, Ontario, Canada). The cotinine assay had a lower limit of quantification of 8.78 ng/mL. The results presented below were corrected for creatinine.

Puff Measures

Measures of topography included: number of puffs, time to smoke (TTS), TPV, average puff volume (APV), puff duration, puff velocity, and interpuff interval (IPI). Smoking topography was measured using a SPA/D Puff Analyzer (Sodim Instruments, MebTEC, Mebane, NC). Battelle fabricated a mouthpiece for the SPA/D to fit a Phillies Blunt large cigar. A graduated syringe was used to pull "puffs" of the large cigar. The syringe PV was compared to the SPA/D PV to validate the accuracy of the mouthpiece. Participants smoked *ad libitum* as they sat in a comfortable chair in a well-ventilated room while under observation by laboratory personnel through a one-way mirror. The large cigar (or cigarette) was lit by the study staff to assure accurate measurement of smoking onset time. At the end of the last puff, participants provided a specific visual cue to signal the end of smoking.

Subjective Evaluations

Nicotine craving was assessed using the 10-question brief version of the Questionnaire on Smoking Urges (QSU)[33–35] which was administered before and about 10 minutes after smoking. Along with a total score, the QSU contains two factors related to smoking urge: Factor 1 measures intention and desire to smoke, whereas Factor 2 represents the anticipation of negative reinforcement associated with smoking.[33] Subjective effects were evaluated with the Duke Sensory Questionnaire (DSQ)[36] and Cigarette Evaluation Scale (CES),[37] administered approximately 10 minutes after smoking. Both questionnaires utilize a seven-point Likert scale with 1 = "not at all" and 7 = "extremely." The nine-question DSQ contains items related to puff liking, puff satisfaction, nicotine in puffs, puff strength on the tongue, nose, mouth and throat, windpipe, and chest, and similarity to own brand. An overall strength score was generated by collapsing several items from the DSQ: puff strength on tongue, nose, mouth and throat, windpipe, and chest with a range of 7–35. For the own cigarette smoking condition, questions on similarity to own brand were excluded and not included in statistical analyses. The CES is an 11-item questionnaire with questions related to cigarette satisfaction, good taste, and effects (dizziness, calmness, concentration, wakefulness, hunger reduction, nausea, irritability, enjoyment of sensations in the throat and chest, and reduction of cigarette craving). Composite scores for satisfaction (satisfaction and good taste), psychological reward (calmness, concentration, wakefulness, hunger reduction, and irritability), and aversion (dizziness and nausea) were also generated.[38]

Initiation and Continuation

A brief qualitative questionnaire was administered to participants to assess reasons for initiating and continuing large cigar use at the conclusion of the second visit. Two independent coders systematically reviewed participant responses and extracted themes. If there was not a consensus, a third independent reviewer made the final interpretation.

Statistical Analysis

Statistical analyses were similar to those used to assess acute effects of little cigars[27] and cigarillos.[28] Change in plasma nicotine concentration for cigarettes and large cigars was adjusted for the amount of tobacco smoked (ng mL^{-1} gm^{-1} of tobacco) and for mouth level exposure by adjusting for TPV (ng mL^{-1} 1000 mL^{-1} PV). Similarly, the change in COex was adjusted for grams of tobacco smoked (ppm/gm) and for mouth level exposure by adjusting for TPV (ppm/1000 mL TPV) to account for differences in product size and consumption.

Along with visual inspections of the data distribution, skewness, kurtosis, and Shapiro–Wilk tests were used to assess normality. Variables that were not normally distributed (COex, number of puffs, TPV, puff velocity, and IPI) were log-transformed for analysis. Repeated measures Analysis of Variance (rANOVA) was performed to examine differences among dependent variables collected both before and after smoking (ie, CO, plasma nicotine concentration, product weight, and QSU). A 2 × 2 rANOVA with fixed effects for product type (cigarette and large cigar), time (pre- and post-smoking), and the interaction of product type and time was fitted to the data separately for each outcome of interest. A random effect for subject was also included in the rANOVA model to account for repeated measures within a subject. The model results are presented in Table 2 with means and standard deviations. Additionally, one-way rANOVA with a random effect for subject were fitted to data collected once during each product use (ie, puff topography, DSQ, CES, and measures of exposure adjusted for grams of tobacco smoked and 1000 mL TPV) to determine whether results were significantly different by product. The results of the one-way rANOVA models including the *F*-value and *p*-value for the product type effect are presented in Table 3. Paired-samples *t*-tests were used for related variables that were not assessed at each smoking condition (ie, age of initiation for each product type). A 2 × 2 ANOVA with fixed effects for product type, time, and the interaction between product type and time was also used to compare topography variables averaged over the first and last three puffs; Scheffe *post hoc* tests were used to identify significant contrasts. Statistical analyses were conducted using Stata version 13.1 and Statistica version 12.

