Published in final edited form as:

Tob Regul Sci. 2017 July ; 3(3): 258–265. doi:10.18001/TRS.3.3.2.

International Organization of Standardization (ISO) and Cambridge Filter Test (CFT) Smoking Regimen Data Comparisons in Tobacco Product Marketing Applications

Changyu Chae, PhD,

Senior Chemist, Division of Product Science, Office of Science, Center for Tobacco Products, US Food and Drug Administration, Silver Spring, MD

Matthew J. Walters, PhD, MPH, and

Chemistry Branch Chief, Division of Product Science, Office of Science, Center for Tobacco Products, US Food and Drug Administration, Silver Spring, MD

Matthew R. Holman, PhD

Division Director, Division of Product Science, Office of Science, Center for Tobacco Products, US Food and Drug Administration, Silver Spring, MD

Abstract

Objective—We investigated the differences in TNCO (tar, nicotine, and carbon monoxide) smoke yields generated under the International Organization of Standardization (ISO) and Federal Trade Commission (FTC) Cambridge Filter Test (CFT) smoking regimens.

Methods—Twenty-nine commercial cigarette products from the US marketplace were acquired in 2015 and tested by measuring the TNCO smoke yields generated under these 2 nonintense smoking regimens.

Results—Data obtained demonstrated a linear relationship between the TNCO yields produced under the 2 smoking regimens ($R^2 > 0.99$). TNCO yields produced by each product were higher under the CFT smoking regimen than the ISO smoking regimen.

Conclusion—We found that tar, nicotine, and carbon monoxide yields were consistently 10% to 13% higher under the CFT smoking regimen than under the ISO smoking regimen. This strong correlation indicates that the 2 smoking regimens can be used to apply a correlation correction to CFT TNCO data and allow its comparison to ISO TNCO data in tobacco product marketing applications.

Correspondence Dr Walters; matthew.walters@fda.hhs.gov.

Human Subjects Statement

No human subjects were involved in this study.

Conflict of Interest Statement

The authors report no conflict of interest to disclose.

Keywords

TNCO (tar, nicotine and carbon monoxide); International Organization of Standardization (ISO) smoking regimen; Federal Trade Commission (FTC) Cambridge Filter Test (CFT) smoking regimen; tobacco product marketing application

The Federal Food, Drug, & Cosmetic Act (FD&C Act) as amended in June 2009 by the Family Smoking Prevention and Tobacco Control Act (FSPTCA) provided the FDA authority to regulate the manufacturing, marketing, and distribution of tobacco products to reduce harm to the public's health. Under section 910(a) (2) of the FD&C Act, tobacco product manufacturers must submit a tobacco product marketing application to the FDA for all tobacco products marketed in the United States (US) after February 15, 2007. There are several types of tobacco product marketing applications, including the Substantial Equivalence Reports (SE Reports) (section 905(j) of the FD&C Act). SE Reports require that the characteristics of the new tobacco product be compared to a predicate tobacco product, which can be a "grandfathered" tobacco product marketed in the US prior to February 15, 2007 or a tobacco product that the FDA previously found substantially equivalent. The new tobacco product is substantially equivalent if: (1) it has the same characteristics as the predicate tobacco product; or (2) it has different characteristics than the predicate tobacco product but the differences in characteristics do not cause the new tobacco product to raise different questions of public health. Many SE Reports include TNCO for the new and predicate tobacco product as evidence to support a determination of substantial equivalence. Because the new tobacco products often have been manufactured and analyzed more recently than the predicate tobacco products, TNCO data in many SE Reports were generated under different smoking regimens for the new and predicate tobacco products.

Various smoking regimens have been developed and implemented to measure smoke constituents of combustible tobacco products including the Massachusetts, International Organization of Standardization (ISO), Cambridge Filter Test (CFT) of the Federal Trade Commission (FTC), and Canadian Intense (CI) smoking regimens. Each of these smoking regimens has been developed for various reasons, but they all have been used to meet legal and regulatory requirements around the world. Some of these smoking regimens are considered nonintense smoking regimens (eg, CFT, ISO) whereas others are considered intense smoking regimens (eg, CI). The various intensities of the smoking regimens are used to understand and quantify the various levels of harmful constituents to which consumers may be exposed.

