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Cigarillo and multiple tobacco product use and nicotine dependence in adolescents and young adults

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Abstract

Introduction—Multiple tobacco product (MTP) use is a growing public health concern, particularly among adolescents and young adults. This study identifies subgroups of MTP use among cigarillo users and examines associations with nicotine dependence (ND).

Methods—1,089 youth (ages 14–28) who currently smoke cigarillos completed a web-based survey regarding their current use of cigarillos, little cigars, traditional cigars, cigarettes, e-cigarettes, and waterpipe/hookah. Latent class analysis (LCA) was used to identify patterns of product use by type and amount. The LCA also assessed the relationship between the latent classes and a 38-item measure of ND, controlling for relevant demographics.

Results—Most participants (88.2%) reported using two or more tobacco products in the past 30 days. The best-fitting LCA solution revealed 7 classes: (1) Mixed-Light tipped cigarillo and light cigarette users, 28.9%; (2) Light tipped cigarillo users, 15.8%; (3) Light untipped cigarillo users, 14.3%; (4) Heavy tipped cigarillo users, 13.4%; (5) E-cigarette and waterpipe users, 11.9%; (6)

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Contributors

All authors made a substantial, direct intellectual contribution to this work. All participated in study conceptualization. DG, KJI, and SAF devised the analysis plan. DG conducted the statistical analyses. All contributed to the interpretation of results. KJI drafted the manuscript. SAF, DG, EA, and ET provided critical revisions. All approved the final manuscript as submitted.

Conflict of Interest

The authors have no financial relationships or conflicts of interest to disclose.

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Heavy users of tipped and untipped cigarillos and light users of cigarettes, 9.8%; and (7) Dabblers who primarily used traditional cigars, but were also likely to use a variety of other products, 6.1%. Classes comprised of those using multiple products—particularly those that included cigarettes—had significantly higher levels of ND than other classes (Tukey’s HSD $P < .05$).

Conclusions—Distinct patterns of MTP use are evident among young cigarillo smokers. Smoking multiple products, particularly smoking cigarillos in combination with cigarettes, is associated with higher ND compared to other product use patterns.

Keywords

Latent Class Analysis; Adolescents; Young Adults; Tobacco; Nicotine Dependence

1.0 Introduction

Multiple tobacco product (MTP) use, defined here as concurrent use of more than one tobacco product, is common. In 2013–2014, roughly 40% of all tobacco product users in the US reported using multiple products [1]. MTP has implications for health and nicotine dependence (ND). Understanding the diversity of tobacco products is necessary to inform regulatory activities and public education efforts.

MTP is especially common among adolescents and young adults. For example, among youth age 12–17 who used tobacco in the past 30 days, 23.7% reported using two products and 19.3% reported using three or more products [1]. An estimated 46.2% of tobacco-using young adults (ages 17–25) use two or more products [2]. Data suggest that among youth, MTP may be on the rise. For example, data from the National Youth Tobacco Survey (NYTS) showed a 22.8% increase in the prevalence of MTP use among high school students between 2017 and 2018. In 2018, 41.7% of high school-age current tobacco product users reported the use of 2 or more tobacco products in the past 30 days [3].

MTP has consequences for both harm and addiction. Adult dual cigarette and cigar product (e.g., cigars and cigarillos) users report more ND symptoms than do cigarette-only users [4]. Youth “poly-tobacco” users display increased levels of ND and reduced quitting intentions [5]. Poly-tobacco use has been linked to increased cigarette consumption among non-daily young-adult cigarette smokers [6]. In these and many prior studies, MTP users are considered en masse, overlooking substantial within-group variability. Thus, understanding MTP profiles among youth and their associations with ND can inform efforts to curtail MTP.

Extant knowledge regarding MTP derives largely from studies dominated by cigarette users. Moreover, MTP is often limited to (a) the addition of any non-cigarette product (aka “dual-use”) or (b) a simple count of the number of tobacco products used (aka “poly-tobacco use”). Studies may describe common product combinations, but tend to focus on the correlates and predictors of dual- or polytobacco use [1, 7]. Although valuable in helping to characterize broad patterns of product use, such studies may mute important distinctions among MTP subgroups.

Among young adult tobacco users, 51.5% of single-product users use a non-cigarette tobacco product, but this number exceeds 85% among MTP users [2]. Usage rates for cigar products (including cigarillos) and e-cigarettes are climbing, especially among adolescents and young adults [1, 8]. For example, cigar products were the second most-commonly used product (after e-cigarettes) among high school tobacco users in the 2019 NYTS; among those using multiple products, the most common product combination was e-cigarettes and cigars [8].