RESULTS

Participants

Twenty-four participants were enrolled, and 17 participants completed the study (met eligibility criteria and attended both study sessions). Participants who did not complete the study dropped out for various reasons including not showing up for appointments (n = 1),

dismissal for high cardiovascular measurements (n = 3), and poor venous blood flow inhibiting the ability to collect blood samples (n = 3). Participant characteristics are shown in Table 1. The sample consisted of mostly African American men with an average age of 36 years. The Fagerström Score and the number of cigarettes smoked per day indicates that participants were dependent on nicotine.

Tobacco Use History

Smoking characteristics of the sample are also included in Table 1. Participants reported smoking a variety of large cigars and most regularly smoked Newport cigarettes. Although most participants smoked menthol cigarettes, 59% smoked unflavored large cigars. The age of initiation was significantly lower for cigarettes compared to large cigars (13.4 and 19.7 years of age, respectively, $p < .01$).

Dependent Measures

Toxicant Exposure: Plasma Nicotine

The peak plasma nicotine concentration occurred at 5 minutes post-smoking both the large cigar and the cigarette; data from this time point was used in the rANOVA models shown in Table 2. Plasma nicotine significantly increased from pre- to post-smoking for both products ($p < .001$), but this increase did not differ by product. The means and standard deviations of plasma nicotine concentration for large cigars and cigarettes before and after smoking are also presented in Table 2.

Table 1. Participant Characteristics

Variable	% (n)
Demographics	
Gender	
Male	94.1 (16)
Race	
African American	76.5 (13)
Caucasian	17.7 (3)
Other	5.9 (1)
Education	
At least high school	88.2 (15)
Household income	
<$20 000	76.5 (13)
Age in years	
Mean ± *SD* (Range)	36.1 ± 7.9 (26–52)
Smoking characteristics	
Preferred cigarette brand	
Newport	88.2 (15)
Preferred cigarette flavor	
Menthol	94.1 (16)
Preferred large cigar brand	
Phillies Blunt	64.7 (11)
Dutch Masters	23.52 (4)
Garcia y Vega	11.8 (2)
Preferred large cigar flavor	
Flavored	41.2 (7)
Unflavored	58.8 (10)
Large cigar frequency of use	
At least once per day	23.5 (4)
<1 per day	76.5 (13)
Cigarettes per day	
Mean ± *SD* (range)	20.5 ± 8.0 (10–30)
Number of large cigars in past 30 days	
Mean ± *SD* (range)	17.6 ± 15.0 (4–60)
Age of cigarette initiation	
Mean ± *SD* (range)	13.4 ± 3.1 (7–18)
Age of large cigar initiation	
Mean ± *SD* (range)	19.7 ± 7.8 (13–47)
FTND	
Mean ± *SD* (range)	6.9 ± 1.6 (4–9)
Urinary cotinine (ng mL $^{-1}$ g^{-1} creatinine)	
Mean ± *SD* (range)	793 ± 409 (115–1871)

Toxicant Exposure: Exhaled Carbon Monoxide

As shown in Table 2, COex significantly increased from pre- to post-smoking ($p < .001$). Post-smoking COex was significantly greater after large cigar smoking compared to cigarette smoking ($p < .05$). There was no significant interaction between time and product type on COex. The means and standard deviations of COex both before and after smoking each product are shown in Table 2.