The first smoke-machine guidelines were established by the US Federal Trade Commission (FTC) in 1966.¹ The original intent of the FTC's cigarette smoking Cambridge Filter Test (CFT) method was to provide information and guidance to the consumer regarding the tar and nicotine contents.¹ This method has become known as the FTC smoking method. Since then, a number of different countries and organizations, including the Cooperation Centre for Scientific Research Relative to Tobacco (CORESTA), developed their own smoking regimens, which led to minor differences in butt length, smoke collection, and analytical methods that yielded minor difference of tar, in the late 1960s.² In the early 1990s, the ISO harmonized the different smoking regimens². Therefore, smoking under identical conditions

with identical cigarettes is expected to yield reasonably equivalent yields of TNCO.³ Given that the CFT and the ISO smoking regimens are nonintense smoking regimens, many SE Reports contain measured TNCO yields for the predicate tobacco products under the CFT smoking regimen, whereas TNCO yields for the new tobacco products are measured under the ISO smoking regimen. This presents a challenge in evaluating the substantial equivalence of tobacco products, and determining whether differences in measured TNCO yields from new and predicate products are meaningful and cause the new product to raise concerns for public health agencies.

Table 1³ shows how closely the ISO and CFT smoking regimens are to each other and the relatively small differences that exist between the 2 smoking regimens. With these differences, the ISO smoking regimen has narrower specifications than the CFT smoking regimen. Air ventilation velocity is specified in the ISO smoking regimen, whereas the CFT smoking regimen is generalized as “sufficient to exhaust smoke.” Additionally, noted differences include the following: (1) the smoking restrictor requirement only exists for the CFT smoking regimen; and (2) the air velocity around the cigarettes being smoked is measured and restricted in the ISO smoking regimen, but the CFT smoking regimen is less restrictive in venting all the exhausted smoke. The restrictor is specified in ISO 3308:2000(E) in section 3.3 of this standard. The restricted smoking condition exists when the butt end of a cigarette is closed to the atmosphere between successive puffs.

Given the CFT and ISO smoking regimens are comparable in many specifications to each other as nonintense smoking regimens, we sought to examine the correlations in tar, nicotine, and carbon monoxide (TNCO) yields of 29 commercially available cigarette brands in the US marketplace smoked under CFT and ISO smoking conditions. From these data, we sought to determine if CFT TNCO smoke yields were highly correlated to ISO TNCO yields and, if so, to what extent. Furthermore, we sought to examine the regulatory implications of smoke measurements under the CFT versus the ISO smoking regimes and the utility of this correlation to the review of tobacco marketing applications.

METHODS

Twenty-nine commercially available filtered cigarettes were purchased in 2015 from a retail store (Cigar Masters) in Chesapeake, Virginia, on January 23, 2015 fulfilled by a contractor (NorthStar). Cigarettes were chosen to obtain a representative sample of cigarettes commercially marketed in the US (Table 2). After purchase, the unopened cigarette packages were shipped to Labstat International, ULC (Kitchener, ON, [Canada]), assigned an identification number, and logged into a database. The cigarettes in their original packaging were sealed using plastic bags and stored between 23 °C and 25 °C until tested. Only authorized personnel had access to the samples. In addition, the University of Kentucky 3R4F reference cigarette also was conditioned and tested along with the commercially available cigarette products for testing system suitability purposes.

Prior to testing, all cigarettes were conditioned following ISO 3402: Tobacco and Tobacco Products – Atmosphere for Conditioning and Testing. The cigarettes were conditioned at 22 ± 1 °C with a relative humidity of $60 \pm 3\%$ for a period of 48 hours. Cigarettes were smoked

at 22 ± 2 °C with a relative humidity of $60 \pm 5\%$ on a linear smoking machine (Cerulean Smoking Machine, SM450-11, Model SM450RH with Cerulean VFA box Model VFA 450RH and Cerulean CO Analyzer Model COA205).