Cigarillos are the most popular cigar product [9], and cigarillo use appears to be increasing among youth [10]. The growing prevalence of cigarillo use is concerning because it tends to be concentrated in urban centers among low income, racial/ethnic minority youth [11,12]. Cigarillo users are likely to use other tobacco products [13, 14]. Thus, they represent fertile ground for examining MTP. Yet, due to sampling strategies and measures used in trend (e.g., YRBSS) and cohort studies (e.g., PATH, GfK's KnowledgePanel), cigarillo users are often under-represented. Moreover, users of cigarillos and other cigar products are often combined [15, 16], despite evidence supporting clear distinctions in both product use behaviors and user characteristics [17,18].

The current study utilized latent class analysis (LCA) to: (1) Identify unobserved subgroups (i.e., latent classes) of tobacco product use among adolescent and young adult cigarillo users and estimate the size of and probabilities of membership in these latent classes; (2) Examine the relationship between selected demographic characteristics (race, gender, age) and latent class membership; and (3) Investigate the association between latent class membership and ND.

2.0 Methods

2.1 Study Design & Sample Recruitment

In this cross-sectional, web survey, 1,089 current cigarillo users were recruited in 10 metropolitan areas in the U.S. known to have high rates of cigar product (cigars, cigarillos, or little cigars) use among youth [19]: Baltimore, Maryland; Broward County (Ft. Lauderdale), Florida; Cuyahoga County (Cleveland), Ohio; DeKalb County (Atlanta), Georgia; Detroit, Michigan; Duval County (Jacksonville), Florida; Fort Worth, Texas; Houston, Texas; Philadelphia, Pennsylvania; and Washington, DC. Study recruitment and data collection are described elsewhere [20]. Briefly, participants were recruited via advertisements on Facebook, Instagram, and Twitter. Interested participants completed a screener to determine eligibility. Individuals who (1) smoked at least 2 cigarillos per week, and (2) were age 14–28 were then sent a unique Qualtrics survey link. This age range was designed to be inclusive of high school aged-students, as well as individuals in emerging and young adulthood.

Survey invitations were sent to 3,441 who met study eligibility criteria. Completed surveys were received from 1,511, yielding a 43.9% participation rate which is comparable to rates reported in other online surveys of tobacco use among youth and young adults [21, 22]. Of completed surveys, 72.1% (1,089) were regarded as valid (invalid surveys included duplicate responses, those with cigarillo use below stated eligibility criteria, those with satisficing

response patterns, and those without consent). Respondents received a \$15 gift code to an online retailer. Data were collected from July, 2017 to April, 2018. The Case Western Reserve University IRB approved the study.

2.2 Measures

Demographics included age, gender, and race/ethnicity. Participants were classified as adolescents (ages 14–20) or young adults (ages 21 to 28) in recognition of Tobacco 21 laws which prohibit the sale of tobacco products to those under the age of 21 [23]. Twelve respondents of “Other” gender were grouped with females (the group with whom they were most similar) in order to retain them in the analysis. Race/ethnicity was coded into four categories: White, Black, Hispanic, and Other (including multiracial).

2.2.1 Tobacco use measures—Participants were asked about their use of various tobacco products in the past 30 days, including tipped and untipped cigarillos, little cigars, traditional cigars, cigarettes, e-cigarettes, bidis, clove cigarettes, smokeless tobacco, and waterpipe/hookah. Questions were informed by research illustrating the importance of using brand-specific labels [24, 25] and pictures [26]. Instructions also specified that the product was used only to consume tobacco and not to mix/replace it with marijuana [27–29]. For each product used, participants indicated whether they had used it alone, shared it in a group, or both in the past week. Using a modified timeline follow back method, participants reported the typical number of units used each day of the week. Data were collected separately for use alone and use in a group. Group users also reported the typical group size. We derived a weekly consumption estimate for each product by summing the number of units used alone and used in a group (adjusted for group size). These weekly estimates were then converted to daily averages.