Toxicant Exposure: Product Weight

Cigarettes and large cigars were weighed before and after smoking. The means and standard deviations for the weight of both products before and after smoking are presented in Table 2. The post-smoking weight of the large cigar was significantly greater than that of the cigarette ($p < .001$) which can be attributed to the differences in the products' sizes. The weight of both products also significantly decreased from pre- to post-smoking ($p < .001$). There was a significant interaction between product and time ($p < .001$) suggesting the change in weight was influenced by the product type. Based on this significant interaction term, *post hoc* analyses were conducted to measure differences in exposure relative to the amount of tobacco that was smoked during a single smoking session. Exposure was also adjusted for TPV. The results of these *post hoc* analyses are presented in Table 3.

Adjusted Toxicant Exposure

Differences in toxicant exposure adjusted for 1000 mL PV or for weight of tobacco smoked were assessed using one-way rANOVA with results shown in Table 3. There was no effect of product type on the change in COex nicotine per unit of consumption. However, cigarettes delivered significantly more nicotine per unit of consumption compared to large cigars ($p < .001$).

Puff Topography Measures

Summary statistics for smoking topography measurements are presented in Table 3 along with the main effect of product type in a one-way rANOVA model. Compared to cigarette smoking, large cigar smoking resulted in a significantly greater number of puffs ($p < .001$), TPV ($p < .001$), TTS ($p < .05$), and APV ($p < .001$). The IPI was significantly less for large cigar smoking compared to cigarette smoking ($p < .05$). The temporal pattern of topography as assessed by the average of the first three and last three puffs for cigarette and large cigar smoking is illustrated in Figure 1. Puff duration ($F = 5.81$) was significantly longer and IPI ($F = 29.38$) was significantly shorter in the first three puffs compared to the last three puffs for both products. PV ($F = 8.41$) was greater in the first three puffs compared to the last three puffs for large cigars but was similar for cigarettes. The temporal pattern of APV ($F = 20.92$) was consistent as the first three puffs were similar to the last three puffs regardless of the product smoked.

Subjective Measures

The means and standard deviations for QSU scores before and after smoking are shown in Table 2; the results of the 2 × 2 rANOVA are also shown. Factor 1, Factor 2, and Total QSU scores significantly

Table 2. 2 × 2 rANOVA Models of Outcome Measures

	Mean (*SD*)		Product		Time		Product × time interaction	
Outcome measure	Cigarette smoking	Large cigar smoking	*F* value	*p* value	*F* value	*p* value	*F* value	*p* value
Plasma nicotine (ng/mL)			<0.1	.98	32.2	<0.001*	0.7	0.42
Pre-smoking	18.0 (11.9)	20.7 (15.3)						
Post-smoking	38.8 (15.3)	36.3 (23.0)						
COex (ppm)[a]			4.3	.04*	36.2	<0.001*	3.2	0.08
Pre-smoking	21 (12)	22 (14)						
Post-smoking	30 (12)	47 (26)						
QSU factor 1			4.2	.05*	58.0	<0.001*	1.7	0.20
Pre-smoking	30 (7)	25 (8)						
Post-smoking	16 (9)	15 (9)						
QSU factor 2			2.2	.14	39.3	<0.001*	2.1	0.15
Pre-smoking	21 (8)	17 (8)						
Post-smoking	12 (6)	11 (8)						
QSU total			3.9	.05	59.0	<0.001*	2.2	0.14
Pre-smoking	51 (14)	42 (14)						
Post-smoking	28 (14)	26 (17)						
Product weight (g)			163.3	<.001*	3761.6	<0.001*	28.3	<0.001*
Pre-smoking	1.08 (0.07)	6.57 (0.39)						
Post-smoking	0.47 (0.16)	5.08 (0.68)						

COex = exhaled carbon monoxide; QSU = Questionnaire on Smoking Urges.
[a]Log-transformed variable included in the rANOVA model.
*Denotes significance at $p < .05$.