Cigarettes were smoked under the CFT and ISO smoking regimens (smoking parameters summarized in Table 1). Seven replicates were measured for each constituent (TNCO). Cigarette samples were smoked on an automated, constant volume, linear smoking machine equipped with a carbon monoxide analyzer onto a conditioned, pre-weighed filter pad. The gas phase was collected in a vapor phase collection bag. A Non-Dispersive Infra-Red Analyzer (NDIR) analyzed the collected gas in the bag for the percent carbon monoxide. This procedure followed closely to that of ISO 8454: Determination of Carbon Monoxide in the Vapor Phase of Cigarette Smoke – NDIR Method.⁴ The pad was re-weighed to measure the weight difference, from the blank pad, to determine the total particulate matter (TPM). The pad, with internal standards, was extracted with Isopropyl Alcohol (IPA). This procedure followed closely to that of ISO 4387, Determination of Total Nicotine-Free Dry Matter Using a Routine Analytical Smoking Machine.⁵ The nicotine and moisture were analyzed from the extract by gas chromatography. Nicotine measurements were conducted on a Agilent GC 6890N (G1530N), HP (Agilent) Autosampler Tower 7683 Series (Model G2613A) and Agilent Autosampler Tray 7683 Series (Model G2614A) with flame ionization detector and moisture analysis were conducted on a Varian GC3800, Varian CP-8400 auto-sampler with flame ionization detector. This procedure followed closely to that of ISO 10315, Determination of Nicotine in Smoke Condensates – Gas Chromatographic Method⁶ and ISO 103621: Determination of Water in Smoke Condensates – Part 1: Gas-Chromatographic Method.⁷ The difference in weight between the TPM minus the water and nicotine yields the tar yield. Each tobacco product resulted in 7 replicates with each replicate requiring 4 pads and 5 cigarettes per pad. As a result, each smoking regimen required 140 cigarettes per tobacco product.

Following data collection, the means and standard deviations were determined for tar, nicotine, and carbon monoxide of the 29 commercial cigarettes smoked under the CFT and ISO smoking regimens (Table 2). The ISO smoke yield versus the CFT smoke yield of each cigarette brand for each constituent (TNCO) was plotted to determine the mathematical relationship between the 2 smoking regimens. This was plotted using Excel to determine the best fit line which resulted in a linear relationship among tar, nicotine, and carbon monoxide for the selected cigarettes measured under the CFT and ISO smoking regimens (Figure 1). We considered the Pearson's correlation coefficient r ; however, for this study there is no significant advantage in using Pearson's correlation coefficient over that of R^2 . The only advantage of reporting Pearson's r is that it indicates whether the variables are directly (+) or inversely (–) correlated. In this case, where $R^2 = 0.990$, we have $r = 0.995$, and a p-value (for $N = 29$) much less than .001, which suggests that the correlation is statistically significant. A linear mixed model approach also was conducted to confirm that the CFT smoking regimens and ISO smoking regimens were indeed different from each other. This approach is more appropriate than a 2-tailed t-test for clustered data where the replicates under each product are considered a cluster, and is generally considered robust to deviations from normality when sample size is large (~200 replicates per constituent for each smoking regimen) as is the case in this study.

RESULTS

The ISO and FTC CFT method smoking regimens are well-recognized nonintense smoking regimens to measure TNCO and other chemical constituents such as those on the FDA's established Harmful and Potentially Harmful Constituent (HPHC) list.⁸ Table 3 reports the measured tar, nicotine, and carbon monoxide for the 29 commercially available cigarette tobacco products sampled and the University of Kentucky 3R4F reference product measured under CFT and ISO smoking conditions. The puff count for the University of Kentucky 3R4F reference product measured under the CFT and ISO smoking regimens was 9 and 8 puffs, respectively. In comparison, the puff count for the cigarettes under the CFT regimen resulted in between 7 and 13 puffs per cigarette, whereas the puff count for the cigarettes under the ISO regimen resulted in between 7 and 12 puffs per cigarette. Overall, the puff counts are similar between the 2 smoking regimens with the CFT smoking regimen containing one extra puff when comparing each cigarette brand across the 2 smoking regimens. Examination of the mean of the constituents (TNCO) demonstrates that the CFT smoking regimen consistently produces higher smoke yields when compared to the ISO smoking regimen, which is likely due to the extra puff generated in the CFT smoking regimen. This has explicit regulatory implications during tobacco product marketing application review. A strong correlation was observed between these 2 nonintense smoking regimens that ultimately can be used to apply a correlation correction to the CFT TNCO data and allow its comparison to ISO TNCO data in tobacco product marketing applications.