Participant responses were used to create seven indicators for the LCA (see Section 2.3). Due to very low usage rates, smokeless tobacco (6.3%), clove cigarettes (3.1%), and bidis (1.8%) were excluded. Four products with modest rates of use—waterpipe/hookah, little cigars, traditional cigars, and e-cigarettes—were each dichotomized to indicate use (or non-use) in the past 30 days. The remaining products—tipped cigarillos, untipped cigarillos, and cigarettes—were each coded into three levels based on average daily use: No use, Light Use (1 cigarillo or less, 5 cigarettes or less), and Heavy Use (> 1 cigarillo, > 5 cigarettes). These cutpoints are generally consistent with efforts to characterize “light” cigarette use [30, 31] and to quantify cigarillo use [32, 33]. Separate indicators were created for tipped and untipped cigarillos because we anticipated possible differences in patterns of product use on the basis of past research [28, 34]. For example, some users prefer to use untipped cigarillos for smoking marijuana; certain brands even enhance the ease with which the outer shell can be modified [35].

2.2.2 Nicotine dependence (ND)—Existing ND measures were developed and validated with cigarette smokers. The parent grant for this project evaluated a 38-item measure that included 31 items adapted from the PROMIS ND [36], along with 7 items generated based on interviews with cigarillo users [34]. We made the PROMIS items product neutral (i.e., replacing “cigarette” with “tobacco product”) and included all types of

tobacco products in the instruction block. Items were summed to create a total score. Internal consistency reliability was .98. We standardized scores within the current sample and created T-scores ($M=50$, $SD=10$), with higher scores indicating higher ND.

2.3 Data Analysis

Finite mixture modeling is a multivariate technique that identifies unique classes of individuals, based on patterns observed across characteristics or behaviors [37]. LCA is an application of finite mixture modeling for categorical data [37]. We used LCA to uncover underlying subgroups of cigarillo users characterized by different patterns of use of cigarillos and other tobacco products. The seven categorical tobacco use variables (described above) served as manifest indicators of the latent classes. The latent classes identified by LCA are not known a priori, but are determined empirically. A single-class model is specified first. Models with increasing numbers of classes are then compared and the best-fitting model is identified. We compared models with one through eight latent classes.

The optimal class solution was determined by evaluating model fit and comparison indices [38], including the Akaike information criterion (AIC), the Bayesian information criterion (BIC), and the adjusted BIC (aBIC), as well as the bootstrap likelihood ratio test (bLRT). Final model selection was also influenced by the theoretical and practical interpretability of the solutions, class size, and model classification accuracy (i.e., entropy, and diagonal entries in the average latent class probability matrix). The mean predicted probabilities for use (or level of use) of each product within each class helped in assigning class names.

After determining the number of classes, information about classification accuracy was incorporated into a mixture model that simultaneously (a) examined the relationships between demographic covariates (gender, age group, and race/ethnicity) and the latent classes, and (b) used the latent classes to estimate ND T-scores, controlling for the average effects of these covariates. We used a modified 3-step “BCH” approach [39] that retains the measurement error associated with latent class membership. This approach also keeps class membership consistent when adding covariates and yields robust estimates when outcome variance is unequal across classes. Covariate statistical significance was evaluated at $\alpha=.05$ and assessed using the 95% CIs of the odds ratios. Tukey’s HSD test (family-wise $\alpha=.05$) was used to evaluate differences in the estimated ND T-scores of the seven latent classes. All analyses used Mplus version 8 [40].

3.0 RESULTS

The average age of the sample was 22.6 ($SD=2.9$), with the majority (77%) age 21 or older. Just over half (52%) were male. Forty percent identified as White, 31% as Black, and 18% as Hispanic/Latino. The remaining 11% identified as multi-racial or other race.

Table 1 displays rates and/or levels of use for each of the seven tobacco products. Eighty-seven percent of the sample used tipped cigarillos. Among tipped cigarillo users, 55.9% reported smoking 1 or less per day on average (light use), while 44.1% reported smoking > 1 per day (heavy use). Cigarettes were used by 53.7% of participants, with most (70.6%) smoking an average of 5 or fewer per day (light use). Untipped cigarillos were used by

46.6% of the sample, with most (66.9%) reporting light use. E-cigarettes were used by 42.1% and waterpipe/hookah by 36.7%. Fewer participants used traditional cigars (20.8%) or little cigars (19.0%).

MTP was common. The median number of products used by participants was 3 (out of 7). The vast majority of participants (88.2%) used 2 or more products, and 34.5% used 4 or more products. Notably, only one-third of participants reported using both types of cigarillos (i.e., tipped and untipped).

