Environmental exposure to emissions from emerging nicotine delivery devices

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Secondhand emissions from ENDS devices

Systemic absorption in bystanders

Potential health effects in bystanders
SECONDHAND EXPOSURE FROM ENDS VS. TOBACCO CIGARETTES

• We compared secondhand exposure with ENDS emissions and tobacco smoke generated by 5 dual users.

• We measured selected airborne markers of secondhand exposure: nicotine, aerosol particles (PM$_{2.5}$), carbon monoxide, and volatile organic compounds (VOCs) in an exposure chamber.

• The study showed that e-cigarettes are a source of secondhand exposure to nicotine but not to combustion toxicants.

Source: Czogala et al. Nicotine Tob Res; 2014
Pilot data highlighted that differences in products and behavior can contribute to possible secondhand and thirdhand exposure to nicotine.
## STUDY OBJECTIVES

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<th>Evaluation</th>
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<td>1. Puffing Behavior</td>
<td>Visual assessment</td>
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<td>2. Particulate Matter (PM$_{2.5}$)</td>
<td>TSI personal aerosol monitor</td>
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<td>3. Airborne Nicotine</td>
<td>Sorbent tube sampling/ GC-NPD</td>
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<td>4. Surface Nicotine</td>
<td>Surface wipe sampling/ GC-MS</td>
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STUDY DESIGN

- Smokers are randomized to the order of the e-cigarette devices
- Take assigned device home to practice using before next study visit
- Session #2-7 participants puff on assigned device every 30 seconds for 10 minutes (20 puffs total)
PRODUCTS

Disposable
- 1.8%

Rechargeable
- 2.4%

E-Cigar
- 1.8%

E-Go
- 2.4% e-liquid

Vaporizer (MOD)
- 2.4% e-liquid

E-Pipe
- 2.4% e-liquid
Particulate Matter (PM$_{2.5}$) Sampling

Airborne Nicotine Sampling

XAD-4 sorbent tube

Surface Nicotine Sampling - Wall

Surface Nicotine Sampling - Floor
METHODS

START

10 Minute Smoking/Vaping Session

10 Minute Baseline

10 Minute Post Session

Video Record Smoking/Vaping Session

Collect Baseline Surface Wipe Samples

Collect Post Session Surface Wipe Samples

Post Surface Nicotine Sampling

GilAir Pump ON

GilAir Pump OFF

Baseline Surface Nicotine Sampling

Particulate Matter, PM$_{2.5}$ Sampling

STOP Airborne Nicotine Sampling

START Airborne Nicotine Sampling
RESULTS: PUFFING BEHAVIOR

Tobacco Cigarette  Disposable  MOD
RESULTS

Cigarette* Control Emissions Profile

*Calculated Using Calibration Factor = 0.32
Real-Time PM$_{2.5}$ Emissions for One Participant, by Product

**Rechargeable**

**e-Go**

**Disposable**

**e-Pipe**

**Vaporizer**

**e-Cigar**

**Real-time PM$_{2.5}$ Emissions**
Average Crude PM$_{2.5}$ Emissions per Session by Product Type

*Borderline Significant by paired t-test (p=0.053). All other differences in emission between before and during session groups were statistically significant (p < 0.05).
Adjusted* Average PM$_{2.5}$ Emitted During Session by Product

*Adjusted defined as Average PM$_{2.5}$ during session less average PM$_{2.5}$ before the session
Dashed Line = 12.1 µg/m$^3$ = Mean PM$_{2.5}$ (µg/m$^3$) emitted across all products
†: Mean PM$_{2.5}$ was significantly different from Rechargeable by LSD Test (p<0.05)
RESULTS: AIRBORNE NICOTINE

Average Nicotine Detected During 1 Hour Sampling Period ($\mu g/m^3$)
RESULTS: PUFFING BEHAVIOR

Three different participants using a MOD

Participant 1

Participant 2

Participant 3
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<th>Airborne Nicotine</th>
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<tr>
<td>• Varies based on the product used and by the participant</td>
<td>• 23% of sorbent tubes contained detectable amounts</td>
</tr>
<tr>
<td>• The more palatable the product, the greater amounts of aerosol released</td>
<td>• Pipe had the highest amount of detectable airborne nicotine and rechargeable device had the lowest</td>
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<th>Particulate Matter (PM$_{2.5}$)</th>
<th>Surface Nicotine</th>
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<td>• Rechargeable device released the greatest amount and the disposable device released the lowest</td>
<td>• No detectable nicotine found</td>
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<td>• Aerosol lingered in the air after vaping session was complete</td>
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Secondhand emissions from ENDS devices → Systemic absorption in bystanders → Potential health effects in bystanders
Six nonusers of nicotine-containing products were exposed to secondhand aerosol from ad libitum ENDS use by three vapers for 2 h during two separate sessions (disposables, tank-style).

Pre-exposure (baseline) and post-exposure peak levels (Cmax) of cotinine were measured in nonusers’ serum over a 6-hour follow-up.

Median changes in cotinine for disposable exposure were **0.007 ng/ml** serum.

For tank-style exposure they were **0.041 ng/ml** serum.
Secondhand emissions from ENDS devices

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SECONDHAND ENDS AEROSOL EXPOSURE AND ASTHMA EXACERBATIONS AMONG YOUTH WITH ASTHMA


- Youth who participated in the 2016 Florida Youth Tobacco survey (aged 11-17 years) with a self-reported diagnosis of asthma (N = 11,830) reported asthma attacks in the past 12 months, demographic characteristics, cigarette use, cigar use, hookah use, ENDS use, past 30-day secondhand smoke exposure, and past 30-day secondhand ENDS aerosol exposure.

- Overall, 21% of youth with asthma reported having an asthma attack in the past 12 months, and 33% reported secondhand ENDS aerosol exposure.

- Secondhand ENDS aerosol exposure was associated with higher odds of reporting an asthma attack in the past 12 months, adjusting for covariates (adjusted OR, 1.27; 95% CI, 1.11-1.47).

Limitations:

- Causality cannot be established: The cross-sectional study design limits ability to determine the temporal sequences between secondhand exposure to ENDS aerosols and asthma exacerbations

- Recall bias: not all youth may be aware of their asthma status and secondhand exposures

- Secondhand exposure to ENDS aerosols was measured in the past 30 days, whereas asthma attacks were measured within the past 12 months
FUTURE DIRECTIONS

• Future research should examine the chemical composition of aerosol from ENDS devices.

• Future research should also investigate realistic *ad lib* ENDS product usage

• Increasing the total exposure period and the number of participants may allow for more accurate modeling of real-world ENDS product usage and resulting aerosol emissions

EXPOSURE = CONCENTRATION x DURATION