However, given that the CFT and ISO smoking regimes are nonintense smoking regimens, we wanted to confirm through a linear mixed model approach that the smoking regimens were indeed different from each other for the selected cigarettes in this study (Table 3). Following the approach, 3 cigarette brands (Now Gold 100s, Carlton White 100s, and Marlboro Menthol Silver Pack) were found to produce essentially the same yields under both CFT and ISO smoking regimens when examining the tar yields, whereas only one cigarette brand (Now Gold 100s) produced similar nicotine yields under both the CFT and ISO smoking regimens. All other cigarette brands in this study demonstrated that different yields are produced when measured under the CFT and ISO smoking conditions resulting in a strong correlation between the TNCO yields measured under the CFT and ISO smoking regimens.

DISCUSSION

Our examination noted a strong correlation for these 2 smoking regimens that can be used to apply a correlation correction to CFT TNCO data and allow its comparison to ISO TNCO data in tobacco product marketing applications. On average, the TNCO yields under the CFT smoke regimen resulted in yields that were 10% higher and observed in general, throughout the 29 commercially available cigarette brands we examined. However, we noted a few exceptions. There are 3 cigarette brands that resulted in the CFT and ISO smoking regimens being similar to each other, and producing similar TNCO yields that may be due to the design features and tobacco blend composition of those particular brands. The 3 cigarette brands (Now Gold 100s, Carlton White 100s, and Marlboro Menthol Silver Pack) produced essentially the same yields under both CFT and ISO smoking regimens when examining the

tar yields, whereas only one cigarette brand (Now Gold 100s) produced similar nicotine yields under both the CFT and ISO smoking regimens. The Now Gold 100s may have some unique design features that produce similar TNCO yields when evaluated under the CFT and ISO smoking regimens.

A possible difference in the TNCO yields between the 2 smoke regimens may arise from the puff count. The puff count depends on the marketed butt length in which then the cigarettes are smoked until the butt length marks. If the butt length marks are different between the 2 smoking regimens, the smoke volume yield is different. The butt length is marked at either overwrap + 3mm or filter + 8mm. All samples for the CFT analysis consistently had the butt length marked at overwrap + 3mm; the samples for the ISO analysis were not consistently marked as there are 2 options for marking the butt length: (1) 12mm from overwrap + 3mm; or 17mm of filter + 8mm. Of the 29 samples, 14 had the butt length marked at a longer distance on the ISO smoked samples than the CFT smoked samples. This may explain one reason why higher yield of TNCO in CFT smoke regimen samples was observed when compared to the ISO smoking regimen samples.

Though it is well known that both the CFT and ISO smoking regimens are nonintense smoking regimens and are expected to produce similar constituent yields, it is apparent even in our small sample that not all cigarette brands follow this expectation. Generally speaking, the CFT smoking regimen produces higher TNCO yields, likely due to the increased puff number than the ISO smoking regimen. However, this is not always the case due to cigarette product design and composition. Thus, this has regulatory implications during tobacco product review in determining whether products raise different questions of public health or are appropriate for the protection of public health. Of course, we cannot neglect the difference between the 2 smoking regimens that result from other factors, such as measurement uncertainties, product design features, and tobacco product composition influences.

Although it has been established that the CFT and ISO smoking regimens are unique nonintense smoking regimens, a direct comparison between the CFT and ISO smoking regimens in tobacco product marketing applications is not feasible. This study demonstrates that a direct correlation can be established between CFT and ISO smoke yields of TNCO yields to compare tobacco products characteristics even when constituent yields are measured under different nonintense smoking regimens. Utilizing the correlating correction factor, which on average, can be adjusted by 10%, TNCO yields measured under the CFT smoking yields for tobacco products (eg, predicate tobacco products) can be used and adjusted to compare tobacco products in which TNCO yields were measured under the ISO smoking regimen, and to establish if these differences raise different questions of public health.