3.1 LCA Results

The 7-class solution was regarded as optimal, based on AIC, aBIC, and bLRT (see Supplemental Table 1). The model's overall entropy value of .75 was substantially higher than models with 3 to 6 classes. When participants were categorized based on their most likely latent class membership, the average latent class probabilities ranged from .66 for Class 7 to .86 for Class 1. Together, these data suggested good classification accuracy overall and across classes. Class sizes were also reasonable and their characterizations interpretable.

Table 2 indicates the prevalence of each class and the predicted probability of use (or level of use) for each tobacco product, conditioned on latent class membership. Class 1, "Mixed—Light Tipped & Light Cigarette Users," was the largest (28.9% of the sample). Members had moderate probabilities of light use of tipped cigarillos and cigarettes. Given a very high probability of light tipped cigarillo use, Class 2 members (15.8%) were dubbed "Light Tipped Users." They also had a moderate probability of using waterpipe/hookah. Class 3 members (14.1%) were "Light Untipped Users," owing to a high probability of light untipped cigarillo use. Class 4 (13.5%) was labeled "Heavy Tipped Users," given a high probability of heavy tipped cigarillo use and very low probabilities of using other products. We labeled Class 5 (11.9%) "E-cig/Waterpipe Users," given very high probabilities of using both e-cigarettes and waterpipe/hookah; members also had moderate probabilities of light tipped cigarillo and cigarette use. Members of Class 6 (9.7%) had fairly high probabilities of heavy use of both types of cigarillos, as well as a moderate probability of light cigarette use; they were labeled "Heavy Untipped & Tipped Cigarillo Plus Light Cigarette Users." Class 7, the "Traditional Cigar/Dabblers," was the smallest class (6.1%). Members had a very high probability of using traditional cigars, but also moderate to high probabilities of using several other products including tipped and untipped cigarillos (light use), cigarettes (light use), waterpipe/hookah, little cigars, and e-cigarettes. (Supplemental Figure 1 graphs the probabilities of use for each product, conditioned on latent class membership).

3.2 Association of Latent Classes with Demographic Characteristics

Table 3 presents the observed distributions of gender, age group, and race/ethnicity in the overall sample and within each latent class. All three demographic covariates were significantly related to latent class membership in the mixture model. Refer to Supplemental Table 2 for details, as results are summarized only briefly here. In general, males were more likely to be Traditional Cigar/Dabblers (Class 7) and Heavy Untipped & Tipped/Light Cigarette Users (Class 6). Young adults were more likely to be members of Class 1 (Mixed-

Light Tipped/Light Cigarette Users) or Class 6 (Heavy Untipped & Tipped/Light Cigarette Users). Compared to Whites, Blacks were more likely to be in classes distinguished by high probabilities of tipped cigarillo use, including Class 2 (Light Tipped), Class 4 (Heavy Tipped), and Class 6. Hispanics were more likely to be in Class 6 than in either Classes 1 or 2. Those of other race were more likely to be in either Class 3 (Light Untipped) or Class 4 than in Class 1.

3.3 Associations with Nicotine Dependence

Observed ND T-scores ranged from 34.4 to 74.8. Figure 1 shows the estimated ND T-scores for each latent class, controlling for gender, age group, and race/ethnicity. Classes are ordered by score along the X-axis. Bars with different fill patterns indicate classes with significantly different ND T-scores. The seven classes clustered into four ND levels. Light Tipped Users (Class 2) had the lowest ND, with an estimated T-score between the 25th and 30th percentiles. Heavy Untipped & Tipped Cigarillo Plus Light Cigarette Users (Class 6) had the highest ND, scoring in the 80th percentile. The mean difference in scores between these two classes was 19.8 (~2 SD units). Light Untipped Users (Class 3) had slightly higher ND than Class 2 (~0.6 SD units), but lower ND than all other classes and a T-score below the median. Yet, the ND T-score of Class 3 was still 1.4 SD units lower than that of Class 6. The remaining four classes had estimated ND T-scores between the 50th and 75th percentiles, falling 0.5–0.8 SDs below Class 6, but more than 1 SD above Class 2.

Gender was the only demographic variable significantly related to ND. On average, males had ND T-scores that were 4 points lower than females ($b=-4.08$, $SE=0.61$, 95% CI: -5.28 , -2.88).

