Identifying E-Cigarette Person and Session Types Using Real-World Puff Topography

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  - The authors have no conflicts of interest

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Background

- Researchers examine combustible cigarette topography (frequency and intensity of puffing behavior) but comparatively little is known about e-cigarette topography
- E-cigarette topography impacts nicotine delivery and contents of aerosol emissions
- Critical to examine users' behavior in naturalistic rather than lab settings
- Need to characterize both puff and session characteristics because user behavior and device functionality can change during a session (e.g., as coil heats up)

Purpose

- Characterize person- and session-level puffing patterns for second generation e-cigarettes in a naturalistic setting

- Consider implications of findings for aerosol testing protocols and understanding exposure to chemicals in e-cigarette aerosol

Methods

Participants & Procedures

- Experienced adult e-cigarette users (n = 34) recruited in 2016 in Rochester, NY
- Two-week testing period with wireless personal use monitor (wPUM) attached to second generation “vape pen”
- Randomly assigned to flavor: tobacco for 1 week and menthol/mint or berry for 1 week (order of weeks also randomly assigned)
- Nicotine concentration was matched to participant’s usual level (6, 12, or 18 mg/ml)
- Online surveys at enrollment and completion plus brief daily and weekly behavioral assessments

Figure 1. Portable Use Monitor (wPUM) on an e-cigarette

Measures

- Puff characteristics
  - Puff duration in seconds (s)
  - Puff interval (time between puffs) in seconds (s)
  - Puff volume in milliliters (ml)
  - Puff flow (outflow of vapor calculated as volume divided by duration) in ml/s

- Session characteristics
  - Day of week
  - Time of day
  - Number of puffs per session

Sample Characteristics

Total Sample: N=34 current pen-style e-cigarette users

- Sex
  - Males: 32 (94%)
  - Females: 2 (6%)
- Reported Usual Nicotine Concentration
  - Low 6 mg/ml: 20 (60%)
  - Med 12 mg/ml: 7 (20%)
  - High 18 mg/ml: 7 (20%)
- Age
  - Age Range: 18-63 years old
  - Mean Age: 27 years old

Analyses

- Multilevel latent profile analysis (MLPA) to characterize classes of person and session
- Classes based on average puff duration, volume, and flow and average puffs per session
- Total of 957 sessions across participants
- Iterative MLPA models added classes of person and session until no improvements in model fit
- Model parameters:
  - Person-class membership probabilities
  - Session-class membership probabilities
  - Conditional means of puff characteristics across session classes
- Included dummy indicators for flavor, time of day, and day of week in multinomial logistic regression simultaneously with class membership modeling

Results

Model Fitting

- Started with base model of 2 person-classes and 2 session-classes (“2,2”)

Person Classes	Session Classes	BIC
2	2	38309
3	2	38049
2	3	38313

- Number of person-classes
  - Superior model fit when increased to 3 classes
  - Model fit further improved for >3 but solutions inadmissible
    - too many parameters and lack of variability within classes

- Number of session-classes
  - 3 class model had worse fit

- Final model = 3 person-classes and 2 session-classes (“3,2”)