IMPLICATIONS FOR TOBACCO REGULATION

The 29 cigarette products represent a diverse selection of cigarettes that are composed of 3 different flavors (Turkish Domes (1), menthol (7) and regular (21)), 4 different sizes (slims (1), super slims (1), 100's (12) and king-size (15)) and various different tobacco blends. We

sought to examine the similarities and/or difference of the CFT and ISO smoking regimens and the implications for tobacco regulation, and in particular, for tobacco product marketing application review. A linear relationship between the 2 smoke regimens was observed, as Figure 1 shows. On average we found that the yields produced for cigarette products under the CFT smoking conditions produced higher amounts of tar, nicotine, and carbon monoxide by 11%, 13%, and 12%, respectively and were highly correlated to each other. In general, the yields from the CFT smoke regimen are higher, in similar magnitude, to that of the ISO smoke regimen yield. The relationship between ISO and CFT smoke regimens can be simplified as the following corrections demonstrate:

Tar: $ISO_{tar} = 0.89 \times CFT_{tar}$, Nicotine: $ISO_{nicotine} = 0.87 \times CFT_{nicotine}$, and Carbon Monoxide: $ISO_{CO} = 0.88 \times CFT_{CO}$. For simplicity, it may easier to apply a 10% correction factor, resulting in the following equation: TNCO: $ISO_{TNCO} = 0.90 \times CFT_{TNCO}$.

The likely cause of higher TNCO yields under the CFT smoke regimen is from the increased puff count for the CFT smoke regimen than the ISO smoke regimen. Understanding the exact relationship between the TNCO yield of the higher smoke yielding machine smoking, CFT, and the relatively lower smoke yielding machine smoking, ISO, would aid the FDA in improving its regulatory review of the pre-market tobacco applications including SE Reports, Premarket Tobacco Applications, and Modified Risk Tobacco Product Applications to determine whether the tobacco products raises different questions for public health, and is appropriate for the protection of public health. This study can be applied to SE Reports and other tobacco product marketing applications to apply a correlation correction factor to adjust TNCO yields when 2 different nonintense smoking regimens are submitted to the FDA for tobacco product review.

Generally, TNCO data obtained under the CFT smoking regimen were due to a historical need when the FTC required tar information to be placed and reported on cigarette brands. Today, the ISO smoking regimen, CFT smoking regimen, and the more intense smoking regimen – Canadian Intense are used to standardize HPHC yields to understand the minimum and maximum constituent yields when a cigarette is consumed. Through better understanding of the differences in the CFT and ISO smoking regimens and their regulatory implications, the FDA will be equipped to make informed decisions about these different smoking regimens and the impact they have in tobacco product review and subsequent decisions for protection of the public's health.

Acknowledgments

All research was supported by internal funds from the Food and Drug Administration (FDA). Use of trade names is for informational purposes only and in no way implies endorsement by the US Government, the US Department of Health and Human Services, or the FDA. The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the FDA. The authors thank Dr Christopher D. Ellison for contributing his expertise in statistical analyses.

References

1. Peeler, CL. Cigarette testing and the Federal Trade Commission: a historical overview. In: National Cancer Institute (NCI). , editor. Smoking and Tobacco Control, Monograph 7 – The FTC Cigarette

Test Method for Determining Tar, Nicotine and Carbon Monoxide Yields of US Cigarettes. Bethesda, MD: NCI; 1994. p. 1-8. Available at: https://can-cercontrol.cancer.gov/brp/tcrb/monographs/7/m7_complete.pdf. Accessed March 22, 2017.