4.0 DISCUSSION

The majority (88.2%) of young cigarillo smokers in this study were MTP users. LCA identified seven classes that were unique, clinically interpretable, and statistically sound. Five of the seven classes were characterized by concurrent use of MTP. Three of these classes—1, 2, and 6—were distinguished by moderate to high probabilities of using two to three products. Together, these three classes accounted for over half (54%) of the sample. Two remaining MTP classes—E-cigarette/Waterpipe Users (Class 5) and Traditional Cigar/Dabblers (Class 7)—comprised 18% of the sample. While they had high probabilities of using a specific product, Class 5 and 7 members were also likely to use several other products. MTP users were dispersed across five latent classes, each displaying a unique product combination (or level of use). These findings suggest that MTP is not a monolith, but rather a complex phenomenon with distinct phenotypes.

This work adds substantially to the extant literature by including a wide array of products and assessing variability in daily consumption of cigarillos and cigarettes. Our work contrasts with prior research that has combined cigarillos with little cigars [41] and/or traditional cigars [15], potentially masking important variations in product use. By focusing on cigarillo users, our study also moves beyond prior work in which MTP has been limited to the use of one or more products in combination with cigarettes [16, 42].

Variability in both cigarillo type (tipped or untipped) and daily consumption were important defining characteristics in this LCA. Just one-third of participants reported using both tipped and untipped cigarillos. Those who used both tended to be heavy users of both. Two classes were distinguished by the exclusive use of either type of cigarillo. With the exception of light untipped cigarillo use by Traditional Cigar/Dabblers (Class 7), use of tipped cigarillos was part of the product profile for all MTP classes. The heterogeneity observed among cigarillo users affirms the importance of collecting detailed product use information. Different patterns of use were also seen for other cigar products: Dabblers were most likely to use traditional cigars, and were the only group with a substantial probability of using little cigars. These data highlight the need to assess products separately, rather than aggregating all “cigar products”—a recommendation endorsed by others [17, 43].

Variation in daily cigarette consumption also factored into this LCA. Cigarette smoking has been dichotomized in many prior LCAs [41, 44]. Cigarette consumption in the current sample was fairly light (i.e., 5 or less per day). Yet, cigarettes were in the product profile of four of the seven classes. Moreover, cigarette use featured prominently for all but one class of MTP users (Class 2, Light Tipped Users). This raises important questions about the potential pathways taken by some youth toward more regular and heavier use of cigarettes.

ND was generally higher among MTP classes than among classes using cigarillos only. This is consistent with prior research documenting higher ND among MTP versus single-product users [5] and even cigarette-only users [4, 45]. This is important, as initiation of a second or subsequent tobacco product may propel users more quickly toward addiction. Because cigarettes were used by four of five MTP classes, cigarette consumption patterns among MTP users warrants further study. MTP users may rely on cigarettes to quell nicotine cravings and withdrawal symptoms [27].

Gender was related directly to ND, with females displaying higher ND than males. This finding is consistent with some studies [46]; however, others have found either no difference [47], or a difference in the opposite direction [48]. Contextualizing this finding is difficult due to a lack of comparable samples and measures of dependence across studies.

Gender, race, and age were each associated with latent class membership. Males were more heavily concentrated in two MTP groups—Dabblers and Heavy Untipped & Tipped/Light Cigarette users. Blacks and Hispanics were more concentrated in the Heavy Untipped & Tipped/Light Cigarette MTP group. Members of this class and the Mixed—Light Tipped/Light Cigarette class also tended to be older. However, the associations between demographics and latent class membership defied simple characterization. Minority race, for instance, was not uniformly associated with MTP: Blacks were more likely to be Heavy Tipped Cigarillo Users (a single product group) than to be in any other group. These results may shed light on prior inconsistent findings regarding MTP: Some studies find MTP more common among Whites [49], while others find MTP more common among non-Whites [10].

Both findings may be correct, depending on the constellation of products used to define MTP. The existence of multiple MTP groups and their diverse associations with demographics and ND have several practical implications. First, these findings highlight the