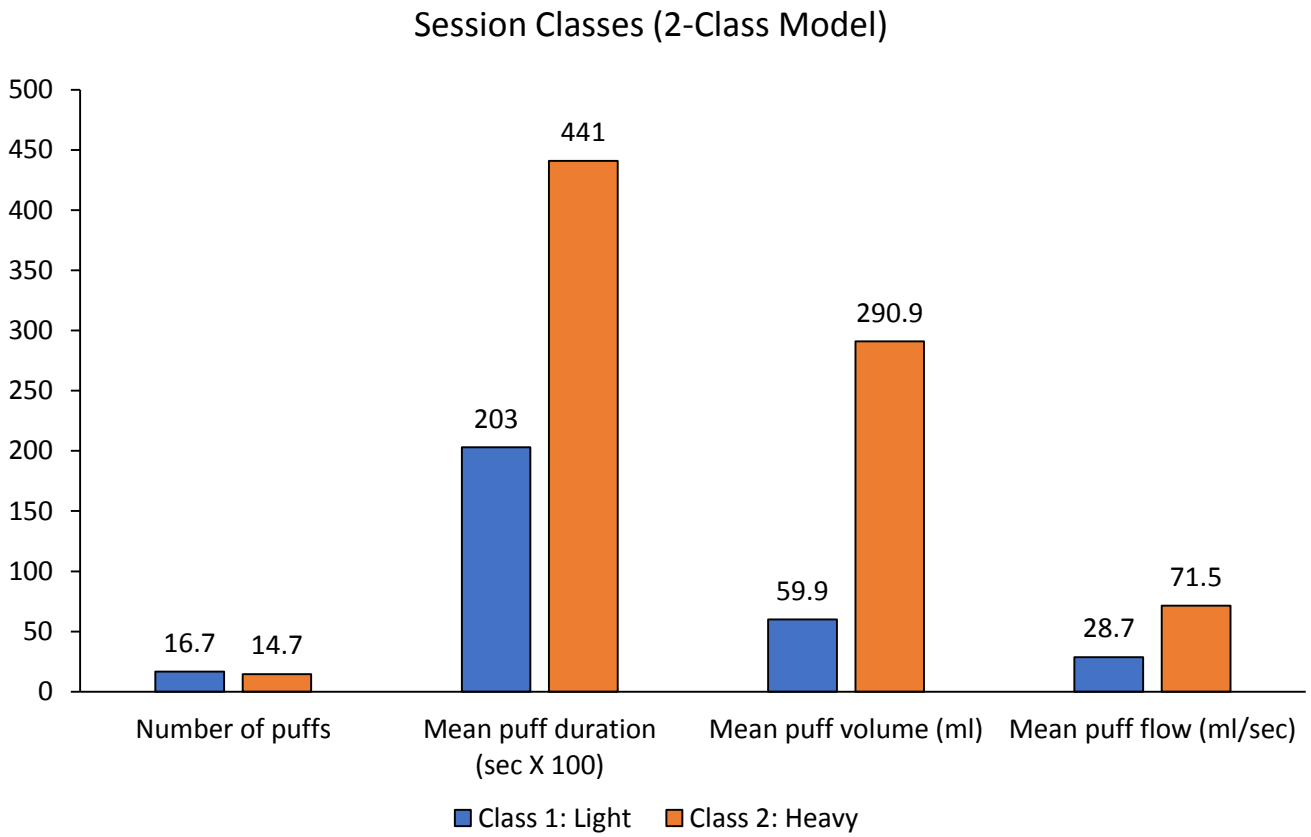
Session Classes

Session class 1 = Light

- Low puff flow and puff volume
- Average puff duration ~2 seconds

Session class 2 = Heavy

- Higher puff flow (almost 2x) and puff volume (almost 5x)
- Average puff duration ~4 seconds



Person Classes

- Defined by relative proportions of session types:
  - Class 1 = predominantly heavy sessions
  - Class 2 = almost exclusively light sessions
  - Class 3 = predominantly light sessions

	N (%) of sessions that are "Light"	N (%) of sessions that are "Heavy"
Person Class 1 (n = 2)	13 sessions (39.3%)	20 sessions (60.7%)
Person Class 2 (n = 20)	640 sessions (98.0%)	13 sessions (2.0%)
Person Class 3 (n = 12)	196 sessions (75.3%)	64 sessions (24.7%)

Other Effects on Session Type

- Flavor
  - No differences by flavor in probability of session class occurrence
- Time of day
  - In the afternoon/evening (12 pm–6 pm), more likely to observe “heavy” sessions than “light” sessions (b = .615 (.323), t = 1.906, p = .057)
- Day of week
  - More “light” sessions on Thursdays than on Saturdays (reference day) (t = 2.896, p = .004)

Discussion

Discussion

- There are different, classifiable types of e-cigarette users who engage in distinct puffing patterns
- Engaging in more “heavy” sessions (greater puff duration and volume) could result in greater exposure to harmful emissions for some users
- Benefits of this study over previous studies include
  - A naturalistic setting
  - Multiple weeks of observation
  - Standardized devices and e-liquids were used to avoid confounding
- Limitations include that the study
  - May not generalize to more advanced vaping devices
  - Did not collect data on cigarettes smoked per day or CO levels
  - Used a non-representative sample, mostly young adult male college students
  - Had limited sample size for analyzing person-level characteristics, such as smoking status or demographics

Future Directions

- Results can
  - Inform our understanding of variations in user behavior
  - Suggest how variations in behavior could result in variations on exposure to harmful emissions

- Future studies might
  - Compare device types, including advanced “mods”
  - Examine how characteristics of users (e.g., age, smoking history), products (e.g., e-liquid type, device brand), or the environment (e.g., location) might influence puffing behavior

- Regulatory implications
  - Variation in user behavior could influence individual- or population-level health effects.
  - Regulation of products and public education efforts may benefit from improved understanding of variation in user behavior.

Questions?

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