Table 3. One-Way rANOVA Models of Outcome Measures

	Mean (*SD*)			
Outcome measures	Cigarette smoking	Large cigar smoking	Product *F* value[a]	Product *p* value[a]
Puff topography				
Number of puffs[a]	12 (4)	23 (11)	54.2	<.001*
Total puff volume (mL)[a]	658 (215)	1660 (1060)	72.1	<.001*
Time to smoke (s)	252 (89)	371 (207)	8.0	.01*
Average puff volume (mL)	57.8 (20.4)	73.9 (20.0)	10.6	<.01*
Puff velocity (mL/s)[a]	23.6 (5.1)	34.3 (13.0)	20.6	<.001*
Puff duration (s)	2.6 (0.7)	2.5 (0.6)	0.8	.38
Interpuff interval (s)[a]	21.9 (9.8)	16.6 (9.6)	9.0	.01*
DSQ				
Puff liking	5 (1)	5 (2)	2.0	.17
Puff satisfaction	6 (1)	5 (1)	3.4	.08
Nicotine in puffs	5 (1)	5 (1)	0.5	.50
Strength	22 (6)	23 (7)	0.2	.65
CES				
Sensation	5 (2)	4 (2)	1.0	.33
Craving reduction	5 (2)	5 (2)	1.1	.32
Satisfaction	5 (1)	5 (1)	0.1	.74
Psychological reward	4 (1)	4 (2)	1.8	.20
Aversion	2 (1)	2 (1)	1.0	.34
Change in plasma nicotine				
Per gram of tobacco consumed[a]	35.9 (22.3)	7.8 (10.1)	19.2	<.001*
Per 1000 mL of total puff volume[b]	32.8 (17.1)	8.7 (10.5)	24.2	<.001*
Change in COex				
Per gram of tobacco consumed[a]	14 (5)	16 (11)	0.5	.51
Per 1000 mL of total puff volume[b]	14 (7)	16 (12)	0.6	.47

CES = Cigarette Evaluation Scale; DSQ = Duke Sensory Questionnaire.
[a]Log-transformed variable included in the rANOVA model.
*Denotes significance at $p < .05$.

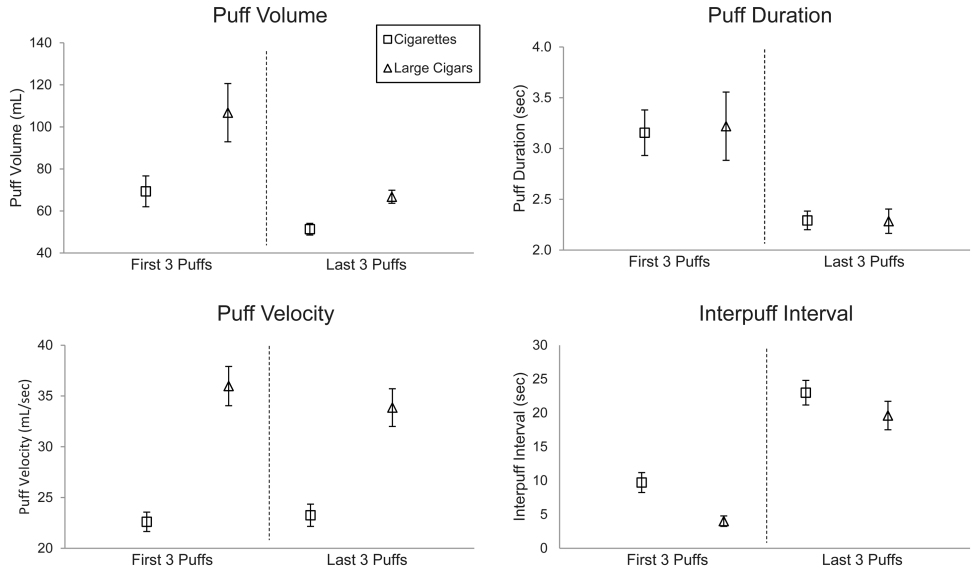

Figure 1. Temporal puff × puff analysis.

decreased from pre- to post-smoking for both products (all $p < .001$). The interaction between product type and time was not significant for any of the QSU measures suggesting the decrease in QSU was not dependent on the product smoked.

One-way rANOVA models examining the effect of product type on DSQ and CES are presented in Table 3. There was no effect of product type on either of these subjective scales.