importance of screening broadly for tobacco use, especially among youth. Health care providers should ask about the use of all tobacco products, including tipped and untipped cigarillos and e-cigarettes. Building on the methodological strategies used here and in other studies [e.g., 25], screening might be improved by making use of standard product images and associated brand names. Second, the extent of MTP use observed among these cigarillo users and the association of MTP with greater ND reinforce the need to routinely assess and monitor MTP use, as well as symptoms of nicotine withdrawal and dependence. Notably, ND symptoms were reported by users whose consumption of one or more individual products was fairly light. MTP users who wish to reduce or curtail use of one or more products may require additional support. Third, the current findings suggest the need to craft tobacco-related health messages with care. Messages regarding the harms of MTP and addiction may be more effective if they are tailored to specific groups and consider their product preferences and patterns of use. Finally, given the extent and complexity of MTP among cigarillos users, regulatory changes that are inclusive of multiple tobacco products seem warranted. For example, packaging and flavor restrictions could be expanded to include tipped and untipped cigarillos, potentially limiting their attractiveness to adolescents and young adults. Similarly, prevention and education campaigns that communicate the harms of using any and all tobacco products may prove most effective.

4.1 Limitations

Although these findings expand our understanding of MTP use among cigarillo users, several limitations merit mention. The use of social media-based convenience sampling may limit generalizability. However, we selectively targeted metropolitan areas throughout the US with high levels of youth cigar product use, yielding a fairly diverse and unique sample.

Our primary sampling frame comprised cigarillo users; thus, we cannot comment on patterns of MTP use that exclude cigarillos. Our findings are also limited to the most commonly-used combustible tobacco products and e-cigarettes. Although we assessed smokeless tobacco and clove cigarette use, these products were used too infrequently to include them meaningfully in the LCA.

We did not include marijuana in the LCA because of our focus on patterns of tobacco use and ND. The widespread use and modification of cigar products (especially cigarillos) to smoke marijuana is amply documented [27, 50, 51]. A notable strength of this study is that we instructed participants to report on products used solely to consume tobacco.

Adolescents and young adults were combined in the current LCA. Age was included a covariate in the analyses. Although age was not significantly related to ND, it was associated with membership in some classes, with young adults more heavily concentrated in classes using both tipped cigarillos and cigarettes. Latent class structure and composition could conceivably vary by age group; however, testing a multi-group LCA would require a much larger adolescent subgroup.

Because LCA is exploratory, replication with other samples is warranted. Overall entropy for the 7-class model (.75) was below a commonly-cited value of .80 [52]. However, classification quality as measured by entropy can be very context dependent, leading some

[37] to eschew its use in model selection. Finally, although we conceptualized and modeled ND as a distal outcome, the cross-sectional nature of these survey data prohibits causal inference.

4.2 Implications for Future Research

The current study provides a unique perspective on MTP among young cigarillo users and suggests several avenues for research. There is a need to better understand pathways to MTP. For example, does the MTP emerge early in an individual's tobacco use career, or does it evolve slowly, and over what timeframe? What factors influence youth to initiate use of a second or third product? Longitudinal data are required to examine how patterns of MTP are created and sustained into adulthood. Latent transition analysis may prove useful in this regard, and several groups are beginning to explore such transitions [e.g., 6, 53, 54]. Longitudinal analyses may also help to disentangle the complex relationships that likely exist among chronological age, tobacco use history, and nicotine dependence. In addition to encouraging greater breadth and depth in measuring product use, the current study underscores the importance of examining MTP among community-dwelling youth. Finally, in light of the growing trend toward the legalization of marijuana for adults, future research should explore marijuana use in relation to youth MTP.

5.0 CONCLUSIONS

We conclude that among young cigarillo users, MTP is common. Yet, MTP users do not comprise a homogenous group. Their unique product use patterns and associated characteristics may require a range of approaches to both prevent and reduce tobacco use and dependence.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Cross-sectional web survey of 1,089 adolescent and young adult cigarillo users
- 7 distinct tobacco product use patterns identified using latent class analysis
- 5 of 7 patterns characterized by use of multiple tobacco products
- Multi-product use tied to higher nicotine dependence, especially if cigarettes used