2. Baker RR. The development and significance of standards for smoking-machine methodology. Contributions to Tobacco Research. 2002; 20(1):23–41. Available at: https://www.researchgate.net/publication/284056739_The_Development_and_Significance_of_Standards_for_Smoking-Machine_Methodology. Accessed March 22, 2017.
3. Marian C, O'Connor RJ, Djordjevic M, et al. Reconciling human smoking behavior and machine smoking patterns: implications for understanding smoking behavior and the impact on laboratory studies. Cancer Epidemiol Biomarkers Prev. 2009; 18(12):3305–3320. [PubMed: 19959678]
4. International Organization for Standardization (ISO). Determination of Carbon Monoxide in the Vapor Phase of Cigarette Smoke – NDIR Method. Geneva, Switzerland: ISO; 2007.
5. International Organization for Standardization (ISO). Cigarettes – Determination of Total and Nicotine-free Dry Particulate Matter Using a Routine Analytical Smoking Machine. Geneva, Switzerland: ISO; 2000.
6. International Organization for Standardization (ISO). Cigarettes – Determination of Nicotine in Smoke Condensates – Gas Chromatographic Method. 3rd. Geneva, Switzerland: ISO; 2013.
7. International Organization for Standardization (ISO). Cigarettes – Determination of Water in Smoke Condensates – Gas-chromatographic Method. 2nd. Geneva, Switzerland: ISO; 1999.
8. Federal Register. Harmful and potentially harmful constituents in tobacco products and tobacco smoke; established list. 2012; 77(64):20034–20037. Available at: <https://www.gpo.gov/fdsys/pkg/FR-2012-04-03/pdf/2012-04-03.pdf>. Accessed March 22, 2017.

Figure 1.
Correlation Plot between Tar (Plot A), Nicotine (Plot B), and Carbon Monoxide (Plot C)
Yields under CFT and ISO Smoking Regimens

Table 1

Smoking Specification Comparison between CFT and ISO Regimens

Parameter	CFT	ISO
Puff Volume, (mL)	35 ± 0.5	35 ± 0.3
Puff Duration, (s)	2 ± 0.5	2 ± 0.5
Puff Frequency, (s)	60 ± 0.5	60 ± 0.5
Ventilation Hole Blocking	None	None
Restrictor Required	No	Yes
Air Velocity, (mL/min)	Sufficient to exhaust smoke	200 ± 50
Butt Length, (choose highest value)	Tipping + 3 mm, Or 23 mm from butt	Tipping + 3 mm, Or Filter + 8 mm, Or 23 mm from butt

Table 2

Product Brands and Mean Tar, Nicotine, and Carbon Monoxide Yields (Standard Deviations Shown in Parentheses)