Initiation and Continuation

Reasons for initiating and continuing smoking large cigars were assessed through a brief qualitative questionnaire. Results of this qualitative questionnaire indicated the importance of peer influence (endorsed by 56% of the sample) as a reason for initiating use of large cigars. However, continuation of use was strongly influenced by the appeal of flavoring (endorsed by 31%) followed by the psychological and subjective effects associated with the use of large cigars (eg, stress relief; 25%), and price considerations (19%).

Discussion

The present study compared toxicant exposure, smoking topography, and subjective effects after large cigar and cigarette smoking. This is one of a series of studies that have compared cigarette smoking to cigarillo[28] and little cigar[27] smoking in a sample of dual users. The results of the present and previous studies indicate that all cigar products (little cigars, cigarillos, and large cigars), like cigarettes, rapidly deliver nicotine and CO to their consumers which represents a significant public health concern. Therefore, these findings support the rationale for regulation of cigar products as has recently been enacted by the FDA.[10]

In this study, exhaled levels of CO significantly increased after large cigar smoking which was similar to levels after cigarillo smoking. (25 ppm),[28] but greater than the CO boost after little cigar smoking (7 ppm).[27] To adjust the COex exposure for differences in product size and puffing behavior, the changes in COex for large cigars and cigarettes were compared relative to the TPV and grams of tobacco smoked. This analysis indicated that large cigars and cigarettes delivered equivalent CO when the puff topography and consumption of tobacco was considered. The delivery of nicotine from large cigars and cigarettes followed a different pattern than exhaled CO exposure. Despite no difference in the change of plasma nicotine between the products after *ad libitum* smoking (Table 2), cigarettes delivered more nicotine than large cigars when exposure was adjusted to grams of tobacco smoked and TPV.

These results from large cigar smoking are similar to those found in other cigar products when exposure was adjusted for TPV and the amount of tobacco smoked—the amount of nicotine delivered by cigarettes was greater than both cigarillos and little cigars (PV only).[27,28] Overall these results indicate that cigarettes tend to be more efficient at delivering nicotine whereas cigar smoking yields greater CO exposure.

Large cigars were smoked differently than cigarettes. There were significant differences in TTS, number of puffs, and TPV—these differences are partially attributable to the greater size of the large cigar compared to the cigarette. However, even among variables that are independent of the article size (eg, individual PV, puff velocity, IPI), there were significant differences between cigarette and large cigar smoking suggesting that the large cigars were smoked more vigorously than cigarettes. As illustrated in Figure 1, there was a similarity in the temporal puff patterns such that large cigars and cigarettes are not smoked uniformly over the length of the tobacco rod—smoking tends to be more intense at the beginning of the article (first three puffs) than at the end (last three puffs). We have observed a similar pattern of puffing with cigarette,[31] little cigar,[27] and cigarillo smoking.[28]

Participants in this study began cigarette use before they began using large cigars. Smoking patterns may be established fairly early in one's tobacco experience and these patterns may persist even if the product being smoked changes.[39] It seems plausible that the similarities in puffing patterns in large cigar smoking may have emanated from smoking patterns that developed with cigarette smoking that occurred years before cigar smoking initiation. This notion is further supported by reports that cigar smoke is frequently inhaled in former cigarette smokers, but inhalation is less frequently observed in people who smoke cigars but have not previously smoked cigarettes.[40]

The significant reduction in QSU Scores after both cigarette and large cigar smoking indicates that both products reduced smoking

urges. Responses to liking and satisfaction and other measures of the CES and DSQ were similar after large cigar and cigarette smoking indicating that product satisfaction was similar.

Qualitative responses suggested the role of peer influence on the initiation of large cigar smoking. The primary factor that influenced the continuation of large cigar use was product flavoring and is supported by others who have found a preference for flavored cigars among young adults.[41] Sterling et al.[42] also suggested that cigar flavoring plays an important role in the perception of risk among dual users. While price was the main factor for continued use of little cigars,[27] price was not the primary consideration in this sample of large cigar and cigarette dual users.