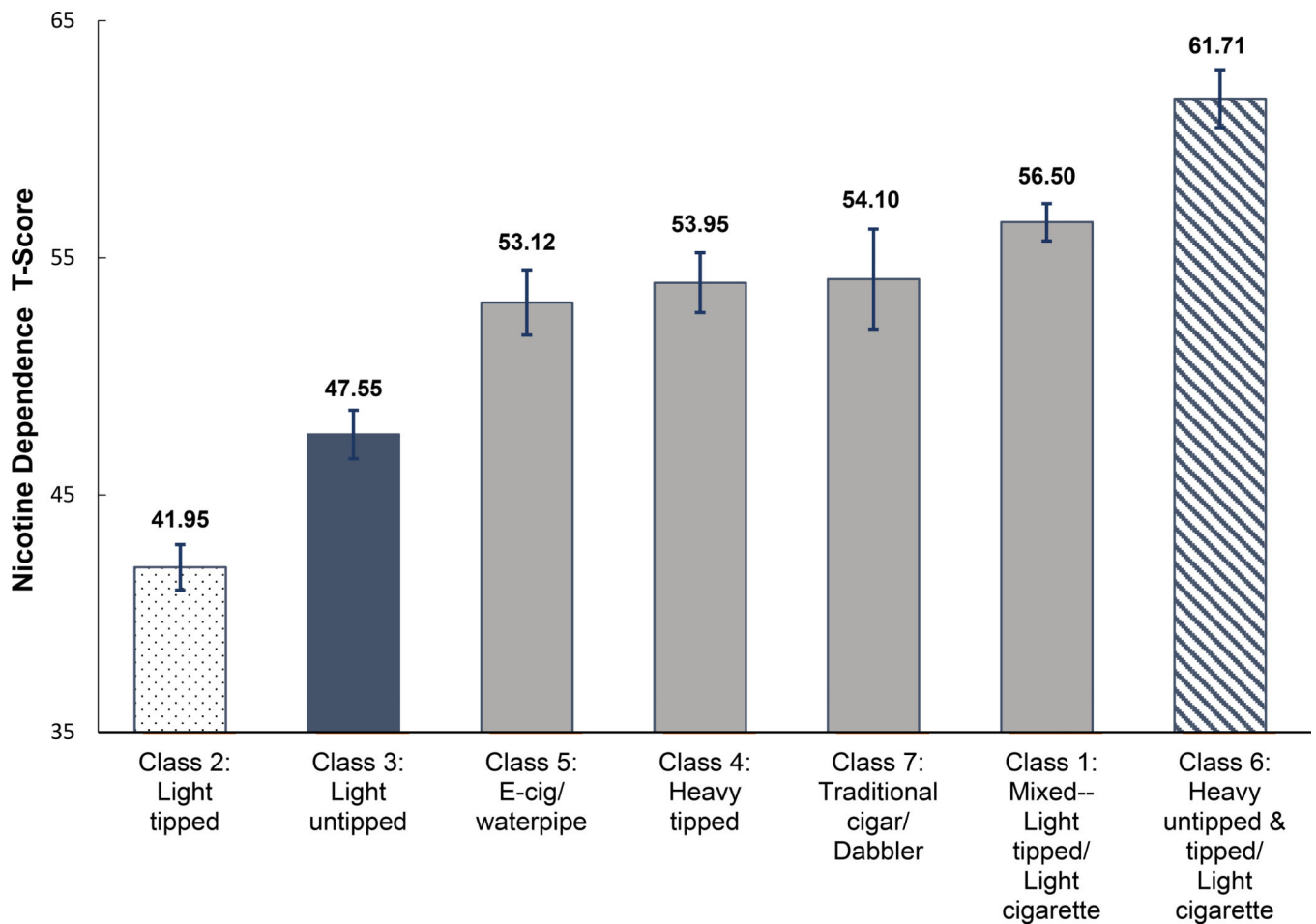


Figure 1.

Estimated Mean Nicotine Dependence (ND) T-Score for Each Latent Class, Controlling for Gender, Age Group, and Race/Ethnicity

Note. Vertical error bars represent + and - 1 SE. Classes are ordered along the X-axis on the basis of ND T-Score, from lowest to highest. Classes represented by bars with different fill patterns have ND T-Scores that differ from each other, based on Tukey's HSD (family-wise alpha = .05): All pairwise comparisons involving Classes 2, 3, and 6 were significant; whereas no pairwise comparisons were significant among Classes 1, 4, 5, and 7.

Table 1.Tobacco Product Use in the Past 30 Days: Indicators Used in Latent Class Analysis ($N = 1089$)

Product	No Use		Any Use or Light Use ^{1,2}		Heavy Use ^{1,2}	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Little Cigars	882	81.0%	207	19.0%		
Traditional Cigars	863	79.2%	226	20.8%		
Waterpipe/Hookah	689	63.3%	400	36.7%		
E-Cigarettes	630	57.9%	459	42.1%		
Tipped Cigarillos ¹	145	13.3%	528	48.5%	416	38.2%
Untipped Cigarillos ¹	581	53.4%	340	31.2%	168	15.4%
Cigarettes ²	504	46.3%	413	37.9%	172	15.8%

Note. Within each row, percentages may not add to 100 due to rounding.