Cigarette Product Brands	Tar (mg/cig)		Nicotine (mg/cig)		Carbon Monoxide (mg/cig)	
	CFT	ISO	CFT	ISO	CFT	ISO
University of Kentucky 3R4F	8.90 (0.4)	7.99 (0.3)	0.776 (0.04)	0.688 (0.03)	11.6 (0.6)	10.1 (0.4)
USA Gold Menthol 100s	13.4 (0.5)	12.5 (0.4)	0.953 (0.03)	0.904 (0.03)	14.3 (0.5)	12.8 (0.5)
Benson & Hedges 100's Menthol Premium	13.8 (0.2)	12.5 (0.6)	1.05 (0.03)	0.995 (0.04)	15.6 (0.6)	13.3 (0.7)
Salem Silver 100s Refreshing Menthol	5.57 (0.2)	5.07 (0.2)	0.465 (0.2)	0.434 (0.02)	10.3 (0.4)	9.03 (0.3)
Newport Box Menthol	16.1 (0.3)	15.0 (0.3)	1.17 (0.02)	1.07 (0.03)	19.1 (0.5)	17.6 (0.5)
Salem Box Refreshing Menthol	16.2 (0.4)	14.7 (0.3)	1.21 (0.03)	1.11 (0.04)	17.2 (0.3)	15.0 (0.4)
Marlboro Menthol Gold Pack	9.95 (0.2)	9.44 (0.3)	0.754 (0.02)	0.708 (0.01)	11.4 (0.2)	10.3 (0.4)
Salem Gold Box Refreshing Menthol	8.95 (0.3)	8.03 (0.2)	0.720 (0.03)	0.643 (0.02)	11.9 (0.3)	10.5 (0.3)
Marlboro Red 100s	15.0 (0.2)	13.8 (0.3)	1.09 (0.02)	1.03 (0.03)	15.8 (0.2)	14.4 (0.4)
Winston Red 100s	14.5 (0.4)	12.9 (0.4)	1.26 (0.05)	1.13 (0.03)	16.2 (0.4)	14.5 (0.4)
Marlboro Gold Pack 100s	10.8 (0.3)	9.53 (0.2)	0.825 (0.03)	0.724 (0.02)	13.3 (0.3)	11.6 (0.3)
Maverick Gold 100s	9.59 (0.3)	8.91 (0.3)	0.723 (0.03)	0.674 (0.04)	11.7 (0.3)	10.4 (0.5)
Marlboro Silver Pack 100s	5.57 (0.1)	5.09 (0.2)	0.474 (0.01)	0.445 (0.01)	8.10 (0.1)	7.36 (0.2)
Doral Silver 100s	5.71 (0.2)	5.30 (0.2)	0.504 (0.02)	0.465 (0.01)	9.58 (0.3)	8.77 (0.5)
Now Gold 100s	1.44 (0.09)	1.37 (0.1)	0.160 (0.01)	0.158 (0.01)	2.59 (0.1)	2.27 (0.05)
Winston White 100s	4.11 (0.08)	3.92 (0.1)	0.415 (0.01)	0.397 (0.02)	6.99 (0.2)	6.48 (0.1)
Carlton White 100s	0.467 (0.08)	0.525 (0.06)	0.059 (0.01)	0.071 (0.01)	1.23 (0.1)	1.08 (0.1)
Marlboro Red Filter Flip Top Box	15.3 (0.4)	13.8 (0.3)	1.06 (0.04)	1.01 (0.04)	15.2 (0.5)	13.3 (0.2)
Winston Red Box	15.0 (0.3)	13.2 (0.4)	1.23 (0.03)	1.13 (0.3)	16.1 (0.3)	14.3 (0.4)
American Spirit	19.7 (0.3)	17.9 (0.4)	2.27 (0.07)	2.00 (0.04)	16.8 (0.3)	14.6 (0.8)
Parliament	8.26 (0.4)	7.74 (0.1)	0.648 (0.03)	0.574 (0.02)	10.6 (0.6)	9.47 (0.6)
Winston Gold Box	9.83 (0.5)	9.03 (0.2)	0.899 (0.03)	0.796 (0.02)	11.9 (0.6)	9.88 (0.6)
Marlboro Menthol Silver Pack	5.18 (0.2)	5.09 (0.2)	0.468 (0.02)	0.430 (0.02)	6.66 (0.3)	6.20 (0.2)
Pall Mall Blue	9.93 (0.3)	9.32 (0.5)	0.870 (0.03)	0.791 (0.04)	10.5 (0.5)	9.28 (0.6)
Merit	7.02 (0.2)	6.47 (0.1)	0.606 (0.02)	0.543 (0.01)	9.85 (0.5)	8.56 (0.5)
True	4.65 (0.2)	4.17 (0.2)	0.423 (0.01)	0.371 (0.02)	5.21 (0.2)	4.72 (0.2)

Cigarette Product Brands	Tar (mg/cig)		Nicotine (mg/cig)		Carbon Monoxide (mg/cig)	
	CFT	ISO	CFT	ISO	CFT	ISO
Virginia Slims	7.72 (0.3)	7.33 (0.1)	0.682 (0.03)	0.616 (0.02)	10.1 (0.5)	9.25 (0.3)
Capri	12.1 (0.3)	10.9 (0.4)	1.14 (0.04)	1.01 (0.03)	11.0 (0.8)	9.40 (0.3)
Camel Filters	15.8 (0.5)	13.8 (0.5)	1.29 (0.03)	1.11 (0.04)	15.2 (0.6)	13.5 (0.5)
Cherokee Red King	18.6 (0.2)	16.9 (0.3)	1.41 (0.03)	1.21 (0.02)	16.4 (0.5)	15.3 (0.4)

Table 3

Linear Mixed Model Results

	Mean Difference	95% Confidence Interval	p-value
Tar	0.895	(0.815, 0.976)	< .001
Nicotine	0.079	(0.071, 0.086)	< .001
Carbon Monoxide	1.299	(1.201, 1.397)	< .001