The present study evaluated large cigar use in a convenience sample of research volunteers recruited in the greater Baltimore area. The proportion of males in this sample (94%) was similar to what was observed in a sample of cigarillo and cigarette dual users (91%),[28] but greater than the proportion of males observed in a sample of little cigar smokers drawn from the same population (71%).[27] Participants from all three samples were primarily African American. In spite of differences in sampling in other studies, the participants of the present study were representative of the results from national surveys that report cigar users are predominately African American males.[11] This sample was also similar in age to national data as the Centers for Disease Control and Prevention has shown that cigar prevalence is highest among adults aged 18–44.[11]

Fewer individuals in this sample preferred a flavored large cigar (41%) compared to individuals who preferred flavored cigarillos (87%)[28] and flavored little cigars (71%)[27] in samples drawn from the same population. The samples differed markedly in the age of initiation of cigar use, as individuals initiated large cigar use an average of 14 years before individuals initiated little cigar use,[27] and 3.3 years before individuals initiated cigarillo use.[28] The younger age of initiation among large cigar and cigarillo users observed in this series of studies may be a result of increasing use of cigars as a route of administering marijuana among adolescents.[43]

At a recent conference on patterns of domestic cigar use, several speakers commented on the concomittant and highly associative use of cigars and marijuana smoking.[44–48] Some of the increase in cigar consumption—especially among young people—may be attributable to the use of large cigars and cigarillos to create blunts (hollowed-out cigar wrapper containing marijuana).[49,50] A recent report indicated that Phillies Blunts, the experimental product used in this study, was the preferred cigar for creating blunts.[50] Individuals using cigars as marijuana delivery devices could be exposed to considerable levels of nicotine and other toxicants from the wrapper and any residual tobacco filler.[51] The delivery of nicotine from blunt smoking may influence the effects of marijuana.[52,53] For example, Cooper and Haney reported higher levels of CO exposure and greater increases in heart rate when marijuana was smoked as a blunt than when smoked in a paper wrapper (joint).[54]

There are acknowledged limitations to this study. This study used a convenience sample of paid research volunteers consisting mostly African American men residing in an urban setting. We tested only one large cigar product (Phillies Blunt) of the many domestic and imported cigars that are commercially available in the United States. However, Phillies Blunts are consistently rated as one of the most popular large cigar brands.[55] Most participants (n = 11) reported regularly using Phillies Blunts, while this was an unfamiliar large cigar brand for six participants. Familiarity with Phillies Blunts may have accounted for differences in the nicotine 23 versus 2 ng/mL and COex boost 32 versus 13 ppm, between those familiar and those unfamiliar with the product, respectively. However, puff topography measures and the weight of tobacco consumed did not differ as a function of familiarity. Also, the Phillies Blunt used in this study was unflavored whereas 41% of the sample usually smoked a flavored large cigar. Another limitation is that information on the use of large cigars to smoke marijuana blunts was not collected in this study. Use behavior and toxicant exposure associated with *ad lib* marijuana blunt smoking are largely unknown. However, this study utilized an unaltered large cigar product. There are thousands of components in cigar smoke[56] and this study evaluated exposure to two components—nicotine and carbon monoxide. Although there were no significant differences in baseline plasma nicotine and exhaled CO levels (these were controlled for in analyses), participants were not tobacco abstinent prior to experimental sessions. This sample consisted of cigarette and large cigar dual users and nicotine dependence was measured based on cigarette smoking alone thus potentially underestimating dependence. More research examining the use behavior and toxicant exposure of a wider variety of large cigar brands and flavors in a more diverse population is warranted. Future research should also consider the importance of product familiarity.

Despite these limitations, large cigars rapidly delivered significant amounts of nicotine, similar to cigarettes. There was also evidence of inhalation during large cigar smoking as shown by the rapid and significant increase in COex. Large cigars decreased the urge to smoke and had similar satisfaction and liking ratings. Despite differences in puff topography, cigarettes and large cigars delivered similar amounts of nicotine and large cigars delivered significantly more CO. The results support the recent "Deeming Rule" decision that extends FDA authorization to regulate all tobacco products including large cigars.[10]

Funding

This work was supported by a grant from by the National Cancer Institute at the National Institutes of Health (5R01CA158045-03).

Declaration of Interests

None declared.

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