¹For tipped and untipped cigarillos: Light use = 1 or less per day, Heavy use = more than 1 per day.

²For cigarettes: Light use = 5 or less per day, Heavy use = more than 5 per day.

Table 2.

LCA 7-Class Solution: Probabilities of Product Use and Class Membership

Product	Level of Use	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7
Little Cigars	No Use	0.740	0.991	0.947	0.985	0.771	0.611	0.464
	Use	0.260	0.009	0.053	0.015	0.229	0.389	0.536
Traditional Cigars	No Use	0.861	0.746	0.806	0.993	0.793	0.853	0.000
	Use	0.139	0.254	0.194	0.007	0.207	0.147	1.000
E-cigarettes	No Use	0.612	0.717	0.566	0.844	0.000	0.565	0.495
	Use	0.388	0.283	0.434	0.156	1.000	0.435	0.505
Waterpipe/Hookah	No Use	0.871	0.496	0.625	0.741	0.000	0.697	0.442
	Use	0.129	0.504	0.375	0.259	1.000	0.303	0.558
Tipped Cigarillos	No Use	0.000	0.000	0.674	0.000	0.000	0.286	0.000
	Light Use (1/day)	0.584	0.961	0.326	0.000	0.639	0.055	0.738
Untipped Cigarillos	Heavy Use (1/day)	0.416	0.039	0.000	1.000	0.361	0.659	0.362
	No Use	0.824	0.807	0.000	0.795	0.381	0.000	0.415
Cigarettes	Light Use (1/day)	0.176	0.164	0.790	0.133	0.371	0.254	0.585
	Heavy Use (1/day)	0.000	0.029	0.210	0.071	0.247	0.746	0.000
Cigarettes	No Use	0.156	0.943	0.592	0.951	0.290	0.181	0.333
	Light Use (5/day)	0.561	0.057	0.408	0.026	0.506	0.505	0.462
Class Label	Heavy Use (5/day)	0.283	0.000	0.000	0.024	0.204	0.314	0.205
	Mixed-Light tipped/ Light cigarette		Light tipped	Light untipped	Heavy tipped	E-cig/Waterpipe	Heavy untipped & tipped/Light cigarette	Traditional cigar/Dabbler
Class Size, n (%)		315 (28.9%)	172 (15.8%)	154 (14.1%)	147 (13.5%)	129 (11.9%)	106 (9.7%)	66 (6.1%)

Table 3. Observed Distribution of Demographic Characteristics (Covariates) in the Overall Sample (N = 1089) and Within Each Latent Class

	Entire Sample		Class														
	N = 1089		Class 1 n = 315		Class 2 n = 172		Class 3 n = 154		Class 4 n = 147		Class 5 n = 129		Class 6 n = 106		Class 7 n = 66		
	n	col%	n	col%	n	col%	n	col%	n	col%	n	col%	n	col%	n	col%	
Gender																	
Female ¹ (ref)	521	47.8	149	47.3	92	53.5	68	44.2	84	57.1	69	53.5	42	39.6	17	25.8	
Male	568	52.2	166	52.7	80	46.5	86	55.8	63	42.9	60	46.5	64	60.4	49	74.2	
Age Group																	
21 or Over (ref)	839	77.0	253	80.3	128	74.4	112	72.7	114	77.6	93	72.1	91	85.8	48	72.7	
Under 21	250	23.0	62	19.7	44	25.6	42	27.3	33	22.4	36	27.9	15	14.2	18	27.3	
Race/Ethnicity																	
White (ref)	436	40.0	156	49.5	64	37.2	63	40.9	25	17.0	56	43.4	38	35.8	34	51.5	
Black	335	30.8	73	23.2	70	40.7	35	22.7	94	64.4	24	18.6	30	28.3	9	13.6	
Hispanic	196	18.0	54	17.2	20	11.6	31	20.1	14	9.6	32	24.8	28	26.4	17	25.8	
Other	120	11.0	31	9.9	18	10.5	25	16.2	13	8.9	17	13.2	10	9.4	6	9.1	
Missing ²	2	0.2	1	0.3					1	0.7							

¹Twelve participants who identified as “Other” gender were grouped with Females in order to retain them in the analysis.

²Two participants missing on race/ethnicity were excluded from the final LCA mixture model.